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West Angelas – Deposit B and F

Ghost Bat Assessment

Robe River Joint Venture

March 2014

DOCUMENT STATUS				
Revision No.	Author	Review / Approved for Issue	Approved for Issue to	
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EXECUTIVE SUMMARY

Rio Tinto commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a survey of known Ghost Bat (*Macroderma gigas*) roost caves at its West Angelas Deposit B and F (hereafter referred to as the Study Area), which is located approximately 100 kilometres west north west of Newman in the Pilbara region of Western Australia. The caves are located adjacent to pits and associated mining infrastructure.

The Ghost Bat is listed as Conservation Priority 4 by the Western Australian Department of Parks and Wildlife (DPaW) and as Vulnerable by the International Union for the Conservation of Nature (IUCN). The presence of Ghost Bats has been known at West Angelas since at least 1979.

In 1997, as part of the West Angelas Iron Ore Proposal a Ghost Bat Management Plan was developed and a series of monitoring surveys was implemented between 1997 and 2003. Disturbance was not originally proposed for any of these caves during development of a mine at Deposit B; however the pit design was subsequently amended and extended northwards in closer vicinity to the caves.

The scope of the present assessment was to undertake a survey of known Ghost Bats roosts near Deposit B at West Angelas (caves A1, A2, L2 and L3) and at Deposit F (AA1) to determine presence and level of use and thus the conservation value of these caves to Ghost Bats. These caves are referred to as the 'monitoring caves.'

The caves at Deposit B had previously been surveyed by Biologic in November 2012. A second monitoring survey was conducted by Biologic between the 11th and 14th November 2013 by two experienced zoologists. The results from both these surveys are provided in this report.

The monitoring caves were searched for bats and their traces and SM2 bat detector was placed in each cave. Scat collection sheets and temperature/ relative humidity data loggers that were left in place during the 2012 survey were collected.

Ghost Bat usage was observed at four of the five monitoring caves; caves A1, A2 and AA1 had recent scats, and Ghost Bat calls were recorded from the mouth of caves A2 and L3. One Ghost Bat was recorded roosting at cave AA1 during the day. There was no indication that cave L2 had been used by Ghost Bats during the survey period or the prior 12 months.

Based on the results of the two monitoring surveys, it is considered that caves A2, L2 and L3 are used as feeding caves / night roosts. Cave A1 is considered to be a feeding/ day roost and possible maternity roost. Cave AA1 has historically been known to be used as a maternity roost.

The pattern of usage of these caves appears to be intermittent, although some caves (A1 and AA1) appear to be used more regularly than others. During the current survey, only AA1 was in use as a day roost. None of the caves adjacent to Deposit B were currently in use as maternity roosts, but occasional use for this purpose cannot be ruled out at A1. Caves A1 and AA1 have the size and complexity requirements for breeding use.

Given the small estimated size of the Ghost Bat population in the Hamersley Range, the unique genetic variations of these populations, and the bats apparent need to utilise a variety of caves at different times and for different purposes, every suitable roost cave is likely to be of importance to the population. None of the caves fall within the proposed pit area, but it is important to protect the cave site from damage and disturbance as a result of mining operations (i.e. blasting). However, even if the bats cease using the caves closest to the pit during the active life of the mine, it is likely that following closure of the mine and rehabilitation of the site, the caves will become available for use in the future.

The presence of a series of Ghost Bat roost caves with a long monitoring history at different distances from the proposed mine provides an ideal opportunity to study the effects of mining disturbance on Ghost Bats in a controlled manner. It is therefore recommended that annual monitoring surveys be continued and a monitoring and mitigation plan be developed prior to pit extension operations commencing.

1 INTRODUCTION

1.1 Project Background

Rio Tinto commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a monitoring survey of known Ghost Bat (*Macroderma gigas*) roosts near Deposit B and F at West Angelas hereafter referred to as the 'Study Area' (Figure 1.1). The Study Area is located approximately 100 kilometres (km) west north west of Newman, in the Pilbara region of Western Australia. Rio Tinto is proposing to develop the Deposit B pit, together with its associated waste dumps and infrastructure (Figure 1.2).

The Ghost Bat is listed as Priority 4 by the Western Australian Department of Parks and Wildlife (DPaW) and as Vulnerable by the International Union for the Conservation of Nature (IUCN) (see Appendix A for explanation of conservation codes).

Five caves have been identified for monitoring; caves A1, A2, L2 and L3 near Deposit B and cave AA1 near Deposit F. These caves are hereafter referred to as the 'monitoring caves.'

Four caves (caves A1, L2, L3 and I1) close to Deposit B have been previously identified as being of value to Ghost Bats (Ecologia, 1998b) and one near Deposit F (AA1) (Armstrong and Anstee 2000). Cave I1 could not be located during a reconnaissance survey by Biologic in October 2012, and no caves within 'Gully I' were considered to be suitable for Ghost Bats. This cave was subsequently removed from the monitoring programme. An additional cave, cave A2, located in close proximity to cave A1, was identified during the reconnaissance survey as being suitable for Ghost Bats, and hence was included in the monitoring survey.

Disturbance was not proposed in the Environmental Review and Management Programme (ERMP) (submitted to the Environmental Protection Authority (EPA) in 1998 (ecologia Environmental Consultants, 1998a)) for any of the original four monitoring caves. However the Deposit B pit design was subsequently altered and extended northwards. It was considered possible that any Ghost Bats present in the caves near Deposit

B may be disturbed by indirect impacts such as noise or vibration from mining activities.

