



**Mining Area C - Southern Flank  
Environmental Impact Assessment of  
Short-range Endemic Invertebrates**

**BHP Billiton Iron Ore Pty Ltd**

**November 2016**



## Mining Area C Southern Flank

### Environmental Impact Assessment of

### Short-range Endemic Invertebrates

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## EXECUTIVE SUMMARY

Mining Area C is located approximately 100 km north west of Newman in the Pilbara region of Western Australia (Figure 1.1). BHP Billiton Iron Ore is currently preparing a Public Environmental Review document to develop satellite orebodies at Southern Flank, located approximately 8 km south of the existing Mining Area C operations (the Proposal). The Proposal will require additional ground disturbance within the existing approved Mining Area C development envelope and the development of the proposed new satellite deposits at Southern Flank within an Additional Development Envelope. For the purposes of impact assessment, areas proposed to be disturbed are referred to as the Indicative Additional Impact Assessment Area. The focus of this assessment relates to potential impacts to short-range endemic (SRE) fauna within the Additional Development Envelope and Indicative Additional Impact Assessment Area. Cumulative impacts associated with areas previously approved for mining within the Proposed Mining Area C Development Envelope have also been considered.

There have been eight SRE fauna surveys undertaken within the Proposed Mining Area C Development Envelope, four completed baseline SRE sampling (collecting all SRE fauna), one undertook both baseline and targeted millipede *Antichiropus* 'DIP007' sampling, one undertook just targeted millipede *Antichiropus* 'DIP007' sampling and two completed habitat assessments only. Overall, the extent of SRE fauna sampling and habitat assessments within the Proposed Mining Area C Development Envelope can be regarded as sufficient for the purposes of mapping SRE habitats and fauna distributions for the impact assessment, and to meet the requirements of current Environmental Protection Authority (EPA) guidance.

Four confirmed SRE taxa and one potential SRE taxon have been recorded within the Additional Development Envelope; *Antichiropus* 'DIP007', *Austrostrophus* 'DIP018', *Yilgarnia* 'MYG197', *Kwonkan* 'MYG339-DNA', and Barychelidae indet. (juv.) (potential SRE). All but Barychelidae indet. (juv.) were recorded within the Indicative Additional Impact Assessment Area.

*Austrostrophus* 'DIP018', *Yilgarnia* 'MYG197', and Barychelidae indet. (juv.) have been recorded outside of the Proposed Mining Area C Development Envelope. *Kwonkan* 'MYG339-DNA' has been recorded beyond the Additional Development Envelope, but the majority of records are only known from the Indicative Additional Impact Assessment Area. All records of this species were recorded within drainage habitats, therefore, the taxon is considered very likely to occur beyond the Proposed Mining Area C Development Envelope due to the wider extent and high connectivity of these habitat types. The Proposal is expected to have a low impact on all of these species.

There are five confirmed records of *Antichiropus* 'DIP007', four of which occur within the Indicative Additional Impact Assessment Area. Eighteen other indeterminate records of juvenile or female specimens were collected and are considered likely to be *A.* 'DIP007' owing to their location in the same, or similar connected habitats as the adult male *A.* 'DIP007' specimens. Twelve of these specimens were recorded outside of the Indicative

Additional Impact Assessment Area (within the Proposed Mining Area C Development Envelope), and one was recorded outside of the Proposed Mining Area C Development Envelope. The estimated extent of suitable habitat for *Antichiropus* 'DIP007' is limited to the south, west and north and covers approximately 7089.7 ha. Approximately 3859.2 ha (54.4%) occurs within the Indicative Additional Impact Assessment Area. The remaining area occurs primarily to the north of the Indicative Additional Impact Assessment Area, with smaller areas also occurring to the east. The direct removal of habitat for *Antichiropus* 'DIP007' as a result of the Proposal is considered to have a moderate to high impact on the species; however, the retention of approximately 2,200 ha of *Antichiropus* 'DIP007' habitat within the Proposed Mining Area C Development Envelope is likely to be sufficient for the species to persist in the medium term with continued fire management strategies, as currently in place at Mining Area C, with a particular emphasis on maintaining a mosaic of burnt and unburnt patches throughout the remaining A. 'DIP007' habitat. In the long term, the reestablishment of habitat suitable for the species, namely *Corymbia hamersleyana* (mallee form) on hill crests, would potentially decrease the direct impact to the species by increasing habitat availability and potentially increasing population size.

In terms of SRE habitat, there are two habitat zones within the Proposed Mining Area C Development Envelope that are considered to have a high suitability for SREs; the Major gorge/ gully zone and the River gorge zone, while the Shallow open gullies/ ridges habitat zone is regarded as moderately suitable. The River gorge zone does not occur within the Indicative Additional Impact Assessment Area and therefore will not be directly impacted by the Proposal. Approximately 367.4 ha of the Major gorge/ gully habitat zone (57% of total area mapped within the Proposed Mining Area C Development Envelope, which does not include areas within Approved Impact Assessment Area) and 1105.0 ha of the Shallow open gullies/ ridges habitat zone (40% of total area mapped within the Proposed Mining Area C Development Envelope) occur within the Indicative Additional Impact Assessment Area. Although no SRE species have been recorded exclusively within the Major gorge/ gully habitat zone, impacts to it are considered to be moderate to high. Impacts to the Shallow open gully/ ridges habitat zone are considered to be low to moderate.

All the other direct and indirect impacts to SRE fauna and habitats remain unchanged from those previously approved under MS 491, assuming current management strategies are maintained.

The Environmental Protection Authority's (EPA's) primary objectives for terrestrial fauna are to "*maintain representation, diversity, viability and ecological function at the species, population and assemblage level*" (EPA 2015). With regards to SRE fauna, it is considered that the Proposal, with the maintenance of current management strategies and the reestablishment of habitat suitable for *Antichiropus* 'DIP007', will meet the EPA objective for terrestrial fauna.

## 1. INTRODUCTION

### 1.1 Proposed Project Description

Mining Area C is located approximately 100 km north west of Newman in the Pilbara region of Western Australia (Figure 1.1). BHP Billiton Iron Ore is planning to develop a new satellite ore body at Southern Flank (the Proposal), which is located approximately 8 km to the south of the existing Mining Area C operations approved under Ministerial Statement 491 (Figure 1.2). The Proposal will require additional ground disturbance (including areas within the existing approved Mining Area C licence boundary) and the development of the proposed new satellite deposits at Southern Flank. Conventional open pit mining methods will continue to extract ore from the existing approved Mining Area C deposits and the proposed Southern Flank deposits. Overland conveyors will transport ore from the Southern Flank deposits to existing processing facilities at Mining Area C. Incremental mining activity will be supported by the construction of new infrastructure including, but not limited to, primary crushers, overland conveyors, and non-process infrastructure such as water and power supplies.

### 1.2 Aims and Objectives

The objective of this report is to provide an assessment of impacts on short-range endemic (SRE) invertebrate fauna within the Proposed Mining Area C Development Envelope, comprising:

- The evaluation of any additional impacts to SRE fauna from development of the Southern Flank project (within the Additional Development Envelope and Indicative Impact Assessment Area); and
- An assessment of the impacts from the Proposal and all projects approved within the Proposed Mining Area C Development Envelope (under Ministerial Statement 491) and surrounding areas, including third party tenure.

For the purposes of this assessment, the following terminology has been applied (Figure 1.2):

- Proposed Mining Area C Development Envelope - This area is the proposed Development Envelope for the Mining Area C hub. It consists of the addition of the Approved Mining Area C (Northern Flank) Development Envelope and the Additional Development Envelope and will constitute the boundary of the new Ministerial Statement if approved.
- Current Approved Development Envelope - This area is the boundary that is currently approved as the Development Envelope under MS 491.
- Indicative Additional Impact Assessment Area - This is the indicative area that is proposed to be impacted as part of the Proposal.
- Approved Impact Assessment Area - This is the area that was impact assessed and approved in line with Condition 7 of MS 491 via Environmental Management Plan (EMP) Revision 6 in January 2016.

- Additional Development Envelope - This area is the additional development envelope proposed and assessed for impacts and is proposed to be added to the approved Mining Area C (Northern Flank) Development Envelope to form the Mining Area C Development Envelope.

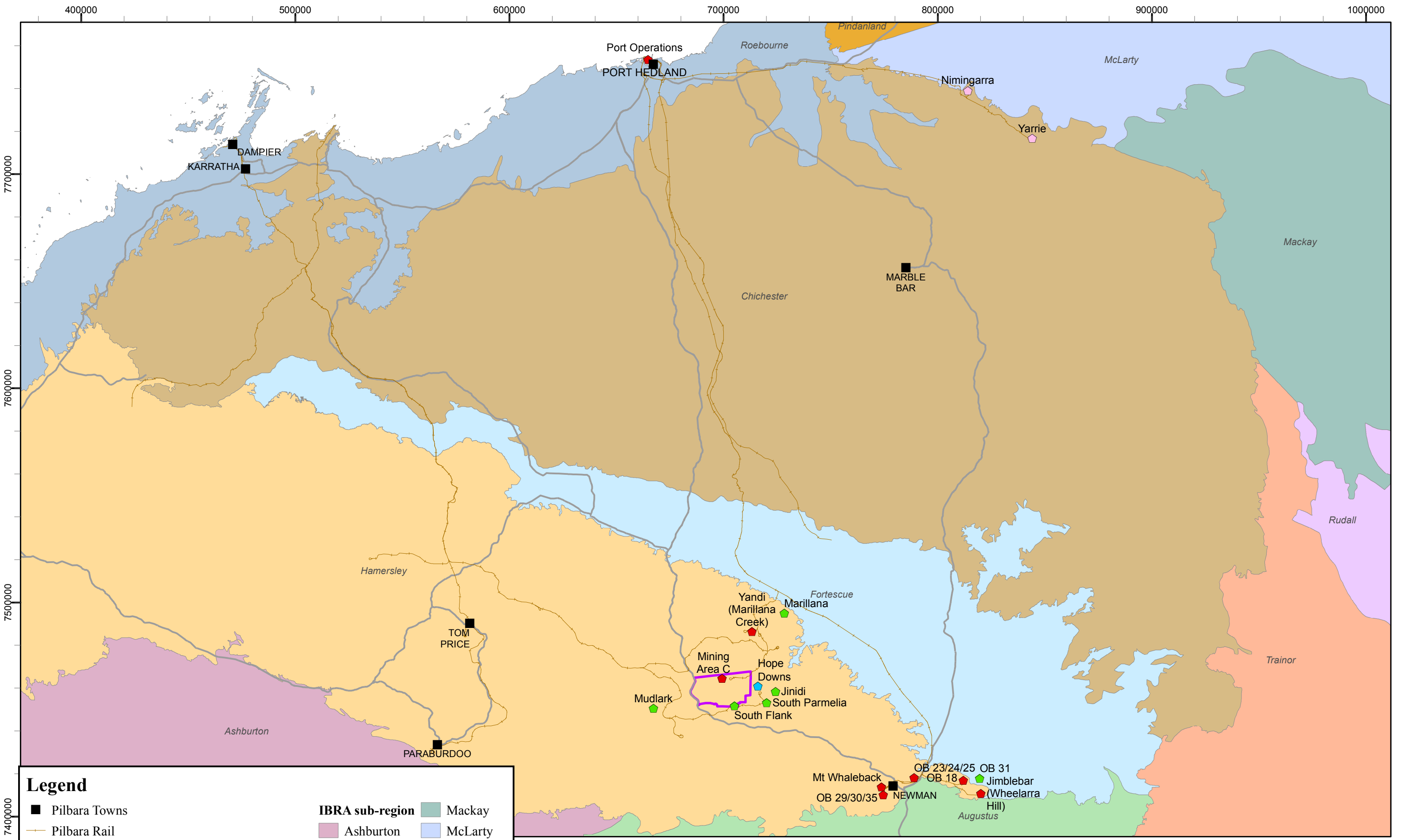
The focus of this assessment relates potential impacts to SRE within the Additional Development Envelope and Indicative Additional Impact Assessment Area. An assessment of disturbance to SREs within the Approved Impact Assessment Area has been undertaken under Ministerial Statement 491.

