



Legend

- Proposed Mining Area C Development Envelope
- Current Approved Development Envelope
- Additional Development Envelope
- Mining Area C EMP Rev 6 Impact Assessment Area
- Modified Indicative Additional Impact Assessment Area

Group, Taxon

- Mygalomorphae, Yilgarnia `MYG197`



N

1:150,000

0 2.25 4.5 9 km

BHP Mining Area C - Southern Flank

Environmental Impact Assessment of SRE Fauna

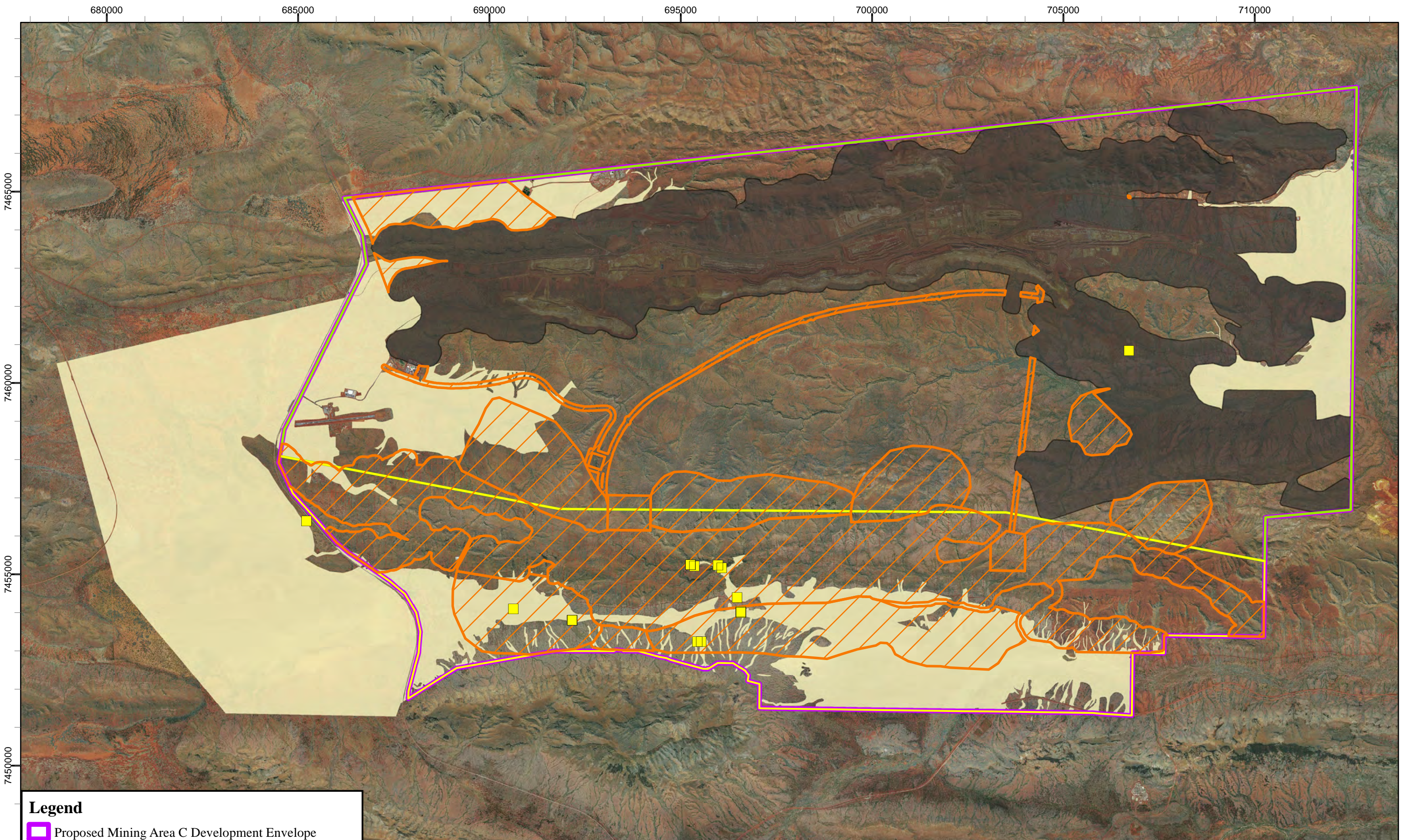
Fig. 1.1: Records of Yilgarnia 'MYG197' relative to the Proposed MAC Development Envelope