In light of the new extended pit plans at Deposit B, Biologic was commissioned to undertake monitoring of Ghost Bat presence at the five monitoring caves. A survey was undertaken in November 2012 and demonstrated that there was evidence of recent use of the caves (i.e. 'fresh' scats) and/or signs of historic occupation (i.e. guano accumulations that do not contain 'fresh' material). This survey was conducted during the known Ghost Bat breeding season in an attempt to determine if the caves were being used as maternity roosts, and hence the conservation value of these caves could be determined.

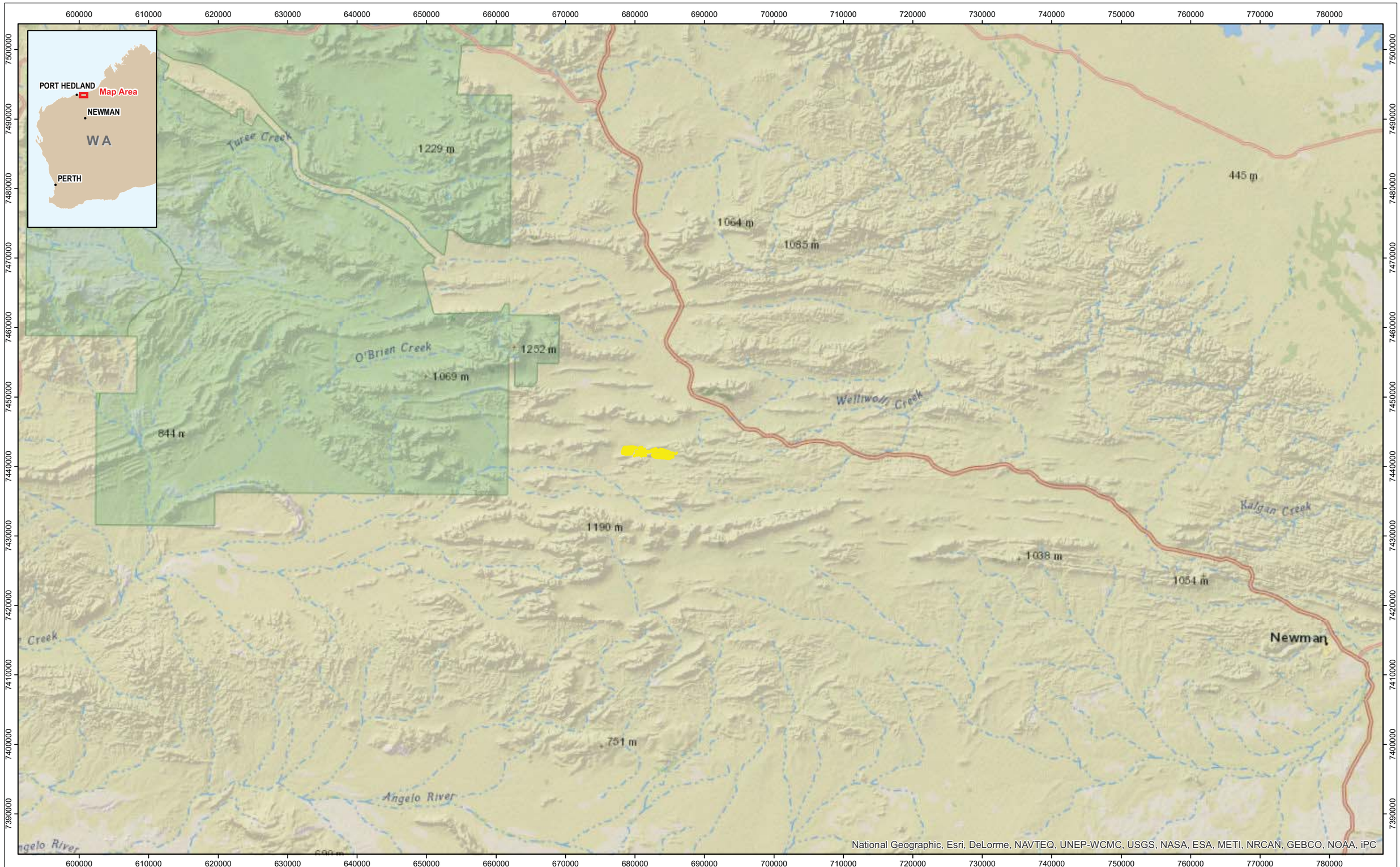
The November 2012 survey identified a pattern of intermittent use of the monitoring caves by Ghost Bats, which was consistent with results from previous monitoring surveys undertaken between 1997 and 2003 (Ecologia 1998a, 1998b, 2000 and 2001, Biota Environmental Services, 2002, 2004b).

1.2 Scope of Works

Biologic were commissioned by Rio Tinto to undertake a survey of five monitoring caves at West Angelas. The main aims of the survey were:

- Review records of historical surveys in the region and other relevant literature to determine the likelihood of use and the conservation significance of caves at West Angelas;
- Undertake a survey of five monitoring caves near Deposit B and Deposit F to determine presence of Ghost Bats or recent use; and
- Determine the importance of each cave for local Ghost Bat populations (i.e. night roost, day roost and/or maternity roost).

This report provides results from surveys undertaken in November 2012 and November 2013.