### 1.3 Short-range Endemism

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale, the latter being commonly referred to as short-range endemism (Allen *et al.* 2002, Harvey 2002). Short-range endemism is influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions and historical conditions which not only influence the distribution of a species, but also the tendency for differentiation and speciation (Ponder and Colgan 2002).

In recent years a number of taxonomic groups of invertebrates have been highlighted as comprising a high proportion of species likely to be regarded as SREs (*i.e.* Harvey 2002; freshwater snails: Ponder and Colgan 2002; land snails: Johnson *et al.* 2004; mygalomorph spiders: Main *et al.* 2000). This identification of restricted taxonomic groups has led to SRE invertebrate fauna being recognised as a potentially significant biodiversity issue, and that SRE fauna “may be at a greater risk of changes in conservation status as a result of habitat loss or other threatening processes” (EPA 2009).

Harvey (2002) proposed a range criterion for terrestrial short-range endemic (SRE) species at less than 10,000 km<sup>2</sup> (or 100 km x 100 km), which has been adopted by regulatory authorities in Western Australia (EPA 2009). SRE invertebrate species often share similar biological, behavioural and life history characteristics that influence their restricted distributions and limit their wider dispersal (Harvey 2002). For example, burrowing taxa such as mygalomorph spiders and *Urodacus* scorpions may only leave their burrows (or a narrow home territory around the burrow) as juveniles dispersing from the maternal burrow, or when males search for a mate. In other cases SRE taxa are dispersal-limited because of their slow pace of movement and cryptic habitats (such as isopods, millipedes and snails), while some specialised taxa can be limited by very specific habitat requirements, such as selenopid spiders within fractured rocky outcrops.



**Legend**

- Pilbara Towns
- Pilbara Rail
- Great Northern Hwy
- ▭ Proposed Mining Area C Development Envelope
- Mining/ Exploration Locations**
  - ◆ Care & Maintenance
  - ◆ Exploration
  - ◆ Operations
  - ◆ Operations (Third party)

**IBRA sub-region**

- Ashburton
- Augustus
- Chichester
- Fortescue
- Hamersley
- Mackay
- McLarty
- Pindanland
- Rudall
- Trainor

1:1,600,000

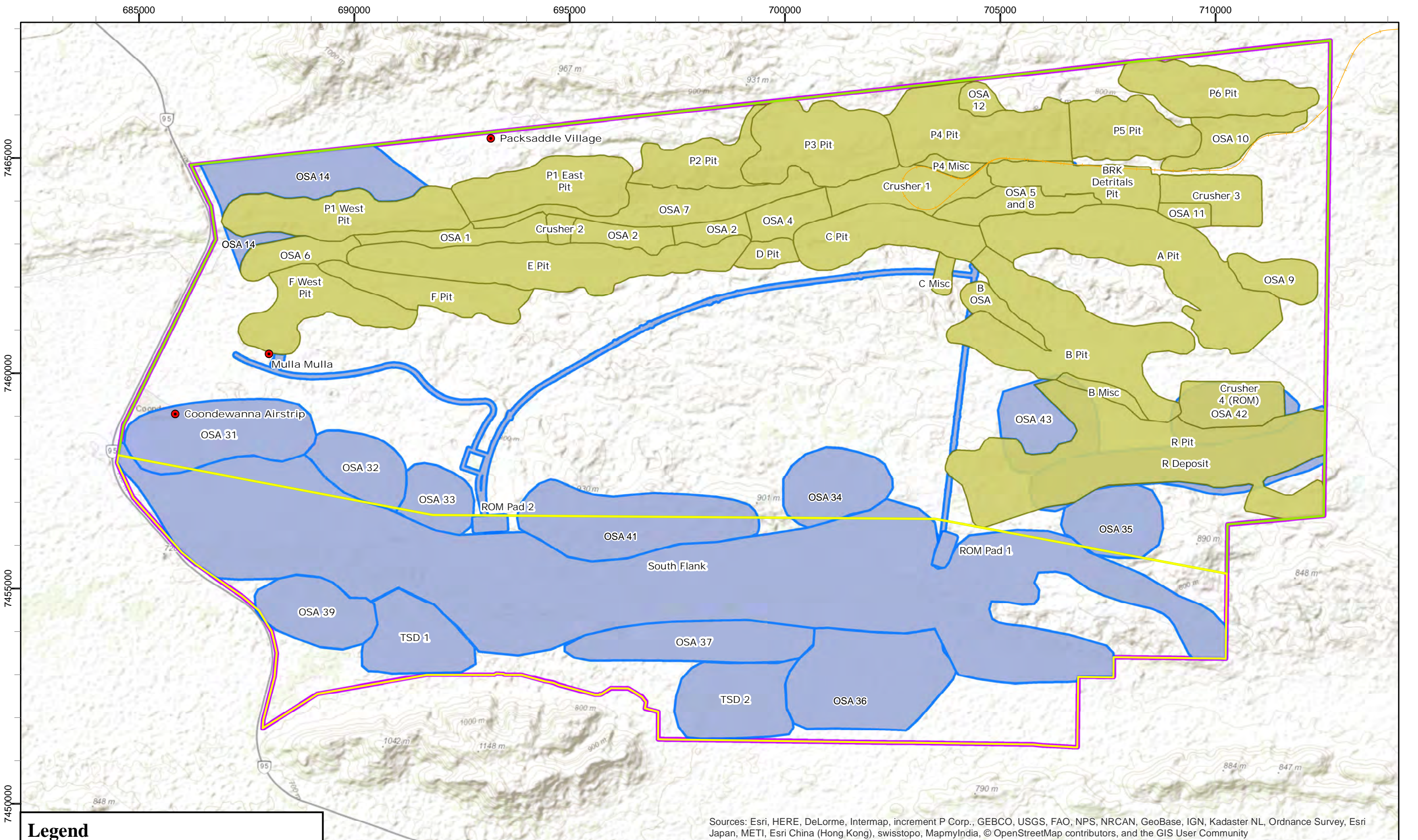
0 700 1,400 2,800 4,200 km

**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 1.1: Regional location and IBRA sub-region**


Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994


Size A3. Created 15/07/2016








**Legend**


 Rail


 Mine Accommodation


 Proposed Mining Area C Development Envelope


 Current Approved Development Envelope

 Additional Development Envelope


 Current Approved Impact Assessment Area

 Additional Impact Assessment Area





N



1:80,000

0

700

1,400

2,800

4,200

km

**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 1.2: Mining Area C Revised Proposal (data supplied by BHP Billiton Iron Ore)**

Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994

Size A3. Created 15/05/2016



### 1.3.1 Legislation and Guidance

An increasingly large number of terrestrial invertebrates exhibit short-range endemism in Western Australia. During environmental impact assessments (EIA) the Environmental Protection Authority's (EPA's) primary objectives for terrestrial fauna are to:

*"maintain representation, diversity, viability and ecological function at the species, population and assemblage level"* (EPA 2015).

Protection for listed (conservation significant) species and/ or Threatened or Priority Ecological Communities is provided under the following State and Federal legislation:

- *Environmental Protection Act 1986* (EP Act 1986) (WA);
- *Wildlife Conservation Act 1950* (WC Act 1950) (WA); and
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) (Commonwealth).

However, the majority of SRE species and communities are not currently listed, partly due to incomplete taxonomic or ecological knowledge; therefore, the assessment of conservation significance is guided primarily by expert advice provided by the Western Australian Museum (WA Museum) and other taxonomic experts.



## 2. METHODS

### 2.1 Review of Previous Studies

All reports from previous SRE surveys overlapping with the Proposed Mining Area C Development Envelope were reviewed for SRE fauna sampling site data, SRE habitat mapping and SRE fauna records so as to determine the survey effort, and the likely SRE habitat and SRE fauna values within the Study Area. These reports were:

- Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Invertebrate Short-range Endemic Assessment (Outback Ecology 2008);
- Area C Mine Short-range Endemic Habitat Assessment (Outback Ecology 2009);
- Area C and Surrounds Short Range Endemic Survey (Biota 2011a);
- Short Range Endemic Invertebrate Fauna Survey - South Flank (Biota 2011b);
- South Flank Targeted Millipede Survey (Biota 2013a);
- Targeted Survey for Short Range Endemic Fauna in the Mudlark Survey Area (Biota 2013b);
- Mining Area C – Life of Project EMP Rev 6. Environmental Impact Assessment of Short-range Endemic Invertebrates (Biologic 2015); and
- South Flank Baseline and Targeted SRE Fauna Survey (Biologic 2016).