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994

Size A3. Created 9/08/2017





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Group, Taxon

- Mygalomorphae, Kwonkan `MYG339`
- Indicative extent of potential habitat



N

1:90,000

0 1.25 2.5 5 km

BHP Mining Area C - Southern Flank

Environmental Impact Assessment of SRE Fauna

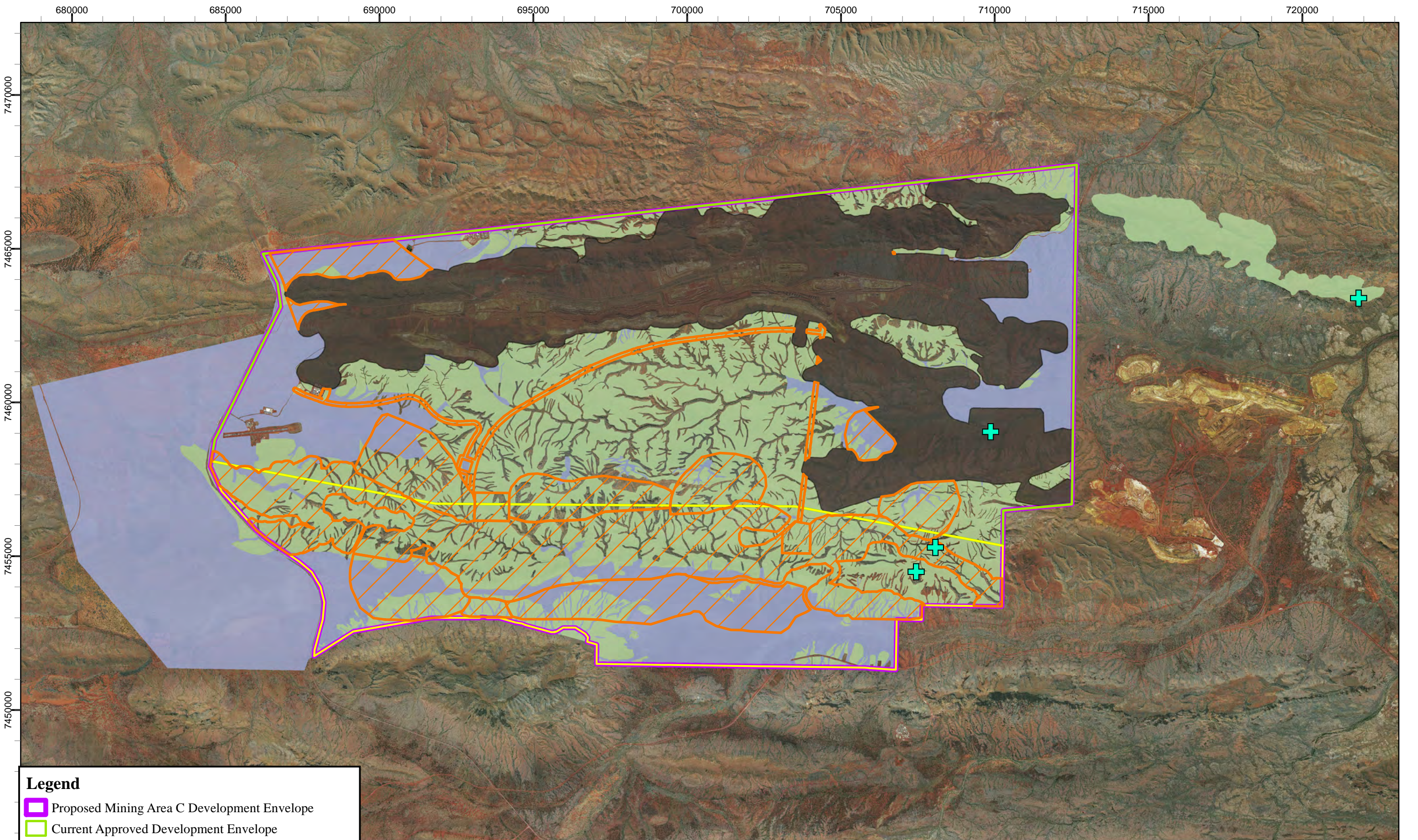
Fig. 1.2: Indicative extent of potential habitat for Kwonkan 'MYG339'