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RTIO

WEST ANGELAS DEPOSIT B
REGIONAL LOCATION
FIGURE 1.1

Legend

Study Location

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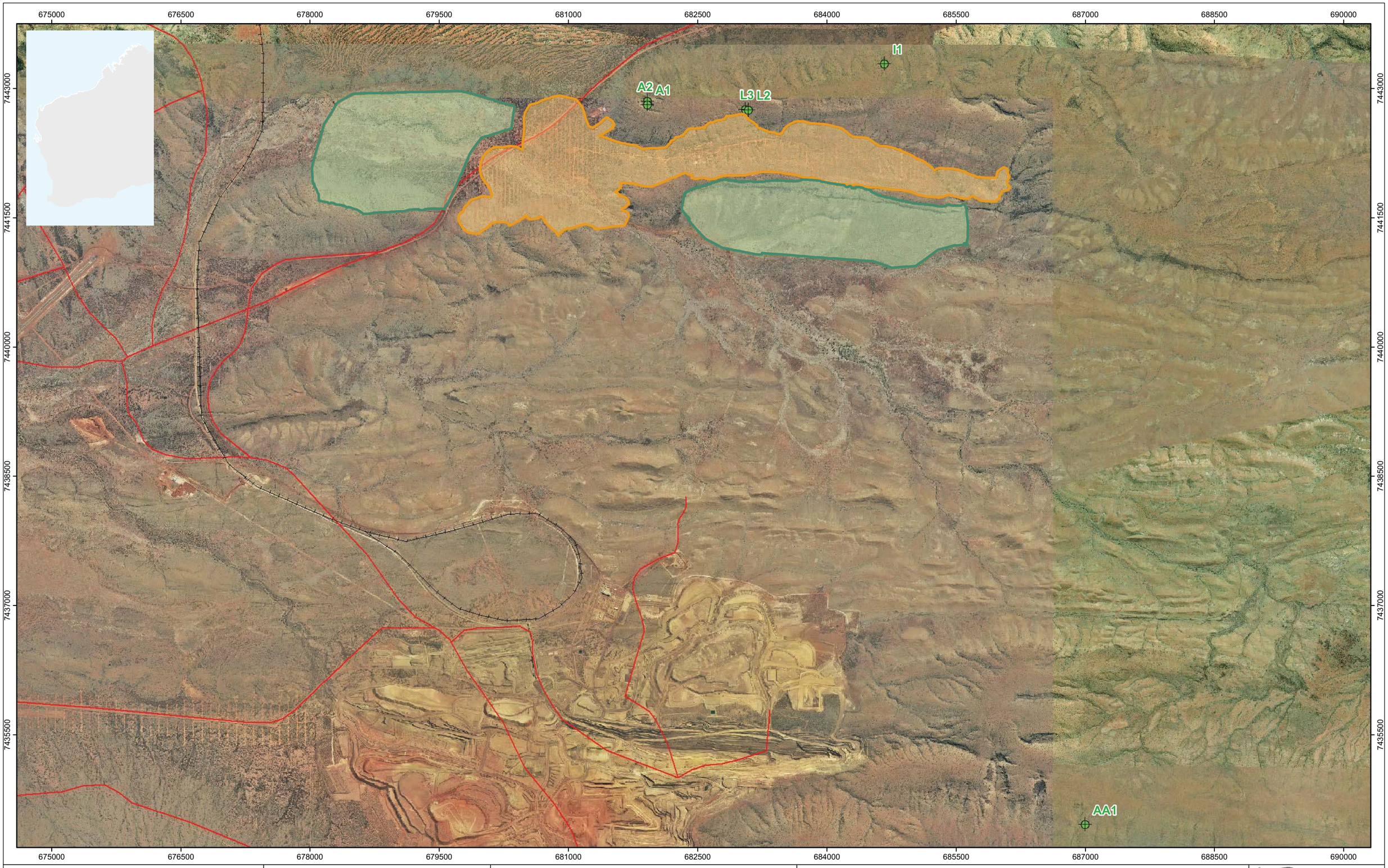

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RTIO

WEST ANGELAS DEPOSIT B LOCATION OF CAVES A1, A2, L2, L3, I1 AND AA1

Legend

- Cave Locations
- Deposit B Dumps
- Deposit B Pit

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2 EXISTING ENVIRONMENT

2.1 Biogeography

Broadly, the Study Area falls within the Pilbara biogeographical region as defined by the Interim Biogeographic Regionalisation of Australia (Thackway and Creswell, 1995). The Pilbara is subdivided into four subregions. The Study Area lies in the Hamersley subregion (PIL-3), which falls in the southern section of the Pilbara Craton (Kendrick, 2001). The subregion is characterised by mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by gorges (Kendrick 2001).

2.2 Geology

The Study Area and its surroundings are underlain by bedrock of Archaean and Proterozoic age, belonging to the Hamersley Basin, consisting mainly of Banded Iron Formation, chert and shale (Tyler *et al.*, 1991). The two larger ore bodies (Deposits A and B) at West Angelas occur within the Marra Mamba Iron Formation, in association with synclinal structures on the banks of the Wanna Munna anticline plunging to the west.

The higher ground is part of a remnant plateau, the Hamersley Surface, of late Mesozoic to early Tertiary age, characterised by lateritic and other ferruginous deposits. The lower ground is occupied by Cainozoic valley-fill deposits of alluvium and colluvium, which may be up to 100 m thick. Older valley-fill deposits are generally consolidated and commonly cemented by iron oxides, being enriched to ore grade in places.

2.3 Land Forms

The Study Area consists of a rounded east-west strike ridge rising about 100 m above the valley, and formed from the Marra Mamba Iron Formation. The slopes of the ridge are incised with steep V-shaped valleys and gorges, which tend to end in horseshoe-shaped gullies below a capping sedimentary outcrop. Cave formation occurred beneath this outcrop. This is well exhibited in gullies ‘A’ and ‘L’ which contain caves used by Ghost Bats.