The following additional reports from previous surveys in the surrounding area were also reviewed for regional context of SRE invertebrate fauna recorded:

- Assessment of Terrestrial Short-range Endemic Invertebrates, from Area C to Jinayri to Mount Newman Railway (AMBS 2010);
- Targeted Survey for Short Range Endemic Invertebrate Fauna of Area C West (Biota 2013c);
- A Survey of the Short Range Endemic Invertebrate Fauna of South Flank to Jinidi (Biota 2013d); and
- Baby Hope Downs Deposit Targeted Fauna Survey (Biota 2015).

### 2.2 Faunal Database Review

Four fauna databases (Table 2.1) were searched for SRE fauna records within and surrounding the Proposed Mining Area C Development Envelope to determine the likely SRE fauna values.

**Table 2.1: Databases used for the review**

Database	Date Accessed	Parameters
NatureMap (DPaW)	March 2016	20 km radius from point: 22°58'11"S; 118°56'42"E
Atlas of Living Australia (ALA)	March 2016	20 km radius from point: 22°58'11"S; 118°56'42"E
WAM Arachnida/ Mollusca	March 2016	20 km radius from point: 22°58'11"S; 118°56'42"E
BHP Billiton Iron Ore SRE Database	March 2016	20 km radius from point: 22°58'11"S; 118°56'42"E

Within these databases, records of mygalomorph spiders, selenopid spiders, pseudoscorpions, scorpions, millipedes, terrestrial snails, and isopods were targeted. Within the WAM databases, a distribution criterion of 10,000 km<sup>2</sup> was applied (following Harvey 2002), thereby selecting species within these groups where the known records occur within 10,000 km<sup>2</sup>. Indeterminate records were excluded, except where generic level characters and distribution information was sufficient to point to a high likelihood that the species could be SRE. The WAM list of species was then used as a filter for the other databases, which did not have the ability to perform a search based on a distribution criterion of 10,000 km<sup>2</sup>. Secondary filtering and examination of the data was also applied internally, within the constraints and assumptions noted in Section 2.3.

### 2.3 Constraints and Assumptions

The taxonomy for nearly all SRE groups in the Pilbara is incomplete, and in various stages of development, depending upon the group in question. Additional survey work over time has increased the number of groups known to have SRE tendencies (for example, selenopid spiders and isopods), leaving some groups more well-studied than others.

Most SRE fauna taxonomic groups require mature male specimens for positive morphological identifications, while the specimens collected are often females or juveniles. As such, identifications often cannot be verified without the use of DNA analyses, which are recently becoming more widely used, although these have their own limitations in terms of suitable species thresholds (Hebert *et al.* 2003), the need for previous sequences to enable regional comparisons, which can sometimes be hampered by the lack of data sharing or submission to the WA Museum (WAM), and collection of specimens using methods that support DNA analysis. The current assessment has relied on the most recent WAM database data and advice from WAM taxonomists to indicate the most up-to-date list of SRE species that are relevant to the assessment of impacts within the Indicative Additional Impact Assessment Area. Where taxonomy is incomplete, likely species identity has been inferred based on the geographic locality of the collection and other confirmed specimens from the locale.

Many terrestrial invertebrate species in the Pilbara are only known from a handful of locations where intensive sampling has been undertaken. Species distributions are therefore dependent upon the size and extent of targeted surveys, as well as the ecology, behaviour, and natural history of the species in question, much of which remains uncertain, especially where the species is undescribed. Detailed habitat assessment data can be used as a basis for inferring the potential occurrence of species within suitable, connected habitats where sampling has been limited; however, such inference has its own limitations in terms of how much is actually known about a species habitat requirements and dispersal capabilities.

The effects of uneven sampling are exacerbated by differences in the experience of survey personnel, methods, targeted groups, sampling intensities, and survey timing. Collection of habitat data and the classification of suitable habitats for SREs have been inconsistent over time, as most of the previous survey work was undertaken before any formal guidance for assessment of SRE invertebrates and habitats was published. The SRE habitat assessment

survey undertaken by Biologic (2015) resolved these inconsistencies, consistent with BHP Billiton Iron Ore's SRE invertebrate fauna assessment methods (BHPBIO, 2009).

The cryptic nature of SRE fauna, along with the effects of uneven sampling, limits our ability to infer a species' presence or absence from a site where it has not been recorded. To alleviate this to some extent, we categorise habitats on the basis of their suitability for SRE fauna, based on our current understanding of SRE fauna requirements and the physical composition of the habitats with respect to these requirements. As such, habitats with moderate to high suitability for SRE fauna will still be regarded as such even if sampling has not recorded any restricted species within the habitat.

### 3. RESULTS

#### 3.1 Survey Effort and Adequacy in the Proposed Mining Area C Development Envelope

Table 3.1 and Figure 3.1 show the extent and focus of the survey effort within and adjacent to the Proposed Mining Area C Development Envelope. Of the eight SRE fauna surveys undertaken within the Proposed Mining Area C Development Envelope, four completed baseline SRE sampling (collecting all SRE fauna), one undertook both baseline and targeted millipede *Antichiropus* 'DIP007' sampling, one undertook just targeted millipede *Antichiropus* 'DIP007' sampling and two completed habitat assessments only (Table 3.1; Figure 3.1).

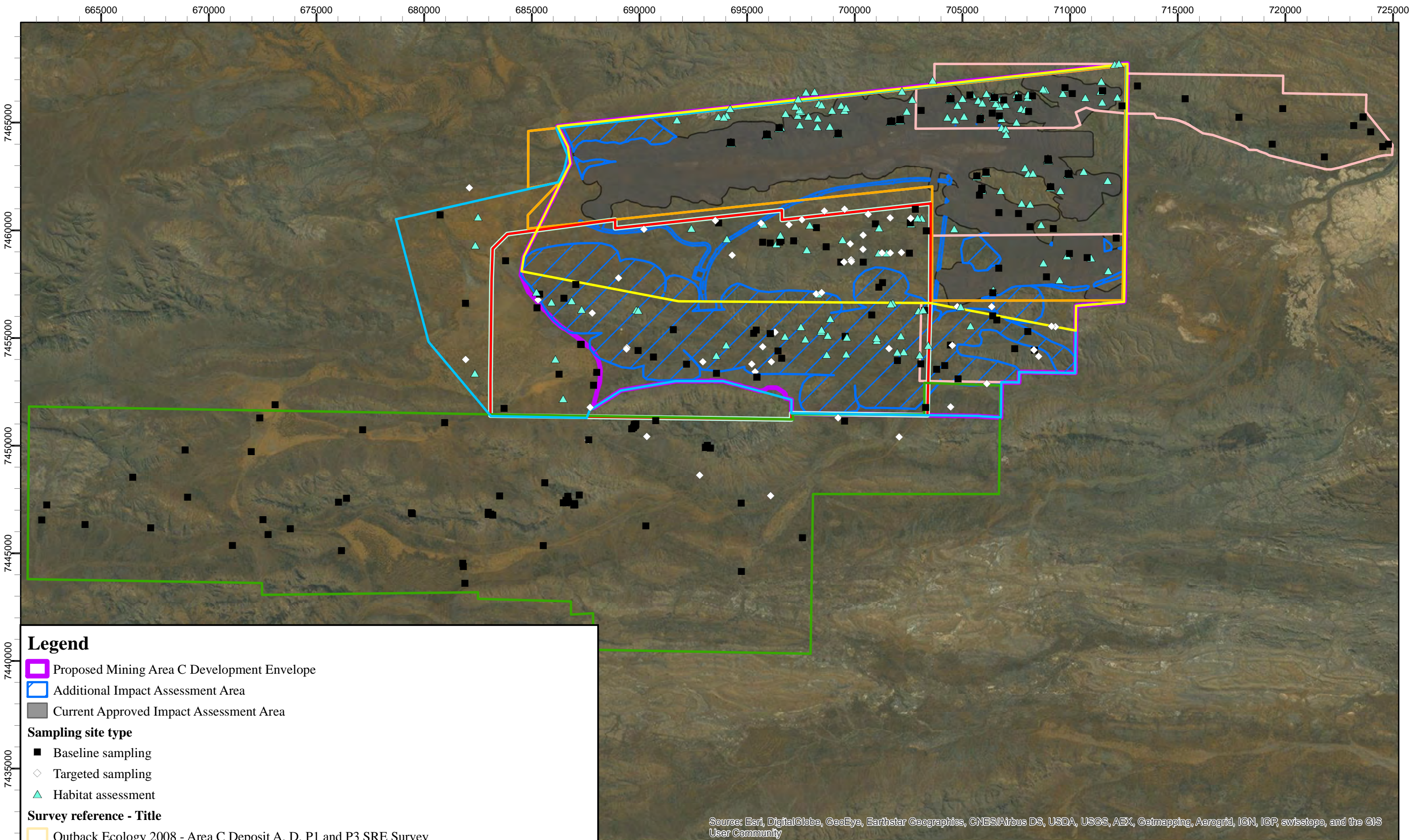
Figure 3.1 shows that the extent of SRE fauna sampling and habitat assessments throughout the Proposed Mining Area C Development Envelope is well spread, with only two areas with limited sampling and habitat assessments. These areas are the southern and western sections of the Current Approved Impact Assessment Area, which covers the central and central western parts of the central Proposed Mining Area C Development Envelope. These areas were assessed prior to SRE surveys being a standard component of the environmental approvals process. The sampling gap in this area does not limit our ability to assess impacts from the Proposal.

Overall, the extent of SRE fauna sampling (90 baseline SRE sites and 43 targeted SRE sampling sites) and habitat assessments (260 habitat assessment sites) within the Proposed Mining Area C Development Envelope can be regarded as sufficient for the purposes of mapping SRE habitats and fauna distribution and to meet the requirements of current EPA Guidance (EPA 2009).