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994

Size A3. Created 9/08/2017





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Group, Taxon

- Myriapoda, Austrostrophus `DIP018`
- Indicative extent of likely dispersal habitat
- Indicative extent of likely primary habitat





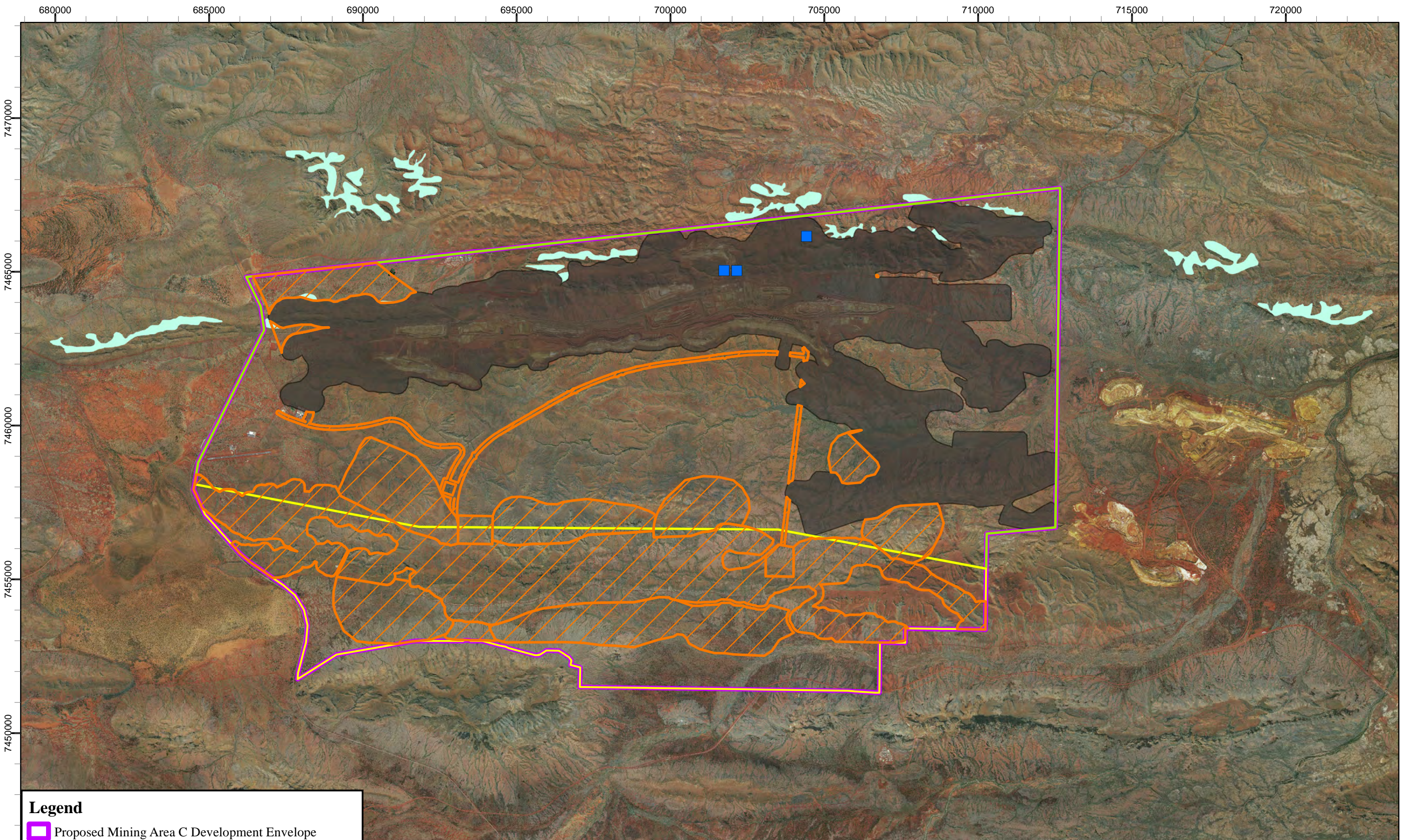
1:112,000

0 1.75 3.5 7 km

BHP Mining Area C - Southern Flank
Environmental Impact Assessment of SRE Fauna
Fig. 1.3: Indicative extent of suitable habitat for Austrostrophus DIP018