2.4 Vegetation

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). The Study Area is situated in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia as per Beard (1975) who broadly mapped the area as ranges and valley plains.

The vegetation of the Study Area is dominated by scattered Snappy Gum (*Eucalyptus leucophloia*) over spinifex hummock grassland (predominantly *Triodia brizoides*) on skeletal soils on the ranges, while between them are swathes of mulga (*Acacia aneura*) low woodland over bunch grasses on fine-textured soils of the valley floors (Kendrick, 2001).

2.5 Climate

The Pilbara region has a semi-desert to tropical climate with highly variable, mostly summer rainfall. The average annual rainfall over the broader Pilbara area ranges from about 200 – 350 millimetres (mm) (predominantly in January, February and March), although rainfall may vary widely from year to year. The Pilbara climate is heavily influenced by tropical cyclones that develop over the Indian Ocean in the north of Australia. These sometimes cross the northwest coastline, bringing heavy rainfall to inland regions of the Pilbara.

The Newman airport (109 km ESE of the Study Area) and Paraburdoo airport (106 km W of the Study Area) weather stations are located closest to the Study Area and provide an indication of temperature and rainfall patterns in the area.). Average annual rainfall and average monthly maximum temperatures are shown in Table 2.1 (BoM 2014).

Table 2.1: Average weather conditions at the Newman and Paraburdoo Airport weather stations (BoM 2014).

Weather station location	Average Annual rainfall (mm)	Average monthly max temperature (°C)
Newman airport	310.2 mm (max in Feb 80.1 mm)	31.4 °C (max 39 °C Jan)
Paraburdoo airport	283.8 mm (max in Feb 56.1 mm)	33.3°C (max 40.8 °C Jan)

2.6 Hydrology

Rainfall occurs mainly as tropical summer storms, therefore monthly and annual totals vary widely (see Figure 2.2). Watercourses flow only after heavy or prolonged rainfall, as short-duration floods with rapid peaks and slightly less rapid decline. Water may pond along major watercourses, and persists as pools for several weeks or months. There are few permanent pools or springs in this region of the Pilbara.

The Study Area falls within the Ashburton River catchment. Weeli Wolli Creek is located to the east of the Study Area.

3 LITERATURE REVIEW

3.1 Ecology and Demography

The Ghost Bat is a large carnivorous bat, weighing 140-165 g (Richards *et al.*, 2008), having a diet of small terrestrial mammals, amphibians, small birds, other bats, lizards, spiders and large insects. Ghost Bats hunt using their excellent vision as well as detecting audible sounds and ultrasonic echoes. The Ghost Bat's foraging strategy and high trophic niche, as a top nocturnal carnivorous predator, is unique in Australian microbats (Churchill, 2008; Richards *et al.*, 2008).

The Pilbara Ghost Bat population is estimated at 1500-2000 based on recently published estimates (approximately 600, N.L. McKenzie pers. comm.; approximately 1000, (Armstrong and Anstee 2000); and "more common than previously supposed", McKenzie and Bullen 2009). These recent data (estimates less than 15 years old) come from surveys throughout the general Pilbara area; however these data are limited to surveys undertaken for mining companies (and therefore contain a bias towards areas of potential ore reserves) and the Pilbara Biological Survey undertaken by the DPaW. A majority of this work relied upon echolocation detectors, which are not considered to be as reliable as visual cave assessments (i.e. the presence of scats within caves can be determined even if bats aren't present at the time of survey, but bat detectors would give presence data only if bats were present at the time of survey). Moreover some bat detector technologies are not always reliable for detection of this species as Ghost Bats occasionally use audible social calls instead of ultrasound. Current population estimates in the Hamersley and Chichester subregions are approximately 300 and 1500 respectively (Mr Robert Bullen, *unpub. data*); however further detailed surveys would be required to validate these estimates.

Ghost Bat breeding populations are currently known from a small number of maternity roosts in the Pilbara. The largest of these are in abandoned mines in the Chichester subregion and number up to several hundred (Armstrong and Anstee 2000). There is no known large, permanent

maternity roost in the Hamersley subregion. Known Hamersley populations are between five and 50 individuals in local groups (Bat Call WA, *unpub. data*).

The Ghost Bat is known to disperse from maternity sites on an annual cycle depending upon seasonal weather conditions and availability of suitable day roosts (Richards *et al.*, 2008). The Ghost Bat uses three types of roost regularly, these being (i) night or feeding roosts, (ii) day roosts and (iii) maternity roosts.

(i) Feeding roosts are only used at night, either habitually or for transitory visits. They are typically shallow caves and shelters/ overhangs that can be well lit during the day. They are often high in the strata and are poorly protected from the elements. They contain guano pile(s) and midden(s) (middens differ from scat piles in that they are extensive in size; the width is typically 500 mm or larger, and contains food remains in the form of feathers and bones) of various sizes.

(ii) Day roosts include caves and mine adits that are deeper and more complex in structure. They typically have one or more large chambers at or beyond the twilight area with additional fissures or chambers at the rear in the fully dark regions. They have a minimum roof height in the chambers of two to three metres providing protection from attack by terrestrial predators. Day roosts are often lower in the strata and are well-insulated overhead providing a stable temperature environment. They typically contain multiple middens of guano and food remains that include feathers and skeletal material.