**Table 3.1: SRE fauna and habitat survey effort within the Proposed Mining Area C Development Envelope**

Survey Area	Author	Survey Dates	Survey Type	SRE Sampling Sites	Targeted SRE Sampling Sites	Habitat Assessment Sites
Area C: A, D, P1 and P3 Deposits	Outback Ecology 2008	April and June 2008	Baseline	15		
Area C: A, D, P1 and P3 Deposits	Outback Ecology 2009	April 2009	Habitat Assessment			23
Area C and Surrounds	Biota 2011a	Feb. and June 2010	Baseline	36		36
South Flank	Biota 2011b	Feb. and Aug. 2010	Baseline	25		25
South Flank	Biota 2013a	April/ May 2012	Targeted		11	
Mudlark	Biota 2013b	March and July 2011, and Feb. 2012	Baseline	1		1
Area C	Biologic 2015	Sept. 2014	Habitat Assessment			85
South Flank	Biologic 2016	May 2016	Baseline and Targeted	13	32	90
<b>Totals</b>				<b>90</b>	<b>43</b>	<b>260</b>

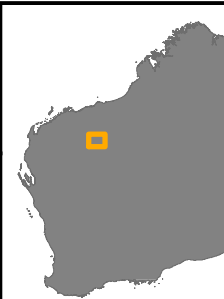




**Legend**

- Proposed Mining Area C Development Envelope
  - Additional Impact Assessment Area
  - Current Approved Impact Assessment Area
- Sampling site type**
- Baseline sampling
  - Targeted sampling
  - Habitat assessment
- Survey reference - Title**
- Outback Ecology 2008 - Area C Deposit A, D, P1 and P3 SRE Survey
  - Outback Ecology 2009 - Area C Deposit A, D, P1 and P3 SRE Habitat Assessment
  - Biota 2011a - Area C and Surrounds SRE Invertebrate Fauna Survey
  - Biota 2011b - SRE Fauna Survey - South Flank
  - Biota 2013a - South Flank Targeted Millipede Survey
  - Biota 2013b - Targeted Survey for SRE Fauna in the Mudlark Survey Area
  - Biologic 2015 - Mining Area C EMP Rev 6 Environmental Impact Assessment of SRE Invertebrates
  - Biologic 2016 - South Flank Baseline and Targeted SRE Fauna Survey

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



biologic  
Environmental Survey

N

1:160,000

0 700 1,400 2,800 4,200 km

**BHP Billiton Iron Ore - MAC Revised Proposal**

**Environmental Impact Assessment of SRE Fauna**

**Fig. 3.1: Survey Effort for SRE Fauna within the Development Envelope**

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994

Size A3. Created 15/07/2016



### 3.2 SRE Fauna in the Proposed Mining Area C Development Envelope

Table 3.2 and Figure 3.2 show the confirmed and potential SRE fauna recorded within the Proposed Mining Area C Development Envelope. The database searches did not provide any additional species to those recorded in the surveys; however, it did provide information on the current identification and SRE status of these taxa, which is also provided in Table 3.2.

Four confirmed SRE taxa and one potential SRE taxon have been recorded within the Additional Development Envelope; *Antichiropus* 'DIP007', *Austrostrophus* 'DIP018', *Yilgarnia* 'MYG197', *Kwonkan* 'MYG339-DNA' and Barychelidae indet. (juv.) (potential SRE) (Table 3.3). All but the Barychelidae indet. (juv.) were recorded within the Indicative Additional Impact Assessment Area.

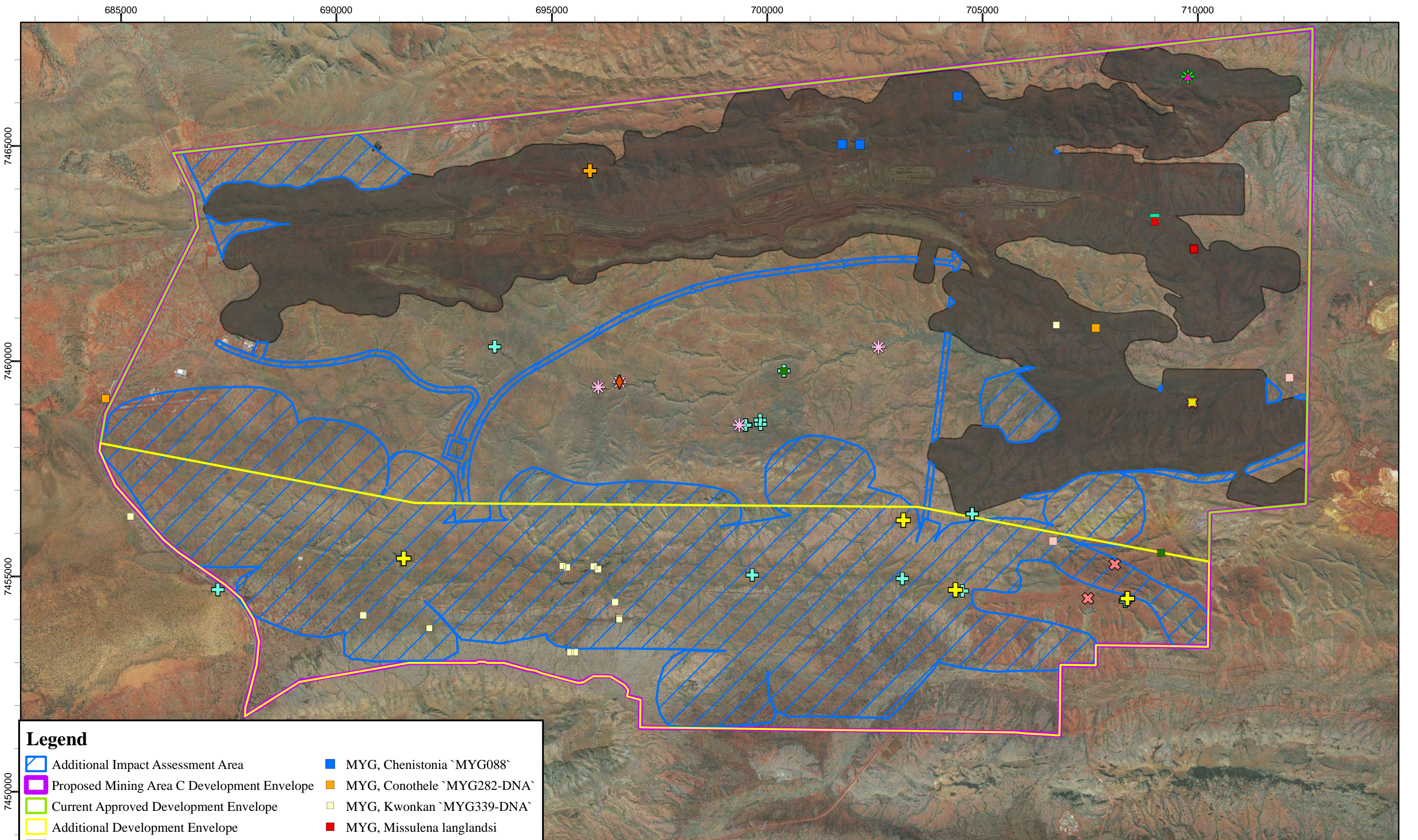
*Austrostrophus* 'DIP018', *Yilgarnia* 'MYG197', and Barychelidae indet. (juv.) have been recorded outside of the Additional Development Envelope (Figure 3.3), the former two also having been recorded outside of the Proposed Mining Area C Development Envelope. Suitable habitat for these taxa is regarded as likely to occur beyond the Proposed Mining Area C Development Envelope (Biologic 2016). *Kwonkan* 'MYG339-DNA' has also been recorded beyond the Additional Development Envelope, but the majority of records (13 of 17) are only known from the Indicative Additional Impact Assessment Area. All records of this species were recorded within drainage habitats, and due to the extent and connectivity of suitable habitat (Biologic 2016) this taxon is considered very likely to occur beyond the Proposed Mining Area C Development Envelope.

Two taxa considered potential SREs, the isopod *Spherillo* 'south-flank' and the selenopid spider ?*Karaops* 'sp. indet. (juv.)', were only recorded within the central section of the Proposed Mining Area C Development Envelope, but outside the Additional and Current Impact Assessment Areas. Neither have been recorded outside of the Proposed Mining Area C Development Envelope. The ?*Karaops* 'sp. indet. (juv.)' can be regarded as likely to occur beyond the Proposed Mining Area C Development Envelope, due to the extent of suitable habitat to the east; however, the lack of knowledge of the *Spherillo* 'south-flank' limits our ability to state whether this taxon is likely to occur beyond the Proposed Mining Area C Development Envelope. The lack of records may be due to a lack of sampling for both of these taxonomic groups in adjacent tenements, and in the case of ?*Karaops* 'sp. indet. (juv.)', incomplete taxonomy.

Five records of *Antichiropus* 'DIP007' have been recorded within the Proposed Mining Area C Development Envelope; four of which occur within the Indicative Additional Impact Assessment Area. Eighteen other indeterminate records of juvenile or female specimens were collected and were considered likely to be *A.* 'DIP007' owing to their location in the same, or similar connected habitats as adult male *A.* 'DIP007' specimens (Biologic 2016). Five of these indeterminate specimens were recorded within the Indicative Additional Impact Assessment Area, 12 others outside of the Indicative Additional Impact Assessment Area

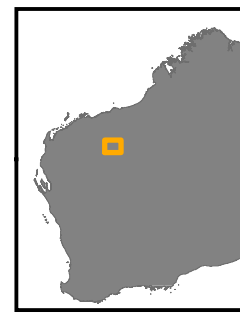
within the Proposed Mining Area C Development Envelope, and one was recorded outside of the Proposed Mining Area C Development Envelope.