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

Size A3. Created 9/08/2017



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Group, Taxon

- Mygalomorphae, Chenistonia 'MYG088'
- Indicative extent of potential habitat (stony crests)

N

1:112,000

0 1.75 3.5 7 km

BHP Mining Area C - Southern Flank

Environmental Impact Assessment of SRE Fauna

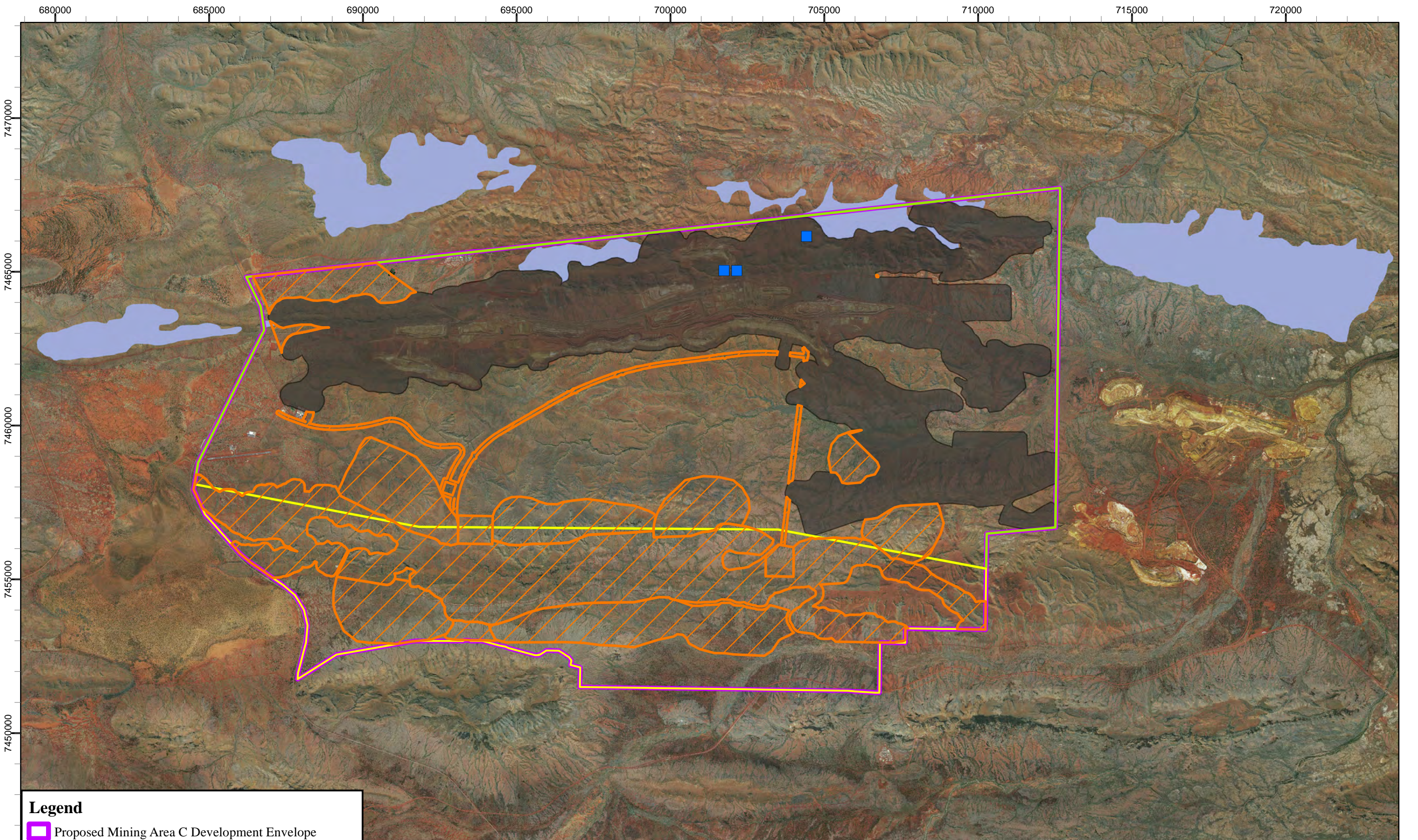
Fig. 1.4: Indicative extent of potential habitat for Chenistonia 'MYG088' (stony crests)