(iii) Maternity roosts are day roosts that provide additional features that are able to support a reproducing population. These features are both natural high temperature (over 27 °C) and humidity levels greater than 75 % relative humidity, or an interior chamber that is rising toward the rear thereby trapping warmer and more humid air at the top, allowing these conditions to form during the period when reproductive females and pups are present. These

roosts are considered regionally significant. It is important to note however that the temperature and humidity characteristics of maternity caves are drawn from caves outside of the Hamersley Range. Recent surveys in the Hamersley Range have recorded breeding in caves that are seemingly less favourable (M O'Connell, pers. obs. 2012).

For aggregations of Ghost Bats to persist in an area, the bats usually require a range of night and day roosting opportunities; at least one deep cave with characteristics of a maternity roost, a productive set of gullies and gorges locally (typically within 1 km) and a productive foraging area within a 5-10 km radius, which usually includes a good quality riparian area, and appropriate protection from human interference (Mr Robert Bullen, pers. comm.). Ghost Bats are known to reproduce in years with high food availability (generally coinciding with above average, prolonged or successive wet seasons) using suitable natural day and maternity roost caves (an example from the Hamersley subregion is a small group of individuals including reproducing females, from caves in the Nammuldi/ Silvergrass area (Hamersley Iron, 1999)).

3.2 Conservation Status

The Ghost Bat has a conservation status of Priority 4 (taxa in need of monitoring) as listed by the DPaW in both the Pilbara and Kimberley. It is Vulnerable C1 (a vulnerable species numbering less than 10,000 and in decline) under the International Union for Conservation (IUCN) Red List (IUCN 2011).

The IUCN (2011) describes its listing as Vulnerable based on the following:

- the species has a small population (less than 10,000 mature individuals);
- the inferred decline in the last three generations has been greater than 10 %, and there is the potential for the population to decline even faster within the next three generations; and

- populations of the species are fragmented, but not considered to be severely fragmented - other than within the Queensland part of the range - as there is likely to be interchange among colonies within, though not between, other parts of the range.

The DPaW do not provide a justification for the Priority 4 listing; however it is likely attributed to the limited roosting habitat available in the Pilbara, and much of this habitat is under threat by mining activities.

3.3 Threats

Numerous surveys have been undertaken over recent years by government departments, universities and research centres, mining companies and environmental consultants in an effort to understand the biological communities present in the region and the effect of changes on the biodiversity (such as development of mining, introduction of feral animals and weeds, changing fire regimes and increased human population) of the region. This has resulted in an increase in the amount of data on species occurrences and distributions.

Currently the main threats to this species in the Pilbara are disturbances associated with mining and entanglement in barbed wire fences (Armstrong and Anstee 2000). The threats to Ghosts Bats in mining areas include direct loss of habitat, disturbances to roosts due to drilling and mining, abandoned mine collapse, human disturbance, competition with introduced predators and foraging habitat modification (Hall *et al.* 1997; Duncan *et al.* 1999).

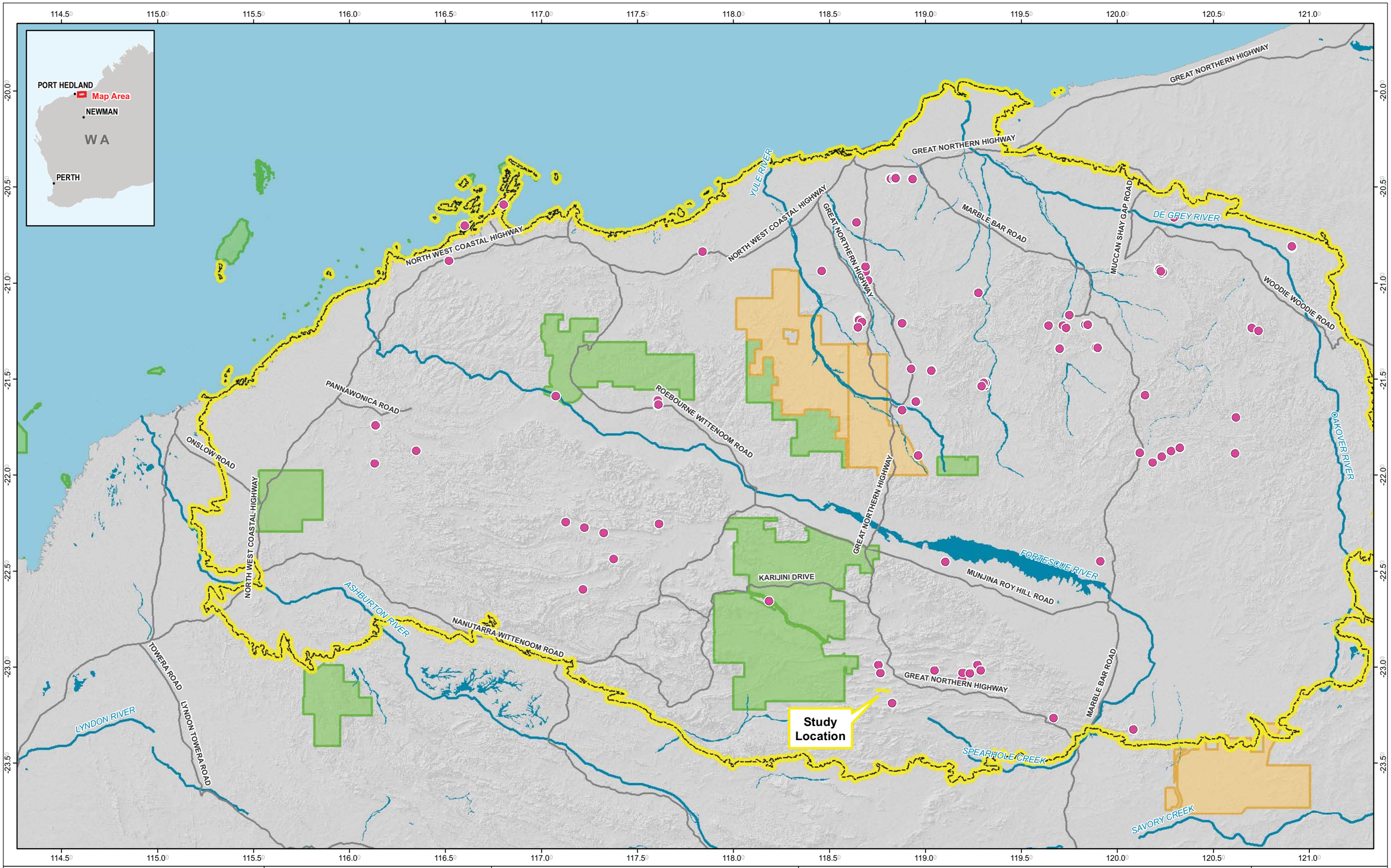
In the context of the current study, the main threats to Ghost Bats using caves located in close proximity to active mining operations (particularly caves L2 and L3) include vibration (potentially resulting in cave collapse or areas of cave collapse rendering them unsuitable for Ghost Bat usage) and increased dust levels (reducing the quality of foraging habitat in the vicinity of the caves) as a result of blasting activities at the nearby Deposit B pit.