**Legend**

- |   |                              |
|---|------------------------------|
| Additional Impact Assessment Area           | MYG, Chenistonia `MYG088`    |
| Proposed Mining Area C Development Envelope | MYG, Conothele `MYG282-DNA`  |
| Current Approved Development Envelope       | MYG, Kwonkan `MYG339-DNA`    |
| Additional Development Envelope             | MYG, Missulena langlandsi    |
| Current Approved Impact Assessment Area     | MYG, Teyl `MYG027`           |
| <b>Group, Taxon</b>                         |                              |
| PSE, Synsphyronus `PSE014 long hand 2`      | MYR, Antichiropus `DIP006`   |
| ARA, Karaops banyjima                       | MYR, Antichiropus `DIP007`   |
| ARA, Karaops indet. (juv.)                  | MYR, Antichiropus indet.     |
| MYG, Aname `MYG104`                         | MYR, Austrostrophus `DIP018` |
| MYG, Barychelidae indet. (juv.)             | ISO, Spherillo `south-flank` |



N

1:80,000

0 700 1,400 2,800 4,200 km

**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 3.2: Confirmed and Potential SRE fauna recorded in the MAC Development Envelope**

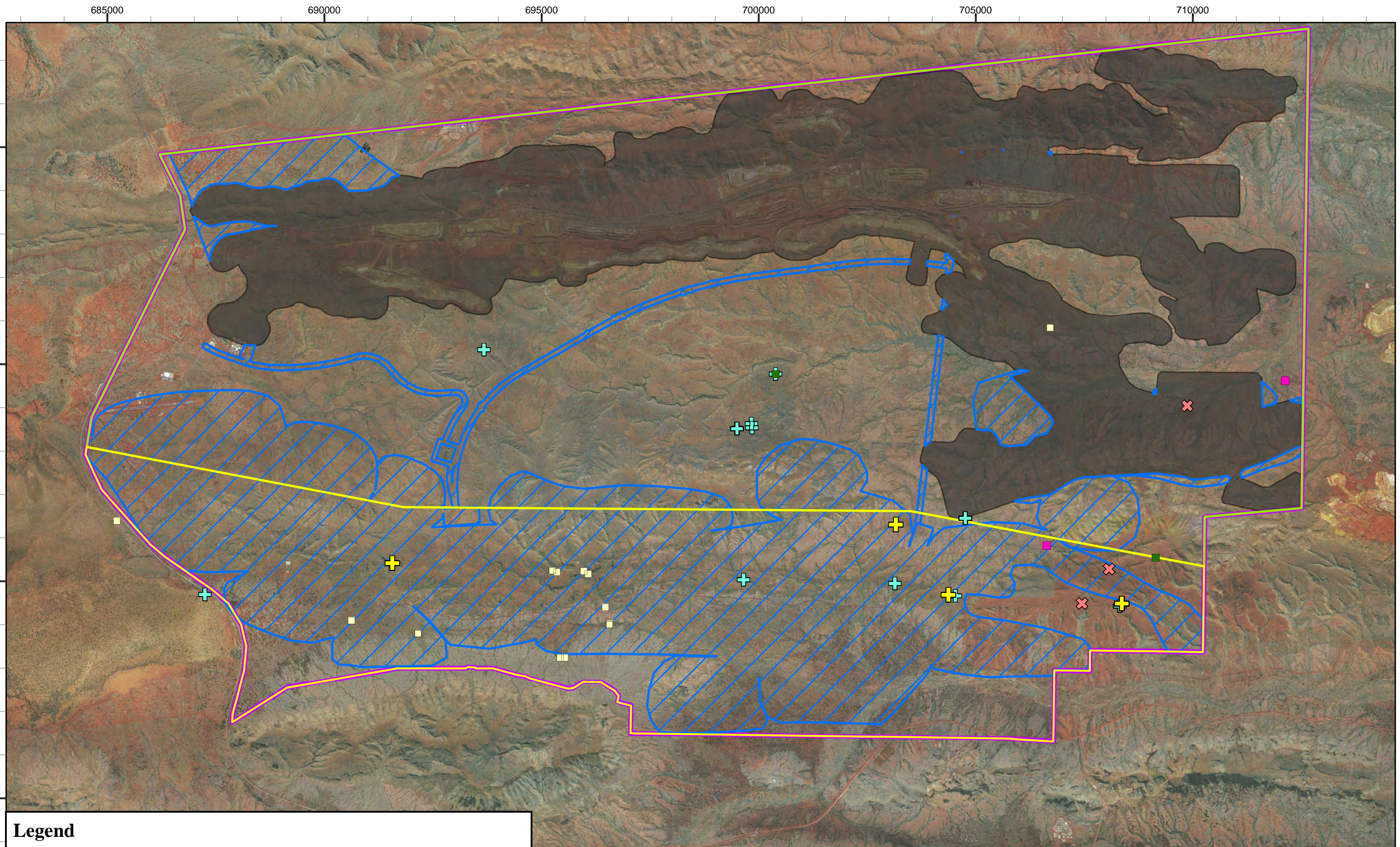
Coordinate System: GDA 1994 MGA Zone 50	Size A3. Created 15/06/2016
Projection: Transverse Mercator	
Datum: GDA 1994	



**Table 3.2: Location of all potential and confirmed SRE taxa with respect to the Proposed Project.**

Higher Taxon	Current WAM ID	Current SRE Status	Within Proposed Mining Area C Development Envelope				Outside Mining Area C Proposed Development Envelope
			Within Additional Development Envelope	Within Indicative Additional Impact Assessment Area	Within Approved Impact Assessment Area	Outside Additional and Approved Impact Assessment Areas	
Myriapoda							
Antichiropus `DIP006`		Confirmed SRE			1		
Antichiropus `sp. indet. (juv.)`		Potential SRE, Likely A. `DIP006`,			2		
Antichiropus `DIP007`		Confirmed SRE	5	4			
Antichiropus `sp. indet. (juv. and female)`		Potential SRE, Likely A. `DIP007`,	7	5		12	1
Austrostrophus `DIP018`		Confirmed SRE	2	1	1	1	1
Selenopidae							
Karaops banyjima		Confirmed SRE			1		
Karaops `sp. indet. (juv.)`		Potential SRE			1		
?Karaops `sp. indet. (juv.)`		Potential SRE				4	
Pseudoscorpiones							
Synsphyronus `PSE014`		Confirmed SRE			1		1
Mygalomorphae							
Aname `MYG104`		Confirmed SRE			1		1
Barychelidae indet. (juv.)		Potential SRE	1			2	
Chenistonia `MYG088`		Confirmed SRE			3		
Conothele `MYG282-DNA`		Confirmed SRE			1		16
Kwonkan `MYG339-DNA`		Confirmed SRE	15	13	1	2	1
Missulena langlandsi		Confirmed SRE			4		2
Teyl `MYG027`		Confirmed SRE			1		2
Yilgarnia `MYG197`		Confirmed SRE	1	1		1	1
Isopoda							
Spherillo `south-flank`		Potential SRE				2	





**Legend**

Additional Impact Assessment Area

Proposed Mining Area C Development Envelope

Current Approved Development Envelope

Additional Development Envelope

Current Approved Impact Assessment Area

**Group, Taxon**

MYG, Barychelidae indet. (juv.)

MYG, Kwonkan `MYG339-DNA`

MYG, Yilgarnia `MYG197`

MYR, Antichiropus `DIP007`

MYR, Antichiropus indet.

MYR, Austrostrophus `DIP018`

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N

1:80,000

0 700 1,400 2,800 4,200 km

**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 3.3: Confirmed and Potential SRE fauna recorded in the Additional Development Envelope**

Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994

Size A3. Created 15/06/2016



### 3.3 Habitat Zones in the Proposed Mining Area C Development Envelope

The habitats within the Proposed Mining Area C Development Envelope were classified into six habitat zones (Figure 3.4) based on Biologic (2015, 2016), and reflect the major changes in landform features, drainage features and vegetation features that influence SRE occurrence. Each zone contained one or several SRE habitat types.

The habitat zones were also ranked on their overall suitability for SRE fauna (Figure 3.5) (Biologic 2015, 2016) with a suitability rank of 5 (High) representing the zones most likely to contain significant SRE values, and a rank of 1 (Low) being the least likely to contain significant SRE values.

The SRE habitat zones within the Proposed Mining Area C Development Envelope comprise:

#### **Major gorge/ gully**

This habitat zone comprises a series of massive, deeply incised gorge/ deep gully/ chasm systems occurring only in the more mountainous areas (Figure 3.4). These systems feature interconnected rocky habitats such as gorges/ deep gullies, ridges/ breakaways, scattered rocky outcrops/ boulder piles, and wide expanses of shallow/ open gullies leading down the steep, open faces.

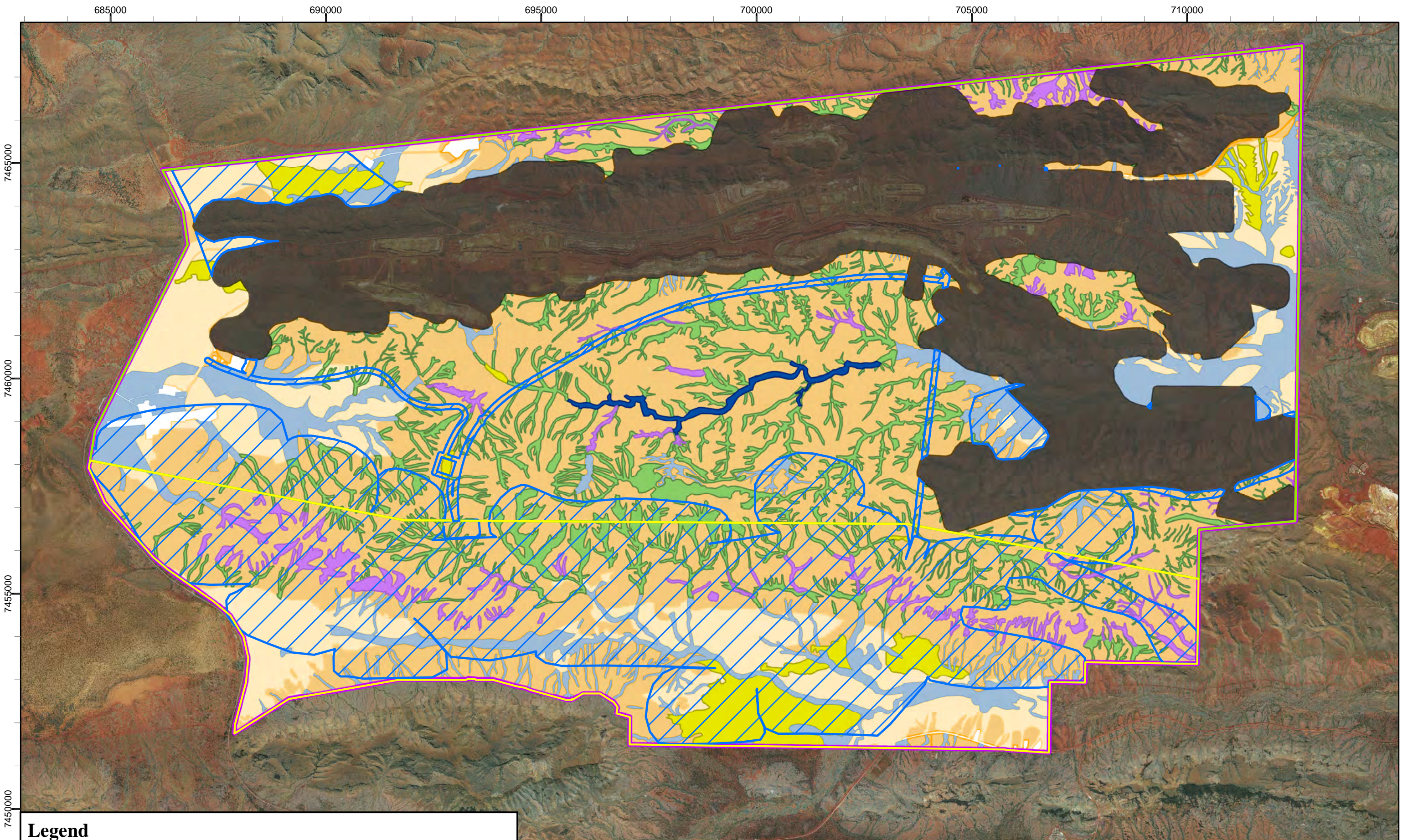
The SRE suitability of the habitat types within this zone is highly dependent upon slope and aspect, with the south-facing Major gorge/ gully systems being more highly suitable overall (rank 5) than the north-facing Major gorge/ gully systems (rank 4) (Figure 3.5), which were in some cases just as steep and complex, but more exposed due to their northerly aspect.