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994

Size A3. Created 9/08/2017



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Group, Taxon

- Mygalomorphae, Chenistonia 'MYG088'
- Indicative extent of potential habitat (rocky habitats)

N

1:112,000

0 1.75 3.5 7 km

BHP Mining Area C - Southern Flank

Environmental Impact Assessment of SRE Fauna

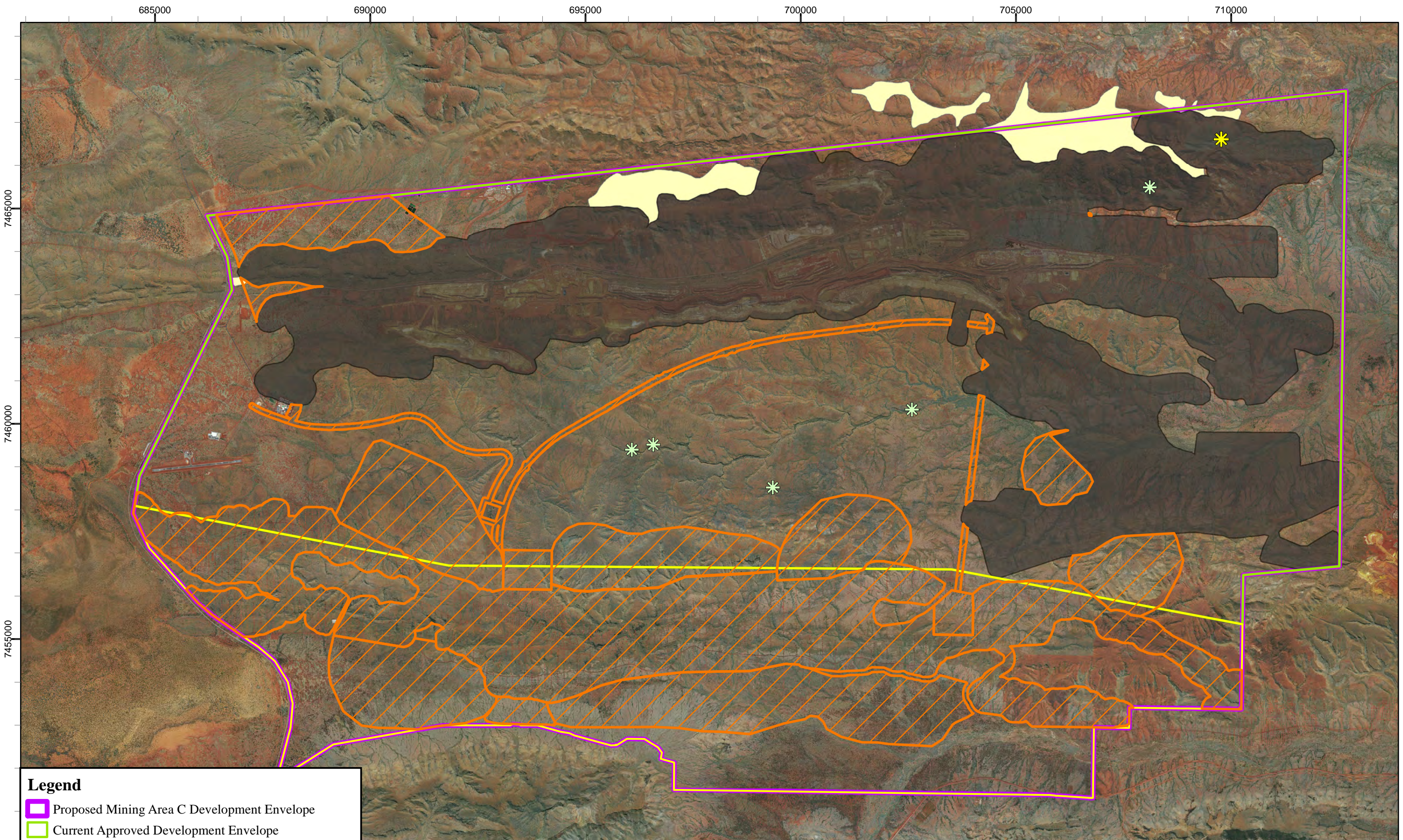
Fig. 1.5: Indicative extent of potential habitat for Chenistonia 'MYG088' (rocky habitats)