3.4 Publicly Available Records

All publicly available records of Ghost Bats from the Pilbara bioregion were compiled using the NatureMap database (Department of Parks and Wildlife (previously Environment and Conservation) and the Western Australian Museum, 2012) and from other records available to Biologic. The distribution of Ghost Bats in the Pilbara is illustrated in Figure 3.1. This indicates that although Ghost Bats are distributed widely across the Pilbara bioregion, the distribution is patchy and sparse. There are fewer records from the Hamersley Range than the Chichester region, in agreement with available population estimates.

Genetic studies indicate that there is a major division between the Hamersley Ghost Bat populations and those from eastern Pilbara (Chichester) Ghost Bats, with the Fortescue valley acting as a barrier to the flow of mtDNA (female philopatry) (Biota Environmental Services, 2004a). Moreover, the Hamersley populations have a higher degree of unique genetic diversity, while the eastern Chichester populations have a lower diversity of haplotypes consistent with recent derivation of the populations through the founder effect. This may result from recent colonisation of abandoned mines in the Chichester area (Biota Environmental Services, 2004a).

The relatively small population size and genetic uniqueness both serve to increase the importance of the Hamersley Ghost Bat populations in term of their conservation.



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Kilometers

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Datum: GDA94

Projection: MGA Zone 50

RTIO

GHOST BAT RECORDS LOCATED IN THE PILBARA BIO-REGION FIGURE 3.1

Legend

- Ghost Bat Records
- Pilbara IBRA 61 Boundary
- Study Location

Reserves

- IndigenousReserve
- NatureConservationReserve

- Roads
- Hydrology
- Lakes

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3.5 Summary of Previous Bat Monitoring at West Angelas

The first sightings of Ghost Bats in the proximity of West Angelas were documented in 1978 (Integrated Environmental Services, 1980). Ghost Bats have been recorded in the West Angelas area, at various levels of intensity, at least six times since they were first reported. A summary of previous Ghost Bat monitoring at West Angelas has been prepared (Nixon, 2012). This is presented in Appendix B and salient points from this are extracted in Table 2 below.

Table 3.5: Summary of Ghost Bat monitoring at West Angelas from 1979 – 2012.

Survey	Summary
An ecological appreciation of the West Angelas environment, Western Australia 1979 (Integrated Environmental Services, 1980)	Results of an extensive fauna and flora survey conducted between 1978 -1979. Ghost Bats were reported from a cave near Deposit E (Cave 1) and presence at two further caves, including one near Deposit B (Cave 3). Caves 1 and 3 were considered to be maternity roosts on the basis of their large middens and the presence of a possibly pregnant female, captured at Cave 1. [Note that Cave 1 appears to be Cave AA1 and the coordinates given for Cave 3, although erroneous, place this cave in the vicinity of the Deposit B Cave A1 of ecologia Environmental Consultants (1998c) and later reports]
West Angelas Iron Ore Project Vertebrate Fauna Assessment Survey (ecologia Environmental Consultants, 1998b)	An extensive vertebrate fauna assessment was undertaken by Ecologia Environmental Consultants between June and October 1997. Four Ghost Bats were recorded in rocky gully habitat (sites WA4, WA12 and WA13) in the mine area including a cave near Deposit B. Eight Ghost Bats were observed roosting in a cave overlooking the Mulga plains in the Coondewanna West section of the rail corridor. These records confirmed earlier reports of Ghost Bat presence at West Angelas (Integrated Environmental Services, 1979).
West Angelas Project Ghost Bat (*Macroderma gigas*) Assessment *Survey (ecologia Environmental Consultants,*	A systematic survey of gullies adjacent to Deposits A, B, E and F was undertaken between August and September 1998. This survey sought to clarify the distribution and abundance of Ghost Bats at West Angelas, as recommended by the West Angelas ERMP to minimise the potential impacts on Ghost Bats. A total of 60 caves in 27 gullies were searched for Ghost Bats, scat material and animal remains. Many