#### **River gorge**

This habitat zone comprises deeply incised low to moderate gorges carved by moderate or major drainage lines, where the base of the gorge is relatively flat, and the vertical or near vertical faces offer consistent shade. This habitat zone can form in highly mountainous areas at the base of steep slopes, or in deeply incised rolling hills, as observed within the Proposed Mining Area C Development Envelope (Figure 3.4). The habitat types within this zone may include gorges/ deep gullies, drainage lines, drainage foci, and ridges/ breakaways in areas where one face is more deeply incised than another.

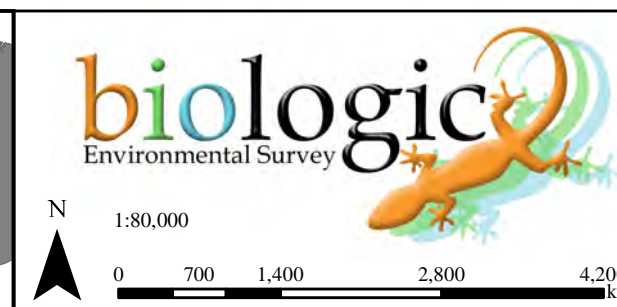
The overall SRE suitability of this habitat zone is high (rank 5) (Figure 3.5), and is not as variable depending on slope and aspect as the more mountainous Major gorge/ gully habitat zones. This is because the narrower, more meandering course of River gorges provides plenty of sheltered aspects, complex microhabitats within rocks, dense vegetation, and higher persistence of moisture.





**Legend**

- |   |                              |
|---|------------------------------|
| Proposed Mining Area C Development Envelope | River Gorge                  |
| Current Approved Development Envelope       | Shallow Open Gullies/ Ridges |
| Additional Development Envelope             | Drainage Areas               |
| Current Approved Impact Assessment Area     | Mulga Woodlands              |
| Additional Impact Assessment Area           | Open Plains                  |
| <b>SRE Habitat Type</b>                     | Hill slopes/ crests          |
| Major Gorge/ Gullies                        | Cleared/ Infrastructure      |

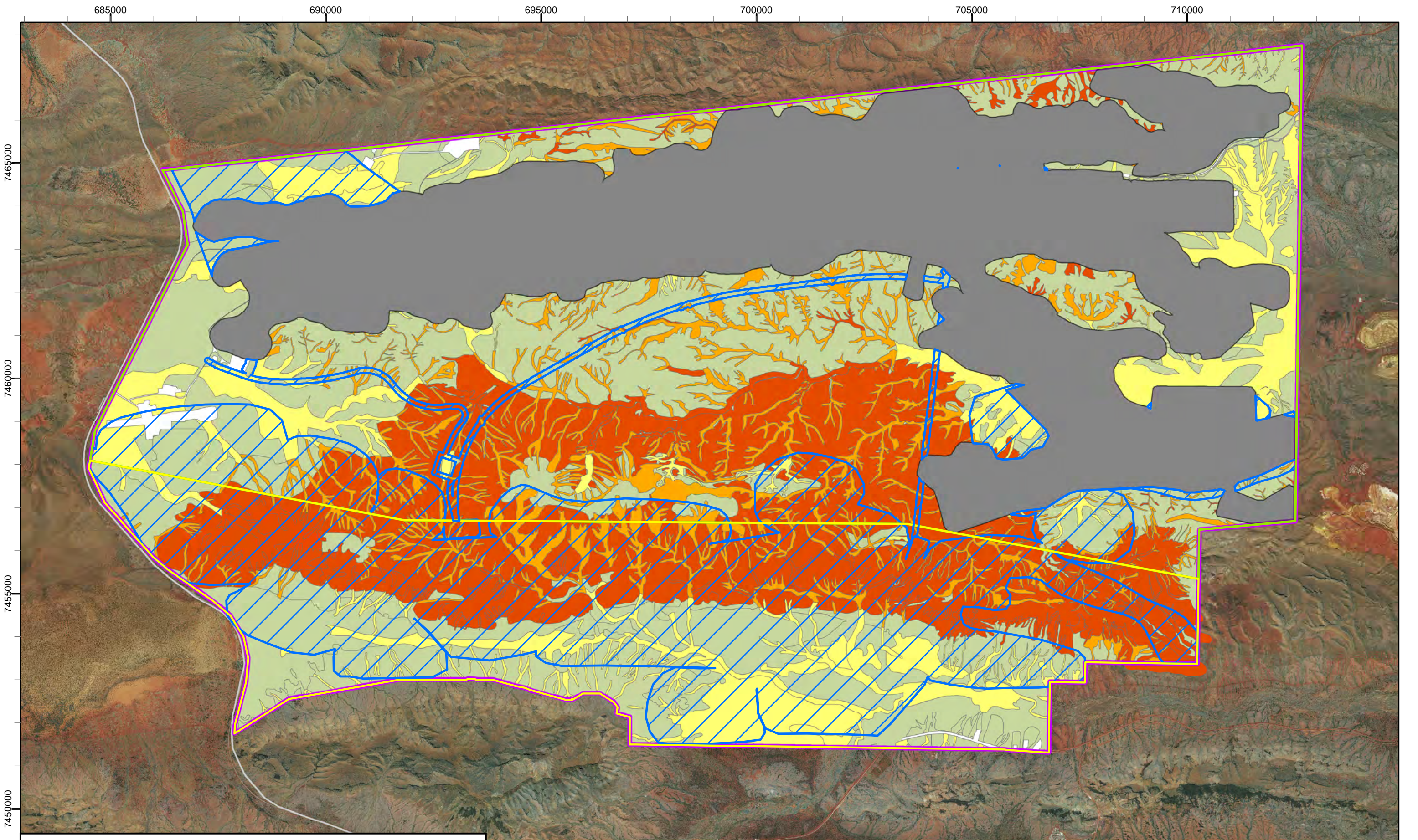


**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 3.4: Indicative SRE habitat zones within the Proposed MAC Development Envelope**

Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994

Size A3. Created 15/06/2016





**Legend**

—

 Great Northern Hwy

▭

 Proposed Mining Area C Development Envelope

▭

 Current Approved Development Envelope

▭

 Additional Development Envelope

▭

 Current Approved Impact Assessment Area

▭

 Additional Impact Assessment Area

**SRE Habitat Suitability**

▭

 High (Rank 5)

▭

 Moderate (Rank 3)

▭


 Moderate-Low (Rank 2)

▭


 Low (Rank 1)

▭

 N/A Unsuitable for SRE



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Environmental Survey



N

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0 700 1,400 2,800 4,200 km

**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 3.5: Indicative SRE habitat suitability within the Proposed MAC Development Envelope**

Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994

Size A3. Created 15/06/2016



### Hill slopes/ crests

This habitat zone comprises the remaining rocky habitats on open slopes and hill crests that do not feature major outcrops, ridges, or gullies. Such areas generally have skeletal soils and open vegetation (often *Triodia* hummock grassland with scattered *Corymbia/ Eucalyptus* spp.) that can provide pockets of protection from exposure. Steeper, south-facing hill slopes can also provide some protection.

These habitat zones are often regarded as having a low suitability for SRE fauna; however, in this instance, due to the presence of the confirmed SRE *Antichiropus* 'DIP007' and the *Antichiropus* 'sp. indet. (juv. and female)', which appear to be restricted to this particular occurrence of this habitat zone, it is given a ranking of high (rank 5) where it coincides with these two taxa and low (rank 1) outside of this extent (Figure 3.5) (Biologic 2016).

### Shallow open gullies/ ridges

This habitat zone comprises all other gully/ valley systems and moderate to tall ridgelines that are not considered to be Major gorge/ gully systems or River gorges. The dominant habitat types within this zone is shallow/ open gullies and ridges/ breakaways, which vary from moderate-low to high suitability, depending on slope, aspect, the abundance of rocky outcropping, and vegetation structure and density. At the landscape scale however, this zone forms a reasonably well-connected network of similar habitat throughout the Proposed Mining Area C Development Envelope (Figure 3.4).

The SRE suitability of this habitat zone is moderate (rank 3) (Figure 3.5).

### Drainage areas

This habitat zone comprises drainage line, drainage foci and vegetation grove habitats associated with the major and minor drainage lines. These areas are dominated by dense shrubland and groves/ thickets of *Acacia* (Mulga and other *Acacia* species) and *Eucalyptus/ Corymbia* species; therefore the majority of SRE habitats are based on vegetation and detritus. Slope and aspect are more or less irrelevant to SRE suitability here; instead the density and structure of vegetation influences complexity of detrital microhabitats, and amount of shelter available. Isolation is generally low, as the groves and drainage line habitats form an interconnected network of vegetation-based habitats along the course of the drainage line and flood plains (Figure 3.4).

The overall SRE suitability of this habitat zone is moderate-low (rank 2) (Figure 3.5).

### Mulga woodlands

This habitat zone comprises woodland and vegetation grove habitats where Mulga (*Acacia aneura*) occurs. These habitat zones are not necessarily following the course of distinct drainage channels, but rather occurring on open plains where they are distinguished from the surrounding shrubland/ grassland of the Open plain habitat zone by providing more shade and a greater abundance of leaf litter and detrital microhabitats. Mulga woodland within the Proposed Mining Area C Development Envelope tends to occur on deep clay-loam soils that provide optimal burrowing habitats for many mygalomorph spiders and scorpions. This zone



generally occurs in large or well-connected patches, and shares many habitat similarities with the Drainage area habitat zone.