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994

Size A3. Created 9/08/2017



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Group, Taxon

- Selenopidae, Karaops banyjima
- Selenopidae, Karaops indet. (juv.)
- Indicative extent of potential habitat

N

1:80,000

0 1.25 2.5 5 km

BHP Mining Area C - Southern Flank

Environmental Impact Assessment of SRE Fauna

Fig. 1.6: Indicative extent of potential habitat for Karaops banyjima

Coordinate System: GDA 1994 MGA Zone 50

Projection: Transverse Mercator

Datum: GDA 1994

Size A3. Created 9/08/2017



Biologic Environmental Survey Pty Ltd

PO Box 179

Floreat, WA, 6014

14th August 2017

Attn: Sarah Williamson

BHP Billiton Iron Ore

125 St Georges Tce

Perth, WA, 6000

Dear Sarah,

Please find below text in response to comments from the Office of the Environmental Protection Authority (OEPA) and Department of Biodiversity, Conservation and Attractions (DBCA) on the PER for Mining Area C – Southern Flank with respect to short-range endemic (SRE) invertebrates.

The figures are available on the BHP SFT and the figure numbers will be modified as required once comments have been received from BHP.

OEPA Comment 18:

Yilgarnia 'MYG197'

Yilgarnia 'MYG197' is known from three locations in the Pilbara, including one approximately 25 km south west of the Proposed Mining Area C Development Envelope (Figure 1.1). All three specimens were adult males captured in pit traps while dispersing, and therefore limited habitat information can be taken from the location of the records. As such, habitat mapping for the species cannot be undertaken; however, it can be regarded as highly likely that the species occurs extensively throughout the area in between the record to the south west and the Proposed Mining Area C Development Envelope. Based on this, the potential impact of the proposal on *Y. 'MYG197'* can be regarded as low.

Kwonkan 'MYG339-DNA'

All specimens of *Kwonkan* 'MYG339-DNA' were collected from burrows and, as such, the habitat information associated with these records can be regarded as a strong indicator of habitat preference. *Kwonkan* 'MYG339-DNA' has only been

recorded from drainage habitats within the Proposed Mining Area C Development Envelope; however, these drainage habitats extend to the west (Figure 1.2) and almost certainly extend to the south and east of the Proposed Mining Area C Development Envelope. The presence of the species in the eastern section of the Proposed Mining Area C Development Envelope also indicates suitable habitat to the north east. It should be noted that it is not known where the species' distribution boundaries are for *K. 'MYG339-DNA'*, although we can say with certainty they are beyond the Proposed Mining Area C Development Envelope. As such, the level of potential impact should be regarded as between low and moderate.