Survey	Summary
1998c)	cave-like structures were found; however not all were regarded as suitable roosts for bats. Bats were only found in caves, none were found in overhangs or other geomorphological features. One female Ghost Bat was captured in a very large cave (AA1) near Deposit F. It was a mature female and may have been pregnant as its abdomen was swollen. The abundance of scats and feeding remains in the AA1 cave suggested long term utilisation. The cave was thought to be a Ghost Bat maternity cave and was considered to be of considerable conservation significance. Although only one Ghost Bat was observed during the survey, a total of six caves and an adit contained evidence of Ghost Bat use. The condition of scat material in the other five caves and the adit suggested all had been used relatively recently, at least within the last year. It appeared that these caves were subject to only temporary, intermittent or seasonal use. Caves with only small amounts of Ghost Bat scat material and feeding remains were thought to be used as feeding sites only (A1, L2, I1, AB1 and the adit).
West Angelas Minesite Ghost Bat Assessment Survey, September 2000. (ecologia Environmental Consultants, 2000)	A survey was undertaken during August 2000 for evidence of Ghost Bats in caves previously surveyed to clarify the distribution and abundance of Ghost Bats in the proposed project area. Many cave-like structures were present in the survey area however not all were regarded as suitable roosts for bats. Of the five caves surveyed, recent evidence of Ghost Bats was recorded in two of the caves (I1 and AA1) and a Ghost Bat was sighted in cave A1. Caves L2 and L3 showed signs that Ghost Bats had been habituating these caves in the past, but it was difficult to evaluate how long ago this occurred.
West Angelas Minesite Ghost Bat Monitoring Survey, September 2001. (ecologia Environmental Consultants, 2001)	A survey of caves identified as supporting Ghost Bats during the September 2000 survey was undertaken during September 2001. Bat occupation was based on the presence of scats and condition of scat material. Of the five caves known to contain evidence of Ghost Bats, recent activity was recorded at only three caves. Evidence collected in two of the caves (AA1 and A1) comprised bone fragments and scats. In the third cave (AB1) only scats were collected. No Ghost Bats were found roosting in any cave searched during the 2001 survey.
Ghost Bats at West Angelas: 2002	All seven Ghost Bat roosts identified previously were examined for current or recent signs of occupancy. The additional caves mentioned in Ecologia (2001)

Survey	Summary
Survey, Data Review and Future Directions. (Biota Environmental Services, 2002)	were not examined as these did not contain evidence of past use by Ghost Bats. No Ghost Bats were observed in any feature. Recent signs of occupancy ('fresh' scats) were present in three caves (AA1, AB1 and L3) and the West Angelas adit. The remainder of the caves (A1, I1 and L2) showed no signs of recent activity. Very little obvious feeding remains were observed in any cave.
Monitoring of Ghost Bat Roosts at West Angelas 2003 (Biota Environmental Services, 2004b)	All seven Ghost Bat roosts (six caves and one adit) identified previously from West Angelas were examined for recent signs of occupancy in December 2003. Ghost Bats were observed in cave A1 adjacent to Deposit B. Recent signs of occupancy (non-degraded scat material) were present in two other caves (AA1 and AB1) indicating that they may have been used by a small number of individuals at most sometime during the year. The West Angelas adit and the remainder of the caves (I1, L2 and L3) showed no signs of recent activity. Very little obvious feeding remains were observed in any cave.
West Angelas – Deposit B Ghost Bat Assessment (Biologic 2012)	Four caves identified as in close proximity to the new pit designed for Deposit B were surveyed for bats and their traces in October 2012. Caves A1 and L3 were also surveyed using passive ultrasound survey. The results of the current study concur with those of previous surveys in that the pattern of usage of these caves is intermittent. Presence of Ghost Bat usage of caves A1 and L3 was confirmed by the presence of a significant quantity of recent scats, and by Ghost Bat calls recorded on two nights outside cave L3. However no Ghost Bats were recorded roosting in these caves during the day. These two caves were categorised as feeding/ night roosts and occasional day roosts. The size and complexity of these caves, together with the quantities of scats, suggests use as occasional maternity roosts cannot be ruled out.

4 METHODS

4.1 Survey Team

The assessment was undertaken by ecologists with extensive experience with the target bat species in the Pilbara. The following personnel were involved in the project:

- Mr Morgan O'Connell – Principal Zoologist. Project Manager and quality assurance.
- Dr Drew Gardner – Senior Zoologist. Field survey and reporting.
- Mr Thomas Rasmussen – Senior Zoologist. Field survey.
- Dr Tania Wild – Senior Environmental Advisor. Reporting.
- Mr Robert Bullen – Specialist Bat Consultant (subcontracted from Bat Call WA). Analysis of bat calls.

Assistance in the field was given by Rio Tinto personnel.

4.2 Field Survey

4.2.1 Timing

The field survey was conducted from the 11th to 14th November 2013. The survey was timed to coincide with the breeding season of Ghost Bats (see Section 3).

4.2.2 Weather

Temperatures at Newman airport (BOM station 007176, 109 km ESE of the Study Area) during the survey ranged between 17.5 ºC and 40.6 ºC, which fall within the typical temperature range for November. Relative humidity ranged between 1 % and 15 % which was low compared to the average relative humidity for November (15 % to 23 %). In November 2013, the total monthly rainfall was 7.4 mm, which was slightly lower than the monthly average (9.8 mm) (BoM 2014).