The overall SRE suitability of this habitat zone is moderate-low (rank 2) (Figure 3.5).

### **Open plains**

This habitat zone comprises the remaining open, flat habitats on detrital or alluvial plains that do not feature significant groves/ thickets, drainage features, or rocky outcrops. Moderately dense shrubland on the plains can provide patches of detrital microhabitats throughout; however, the low levels of habitat complexity, shelter, and isolation generally make these areas unsuitable for SRE species.

The overall SRE suitability of this habitat zone is low (rank 1) (Figure 3.5); however, they can contain suitable microhabitats.

## 4. IMPACT ASSESSMENT

### 4.1 Potential Impacts

Potential impacts to SRE fauna and habitats from implementation of the Proposal include:

- Direct impacts comprising the loss of SRE individuals or populations, the removal of SRE habitat, or complete degradation of SRE habitat values arising from:
  - Mining and earthworks;
  - Construction of infrastructure, OSAs/ stockpiles/ dumps; and
  - Vegetation clearing.
- Indirect impacts *i.e.* more subtle or gradual degradation of SRE habitat values via changes to the physical condition of habitats and microhabitats associated with vegetation, landforms, and drainage features. Indirect impacts may include:
  - Habitat fragmentation (creation of barriers to species movement, increased edge effects);
  - Alteration to surface drainage patterns (via effects on drainage and vegetation-based habitats);
  - Spread of introduced flora or fauna species that may degrade the quality of terrestrial habitats;
  - Alteration of fire regimes (effects on vegetation-based habitats);
  - Spills and contamination (localised effects); and
  - Vibration, noise and dust (localised effects near active mining areas).

### 4.2 Direct Impacts to *Antichiropus* 'DIP007'

Of the five confirmed records of *Antichiropus* 'DIP007', four occur within the Indicative Additional Impact Assessment Area. Eighteen other indeterminate of juvenile and female specimens were collected and were considered likely to be A. 'DIP007' owing to their location in the same, or similar connected habitats as adult male A. 'DIP007' specimens. Five of these indeterminate specimens were recorded within the Indicative Additional Impact Assessment Area, 12 others outside of the Indicative Additional Impact Assessment Area, but within the Proposed Mining Area C Development Envelope, and one was recorded outside of the Proposed Mining Area C Development Envelope.

The estimated extent of suitable habitat for *Antichiropus* 'DIP007', identified in Biologic (2016) as hill crest with *Corymbia hamersleyana* (mallee form), is limited to the south and west by Drainage area and Open plain habitat zones, and to the north by the River gorge habitat zone (Figure 4.1). Targeted survey work in suitable habitat (Biologic 2016) has not recorded the species beyond these areas. There has been no targeted sampling or habitat assessments to the east of the Proposed Mining Area C Development Envelope (within Hope Downs tenure), and this species has not been recorded there. Figure 4.1 shows the potential extent of suitable habitat to the east based on vegetation mapping (Biota 2015), topography and aerial photos.

The estimated extent of suitable habitat for this species within the Proposed Mining Area C Development Envelope is 7089.7 ha, with potentially an additional 629.5 ha within the Hope Downs tenure.

Approximately 3859.2 ha (54.4%) occurs within the Indicative Additional Impact Assessment Area (Table 4.1), while 2875.7 ha (40.6%) occurs outside of the Indicative Addition Impact Assessment Area and the Approved Impact Assessment Area (All Impact Assessment Areas) within three fragments primarily at the north and eastern edges of its estimated range (Figure 4.1).

The direct removal of the estimated extent of suitable habitat for *Antichiropus* 'DIP007' as a result of the Proposal is considered to have a moderate to high impact on this species; however, the re-establishment of habitat suitable for the species, namely *Corymbia hamersleyana* (mallee form) on hill crests, would potentially decrease the direct impact to the species by increasing habitat availability and potentially increasing population size.

**Table 4.1: The estimated extent of *Antichiropus* 'DIP007' habitat with respect to the Proposed Project**

Species	Within Additional Development Envelope (ha)	Within Indicative Additional Impact Assessment Area* (ha)	Within All Impact Assessment Areas* (ha)	Outside All Impact Assessment Areas* (ha)	Maximum Estimated Habitat Extent (ha)
<i>Antichiropus</i> 'DIP007'	3517.4 (49.6%)	3859.2 (54.4%)	4213.9 (59.4%)	2875.7 (40.6%)	<b>7089.7</b>

\* The Indicative Additional Impact Assessment Area and areas approved under MS491. Loss of habitat within the Hope Downs tenure has not been considered here.

### 4.3 Direct Impacts to Habitats

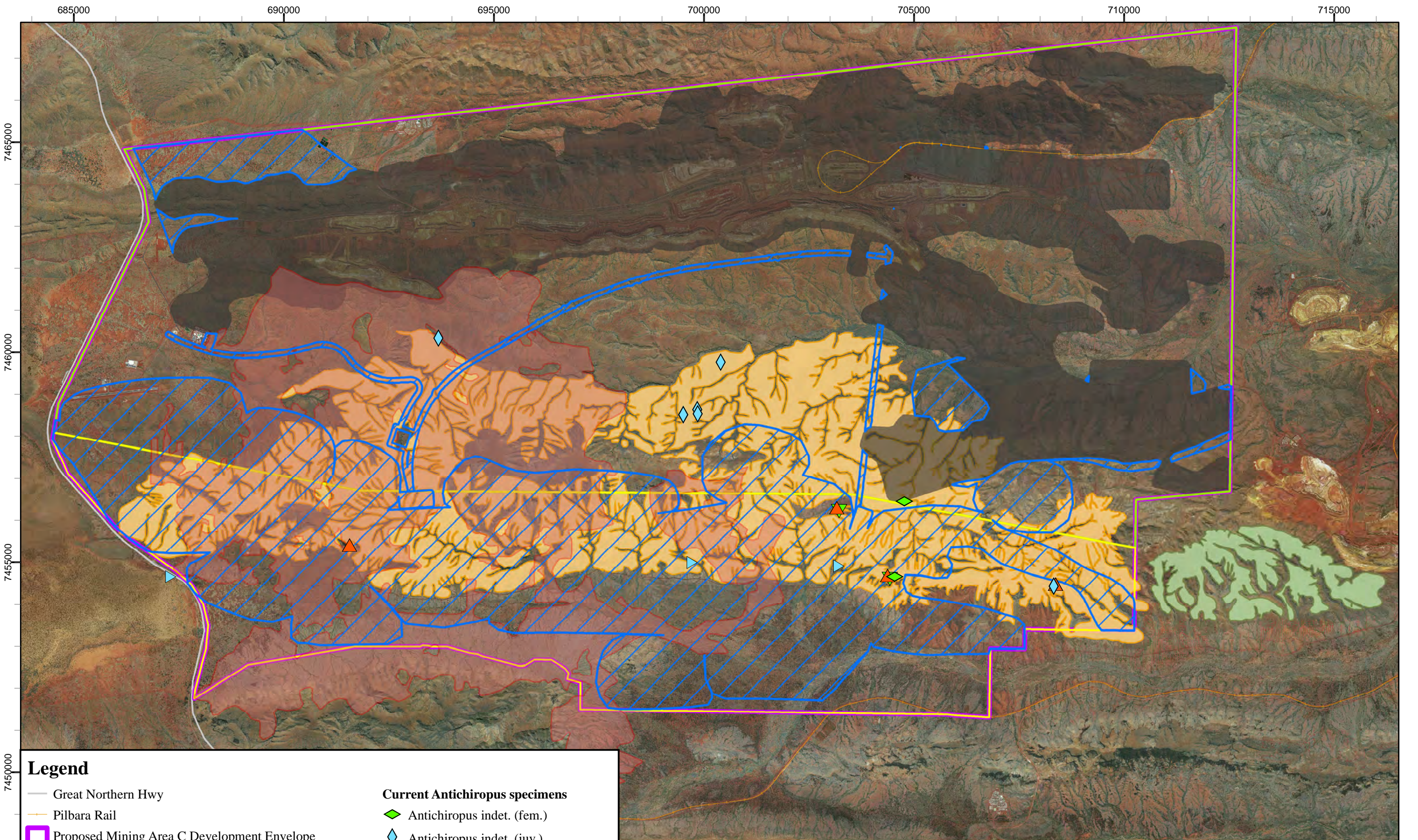
Table 4.2 shows that the Proposed Mining Area C Development Envelope is dominated by Hill slope/ crest and Plains habitats, both of which are generally regarded as having a low suitability for SRE fauna, except where the former contains suitable microhabitats for *Antichiropus* 'DIP007'. There are three habitat zones of high SRE suitability, *i.e.* the Major gorge/ gully, the River gorge and estimated *Antichiropus* 'DIP007' habitat (the latter discussed in Section 4.2). The River gorge habitat zone does not occur within the Additional Development Envelope or the Indicative Additional Impact Assessment Area, and hence there will be no direct impacts to this habitat. Approximately 367.4 ha (57%) of the Major gorge/ gully habitat zone occurs within the Indicative Additional Impact Assessment Area. Of the moderately suitable Shallow open gullies/ ridges habitat zone, 1105.0 ha (40%) occurs within the Indicative Additional Impact Assessment Area.

Whilst there have been no SRE species recorded that are restricted to these habitat zones, the impact of removal of these habitats is considered to be moderate to high for the Major gorge/ gully habitat zone, and low to moderate for the Shallow open gully/ ridges habitat zone.