Austrothropus 'DIP018'

Austrothropus 'DIP018' has been recorded at four locations (Figure 1.3), of which three are within the Proposed Mining Area C Development Envelope. Three of the four records were on hill crests, two within South Flank and the third at Packsaddle East. This habitat is likely to be close to, if not the primary habitat for the species as an adult male, adult female and a juvenile have all been recorded in these habitats. The fourth record (a juvenile) was recorded within drainage habitat and was likely dispersing. The suitable habitat map (Figure 1.3) shows likely primary habitat as the hill crest throughout the Proposed Mining Area C Development Envelope; however, at least two more millipede species are also known from within this habitat in the Proposed Mining Area C Development Envelope, including the widespread species *Austrothropus stictopygus*. As such, there is some potential for a more restricted amount of suitable habitat if *A. stictopygus* and *A. 'DIP018'* are competing for microhabitats. Regardless of the extent of suitable habitat within the Proposed Mining Area C Development Envelope, *A. 'DIP018'* is known to occur at Packsaddle East, and can therefore be regarded as potentially occurring at other hills adjacent to the Proposed Mining Area C Development Envelope. The suitability of the drainage habitats (Figure 1.3) for dispersal of *A. 'DIP018'* can be considered likely as dispersal (and therefore gene flow) between the populations at Packsaddle East and South Flank would not occur otherwise. Given the current uncertainty regarding the extent of suitable habitat for *A. 'DIP018'*, the potential impact of the proposal can be regarded as between low (if *A. 'DIP018'* occurs throughout adjacent hills and northern South Flank) and moderate high (if Packsaddle East is the only population of *A. 'DIP018'* outside of the Proposed Mining Area C Development Envelope).

OEPA Comment 19:

- a) N/A

- b) Whilst there has been no research into the recolonisation of rehabilitated mine sites by millipedes, or any SRE species' groups, in the Pilbara region, there has been extensive research throughout the 1980's, 1990's and 2000's on recolonisation of rehabilitated mine sites by terrestrial invertebrates (ants, collembola, termites, spiders and true bugs) in the southwest of Western Australia. This research has indicated that all trophic groups are well represented in post-mining rehabilitated areas (including detritivores, the trophic group that includes millipedes), that there is no difference in species richness for some groups between rehabilitated areas and unmined reference areas, and species composition for most groups improves with rehabilitation age; however, distinct differences remain in species composition, potentially affected by factors such as time, habitat structure, dispersal ability and interspecific interactions between species (Majer *et al* 2007). The application of this research directly to the arid Pilbara region, and particularly to the successful re-establishment of a specific species, should be taken with some caution; however, it does indicate that post-mining rehabilitation can be successful for many species of terrestrial invertebrates, including detritivores, and that consideration of species specific requirements is important for improving the chances of success.

As such, while there is no direct evidence to support the assumption that SRE species, in particular *Antichiropus* 'DIP007, will naturally re-establish in rehabilitated vegetation in the Pilbara, there is evidence that many terrestrial invertebrates will do so, and that the re-establishment of a specific species is more likely to succeed with a considered approach based on solid knowledge of the species and its ecological requirements.

Reference

Majer, J. D., K. E. C. Brennan & M. L. Moir (2007). *Invertebrates in ecosystem restoration: Thirty years of research in land rehabilitation following mining*. Restoration Ecology 15, 103-114.