**Table 4.2: Direct impacts of the Indicative Additional Impact Assessment Area on SRE habitats (percentages are proportion of total mapped within the Proposed Mining Area C Development envelope. Total mapped does not include areas within the Approved Impact Assessment Area.)**

SRE Habitat Zones	SRE Suitability	Proposed Mining Area C Development Envelope (ha)	Additional Development Envelope (ha) / (proportion of total)	Indicative Additional Impact Assessment Area (ha) / (proportion of total)	Proportion Outside All Impact Assessment Areas (ha) / (proportion of total)
Major gorge/ gullies	High (rank 5)	645.9	438.3 (68%)	367.4 (57%)	278.4 (43%)
River gorge	High (rank 5)	100.7			100.7 (100%)
Hill slopes/ crests ( <i>Antichiropus</i> 'DIP007' habitat)	High (rank 5)	7037.6	3517.4 (50%)	3859.2 (54%)	2875.8 (41%)
Shallow open gullies/ ridges	Moderate (rank 3)	2738.8	787.3 (29%)	1105.0 (40%)	1633.8 (60%)
Drainage areas	Moderate-low (rank 2)	2639.0	911.9 (35%)	1151.4 (44%)	1487.7 (56%)
Mulga woodlands	Moderate-low (rank 2)	967.6	634.8 (66%)	744.9 (77%)	222.6 (23%)
Open plains	Low (rank 1)	3598.0	1818.8 (51%)	1814.6 (50%)	1783.4 (50%)
Hill slopes/ crests (non- <i>Antichiropus</i> 'DIP007' habitat)	Low (rank 1)	7044.0	2080.9 (30%)	2301.1 (33%)	4742.9 (67%)





**Legend**

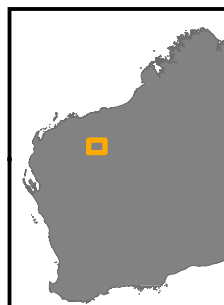
- Great Northern Hwy
- Pilbara Rail
- Proposed Mining Area C Development Envelope
- Current Approved Development Envelope
- Additional Development Envelope
- Current Approved Impact Assessment Area
- Additional Impact Assessment Area
- Fire Scar November 2015
- Antichiropus `DIP007` indicative habitat extent
- Potentially similar hillcrest habitat (Hope Downs tenement)

**Current Antichiropus specimens**

- Antichiropus indet. (fem.)
- Antichiropus indet. (juv.)

**Previous Antichiropus `DIP007` records**

- Confirmed (adult male)
- Presumed (adult female)
- Presumed (juvenile)



**biologic**  
Environmental Survey

0 700 1,400 2,800 4,200 km

1:82,000

N

**BHP Billiton Iron Ore - MAC Revised Proposal**  
**Environmental Impact Assessment of SRE Fauna**  
**Fig. 4.1: Antichiropus `DIP007` indicative extent of habitat relative to current and proposed impacts**

Coordinate System: GDA 1994 MGA Zone 50  
Projection: Transverse Mercator  
Datum: GDA 1994

Size A3. Created 15/07/2016



#### 4.4 Indirect Impacts to Fauna and Habitats

Owing to their proximity to the Indicative Additional Impact Assessment Area, SRE fauna and habitats outside the Indicative Additional Impact Assessment Area may be subject to a variety of indirect impacts such as habitat fragmentation, fire risk, changes to surface and groundwater hydrology, spills and contamination, exotic pests and weeds, and vibration/shock, noise and dust.

##### 4.4.1 Habitat Fragmentation

Fragmentation of highly and moderately suitable SRE habitats may impact on species restricted to these habitats, with respect to inter and intra-population dispersal of individuals. This is most likely to occur in the eastern section of the Proposed Mining Area C Development Envelope where the Indicative Additional Impact Assessment Area and the Approved Impact Assessment Area may create a significant barrier for fauna dispersal between the central and eastern sections of the Proposed Mining Area C Development Envelope and third party tenements to the east and north.

Within the Proposed Mining Area C Development Envelope the extent of habitat suitable for *Antichiropus* 'DIP007' will become fragmented; however, 2208 ha of habitat remains for this species to the north of the Southern Flank deposits. The potential impact from habitat fragmentation is increased from that previously approved under MS 491.

##### 4.4.2 Fire Risk

Changes to fire regimes or an increase in fire risk associated within the Indicative Additional Impact Assessment Area may present an increased risk to the high and moderately suitable SRE habitats; however, these habitats tend to be less susceptible to fire than the surrounding habitats due to their steep, complex topographical features that facilitate the survival of unburnt pockets of vegetation. If current fire management strategies are maintained in the Proposed Mining Area C Development Envelope, the risk of indirect impacts to the highly and moderately suitable SRE habitats is unchanged to that previously assessed under MS 491, and remains low.

With respect to *Antichiropus* 'DIP007', it is unclear the extent to which this species is affected by fire; however, fires occur frequently on hill crests in the Pilbara and individuals of this species are likely to survive; either due to the depth in the soil that they aestivate or possibly relying on patches of unburnt habitat. A reduction in population range and/ or size will place more pressure on any species with respect to disturbances such as fire; however, maintenance of current fire management strategies will likely alleviate this increased pressure, in particular ensuring that patches of unburnt habitat (refuges) exist in the short to medium term to allow the recolonisation of burnt areas after fire. If current fire management strategies can maintain a mosaic of burnt and unburnt patches throughout the remaining A. 'DIP007' habitat, the risk is considered low.

#### **4.4.3 Surface Hydrology**

MWH (2016) determined that the Proposal would impact on 4.7% of the Coondewanna catchment area and 3.5% of the Weeli Wolli catchment, and that creek capture of Pebble Mouse Creek by one of the mine pits was very unlikely. It was concluded that the alteration of local flow paths and runoff volumes for small, ephemeral creeks would be minimised through BHP Billiton Iron Ore's standard surface water management strategies. These drainage areas are not known to support any SRE species restricted to the Indicative Additional Impact Assessment Area or the Proposed Mining Area C Development Envelope.

Assuming that a continuous drainage corridor can be maintained via surface water management strategies, the impacts of changes to surface hydrology would be unchanged to that previously assessed under MS 491, and remain low.

#### **4.4.4 Groundwater Hydrology**

The proposed development will include mining below the groundwater table, which will require pit dewatering, and could result in the propagation of groundwater drawdown; however, none of the key SRE values are associated with habitats that feature groundwater dependent vegetation.

The risk of indirect impacts to SRE habitats from alteration of groundwater hydrology is therefore unchanged to that previously assessed under MS 491, and remains negligible.

#### **4.4.5 Spills and Contamination**

The risks of indirect impacts from environmental incidents such as spills and contamination would be expected to be managed within the Proposed Mining Area C Development Envelope area by the implementation of current environmental management procedures.

As such, the impacts of spills and contamination would be unchanged to that previously assessed under MS 491, and remains low.

#### **4.4.6 Exotic Pests and Weeds**

The risks of indirect impacts from environmental incidents such as exotic pests and weeds would be expected to be adequately managed within the Proposed Mining Area C Development Envelope area by the implementation of current environmental management procedures. As such, the impacts of exotic pests and weeds would be unchanged to that previously assessed under MS 491, and remain low.

#### **4.4.7 Vibration/ shock, noise and dust**

The risks of indirect impacts from vibration/ shock, noise and dust would be expected to be adequately managed within the Proposed Mining Area C Development Envelope area by the implementation of current environmental management procedures. As such, the impacts of vibration/ shock, noise and dust would be unchanged to that previously assessed under MS 491, and remain low.



## 5. CONCLUSION

The extent of SRE fauna sampling (90 baseline SRE sites and 43 targeted SRE sampling sites) and habitat assessments (260 habitat assessment sites) within the Proposed Mining Area C Development Envelope can be regarded as sufficient for the purposes of mapping SRE habitats and fauna distributions for the impact assessment, and to meet the requirements of current EPA guidance (EPA 2009).

The direct impacts to SRE fauna and habitats within the Proposed Mining Area C Development Envelope are increased above those currently approved under MS 491; the removal of 3859.2 ha (54.4%) of *Antichiropus* 'DIP007' habitat and the removal of 367.4 ha (57%) of the highly suitable Major gorge/ gullies habitat are regarded as moderate to high impacts, and the removal of 1105.0 ha (40%) of the moderately suitable Shallow open gullies/ ridges is regarded as a low to moderate impact.

The removal and fragmentation of *Antichiropus* 'DIP007' habitat will significantly reduce what can be regarded as likely to be, or very close to, the full extent of this species' distribution. The impact level of moderate to high also takes into account the uncertainties regarding this species' ecology, in particular population viability thresholds (the minimum population size required for the population to remain viable), and susceptibility to indirect impacts from reduced overall population size, habitat extent, or fragmentation of the habitat. Further knowledge on these ecological aspects could provide a more accurate impact assessment. Nevertheless the retention of approximately 2,200 ha of *Antichiropus* 'DIP007' habitat within the Proposed Mining Area C Development Envelope is considered likely to be sufficient for the species to persist in the medium term with continued fire management strategies, as currently in place at Mining Area C, with a particular emphasis on maintaining a mosaic of burnt and unburnt patches throughout the remaining A. 'DIP007' habitat. In the long term, the reestablishment of habitat suitable for the species, namely *Corymbia hamersleyana* (mallee form) on hill crests, would potentially decrease the direct impact to the species by increasing habitat availability and potentially increasing population size.

The Major gorge/ gully habitat zone contains a range of highly complex, sheltered microhabitats that are known regionally to have a high likelihood of supporting SRE species. Although no SRE species have been recorded that are known to be restricted to this habitat zone within the Indicative Impact Assessment Area, there is a chance that some species may remain undetected, and SRE species associated with Major gorge/ gully habitats are known to occur in the local area. A considerable proportion of the previous extent of this habitat zone within the Proposed Mining Area C Development Envelope has already been removed by mining or approved for mining (within the Approved Impact Assessment Area). Outside of the Approved Impact Assessment Area, the Proposal would result in the removal of a further 57% of the remaining Major gorge/ gully habitats within the Proposed Mining Area C Development Envelope. Although no SRE species have been recorded exclusively within this highly suitable habitat zone, removal or fragmentation of this habitat zone may have a moderate to high impact on SRE values.

The removal and fragmentation of the moderately suitable Shallow open gullies/ ridges is regarded as a low to moderate impact due to the lower suitability of the habitat for SRE fauna and the extent of this habitat, and similar habitats (i.e River gorge and Major gorge/ gullies) throughout the Proposed Mining Area C Development Envelope.

All the other direct and indirect impacts to SRE fauna and habitats remain unchanged from previously approved under MS 491.

The Environmental Protection Authority's (EPA's) primary objectives for terrestrial fauna are to *"maintain representation, diversity, viability and ecological function at the species, population and assemblage level"* (EPA 2015). With regards to SRE fauna, it is considered that the Proposal, with the maintenance of current management strategies and the re-establishment of habitat suitable for *Antichiropus* 'DIP007', will meet the EPA objective for terrestrial fauna.

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