- c) There has not been any research into whether the microhabitats required by *Antichiropus* 'DIP007 can be re-created; however, based on our current understanding of the microhabitats, it is highly likely that through an appropriately resourced and time-framed scientific approach the right physical conditions can be recreated to provide suitable microhabitat for A. 'DIP007'. Based on our current understanding of the microhabitat and the conditions required, the primary characteristics are likely to be as follows:

- A stable pocket of non-skeletal, loamy soil, at least 15 cm deep and 10 cm in diameter. The stability of the soil pocket (protection from being removed and maintaining stable temperature and moisture) is facilitated by the flat terrain (low runoff), the “cage” provided by the mallee (above and below ground) and the surrounding skeletal, outcropping soils;
- A stable layer of leaf litter above the soil pocket, at least a few centimeters thick. The stability of the leaf litter is likely facilitated by the “cage” provided by the mallee, preventing water runoff and wind from removing leaf litter, and the sparse nature of the vegetation improving the chances that some leaf litter will remain following fire; and
- Low, wide foliage to provide shade throughout most of the day and to provide a reliable source of leaf litter.

A number of approaches can be investigated, including re-creating habitat within rehabilitated areas and translocating individuals, translocating suitable habitat and individuals into rehabilitated areas and re-creating habitat within rehabilitated areas adjacent to remaining suitable habitat and allowing natural re-colonising to occur.

OEPA Comment 20:

A genetic analysis is currently being undertaken to determine if the juvenile specimens of *Antichiropus* found within the remaining suitable habitat are *A.* ‘DIP007’. It should be noted that genetic analysis may not provide a clear delineation of the species, and that some genetic variation will exist within the population, particularly as *A.* ‘DIP007’ is a low mobility species and gene flow is likely to be restricted across the population. Careful consideration has been given to the approach taken for the genetic analysis, which is consistent with previous successful genetic work undertaken on other *Antichiropus* species.

DBCA Comment

Antichiropus ‘DIP006’ and ‘DIP007’

A genetic analysis is currently being undertaken to determine if the juvenile specimens of *Antichiropus* found throughout and adjacent to the Proposed Mining Area C Development Envelope are either *A.* ‘DIP006’ or *A.* ‘DIP007’. This genetic analysis will be used to complement recent habitat assessments undertaken to

produce A. 'DIP006' habitat mapping and to refine the current A. 'DIP007' habitat mapping, if required.

It should be noted that genetic analysis may not provide a clear delineation of the species, and that some genetic variation will exist within the population, particularly as A. 'DIP006' and A. 'DIP007' are low mobility species and gene flow is likely to be restricted across the populations. Careful consideration has been given to the approach taken for the genetic analysis, which is consistent with previous successful genetic work undertaken on other *Antichiropus* species.

Chenistonia 'MYG088'

Chenistonia 'MYG088', now known as *Kwonkan* 'MYG088', has been recorded from three sites, all within the Proposed Mining Area C Development Envelope. Figures 1.4 and 1.5 show two different scenarios for suitable habitat for this species, based on current knowledge; however, a targeted survey and habitat assessment will be undertaken in September 2017 to gather more information to further clarify suitable habitat and likely distribution for the species.

Karaops banyjima

Karaops banyjima is only known from one location (Figure 1.6), and was an adult female recorded on the surface within a lower slope shallow gully. Further investigation of the record location will take place in September 2017 to determine the extent to which it is suitable habitat, regarded as "under rocks, or in cracks in rock walls" for *Karaops* in the Pilbara (Dr. K. Crews pers. comm. 2017), particularly given the specimen was recorded on the surface, "within soil", which is regarded as unusual for adult females (Dr. K. Crews pers. comm. 2017). The suitable habitat map is very conservative at this stage, and further investigation should provide further clarification of the likely extent of the species. Also note there are five juvenile *Karaops* specimens recorded within the Proposed Mining Area C Development Envelope, one 2 km to the south of the adult female, and four in the centre of the Proposed Mining Area C Development Envelope, outside of all impact areas. There is some potential that these could be *K. banyjima*, as the suitable habitat may have extended from Packsaddle into South Flank prior to disturbance.

Please let me know if you have any questions regarding any of the text above.

Yours sincerely,

Brad Durrant

Managing Director

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