Temperatures at Paraburdoo airport (BOM station 007185, 106 km W of the Study Area) during the survey ranged between 20.9 ºC and 41.2 ºC, which fall within the typical temperature range for November. Relative

humidity ranged between 6 % and 15 %, which was low compared to the average relative humidity for November (11 % to 23 %). The total monthly rainfall for November 2013 was 0.8 mm, which was lower than the monthly average (6.4 mm) (BoM 2014).

4.2.3 Cave Assessment

The caves were categorised using the following definitions:

- **Feeding Cave / Night Roost** - no individuals seen and only a small number of scats observed.
- **Feeding Cave / Possible Day Roost** –no individuals seen but large scat piles observed.
- **Day Roost** - individuals are or have been observed within the cave during the day. The cave can be visually inspected for the presence of juveniles, and a negative result is obtained.
- **Day Roost / Possible Maternity Roost** - individuals are observed within a cave during the day but flush or hide before a full inspection of individuals possibly carrying juveniles can be made.
- **Maternity Roost** - juveniles are observed attached to females within a cave.

Note that all maternity roosts are day roosts, but not all day roosts are maternity roosts.

At the mouth of each cave a team of two observers documented cave morphology and geology. Assessments on cave stability were undertaken to determine if caves were safe to enter. Readings of gas concentrations (oxygen, carbon dioxide, hydrogen sulphide and the lower explosive limit) in the cave atmosphere, as measured inside the cave mouth, were taken by Rio Tinto personnel using a calibrated hand-held gas meter. If deemed safe, the lead observer entered the caves for a more detailed visual assessment and the second observer remained outside the cave entrance to watch for Ghost Bats departing the cave during the assessment. Radio and vocal communications were maintained between the observers at all times.

The dimensions of each cave were measured using a laser distance measure and measurements of relative humidity, temperature and light levels were made both at the cave entrance and at the roost site inside the cave.

The use of the cave by Ghost Bats was confirmed by a visual sighting and/ or the presence of middens and/ or scat piles within the cave. The Ghost Bat is distinctive in being very much larger than any other cave dwelling bat in the region, and is easily identified. Scats and middens are also distinctive for this species. Any individuals sighted were assessed to determine the reproductive status (i.e. if juveniles were present or if females were gravid).

Sheets of black cotton measuring 1.5 m^2 were placed on any middens or large scat piles present to collect any scats dropped between the present and any subsequent surveys. Presence of scats on the sheets indicates use of the caves by Ghost Bats over a known time period, and enables acquisition of scat samples for further studies (e.g. dietary analysis).

4.2.4 Remote Detection

Ultrasonic bat detectors (SM2 Songmeter, Wildlife Acoustics USA) recording continuously (Hyder *et al.* 2010) were placed in the entrance of all five caves for two nights (12 and 13 November 2013), to determine if Ghost Bats or other bat species were present. The SM2 Songmeters contain omnidirectional microphones and record calls in .wav high quality audio formats, compressed to form .wac files. The SM2 Songmeter also records audible calls, which are often made by Ghost Bats when exiting caves, thus providing an additional method of detecting this species.

5 RESULTS

5.1 2013 Survey

Evidence of Ghost Bat usage was observed at four (AA1, A1, A2 and L3) of the five monitoring caves:.

- Cave AA1: one Ghost Bat was observed in cave during the day on 14th November 2013 and fresh scat piles were present.
- Cave A1: fresh scat piles were present.
- Cave A2: fresh scats and Ghost Bat calls recorded on 12th November.
- Cave L3: Ghost Bat calls were recorded on the 12th November. No scats observed.

Gas measurements for all caves were within normal atmospheric levels.

Two other bat species were recorded during the survey, *Vespadelus finlaysoni* and *Taphozous georgianus.*

5.2 Comparison with Previous Surveys

Monitoring of bat caves has been undertaken at West Angelas since 1978, with nine surveys undertaken over the 25 year period. Eight caves have been assessed during these surveys (Table 5.1).

During a reconnaissance survey by Biologic in October 2012, cave I1 could not be located, and an additional cave (A2) was included in the monitoring programme. On recommendation of Rio Tinto, cave AB1 and the adit were not included in the programme. Cave AB1 is considered unlikely to be impacted by mining operations, and this, along with the adit, was considered by ecologia (1998) to be a night (feeding) roost only.

Cave A1, AA1, AB1, I1, L3 and the Adit have shown signs of Ghost Bat use during all surveys they have been assessed; however the level of use has varied (although it is noted that this may be due to different survey techniques or experience of the consultants). Cave L2 is the only cave which has indicated no use of Ghost Bats during a survey period (this survey and November 2002 (Biota 2002)). Cave A2 has only been

monitored over the past two years, but during both surveys has shown presence of Ghost Bat surveys either during the survey or recently prior.

Note that the use of SM2Bat detectors has only occurred in the last two surveys. Anabat detectors have not been used in the monitoring programme.

Table 5.1 Summary of Ghost Bat records from current and previous surveys.

Cave	1978/ 9	1997	Sep 1998	Aug 2000	Sep 2001	Nov 2002	Dec 2003	Nov 2012	Nov 2013
A1	-	P(4)	R	P(1)	R	O	P(1)	R	R
A2	-	-	-	-	-	-	-	R	R,C
AA1	**P(1)**	-	**P(1)**	R	R	R	R	-	P(1), R
AB1	-	P(8)	R	-	O	R	R	-	-
I1	-	-	R	R	-	O	O	-	-
L2	-	-	R	O	-	N	O	O	N
L3	P	-	O	O	-	R	O	R, C	C
Adit	-	-	O	-	-	O	O	-	-
Ref	IES 1980	Ecologia 1998a	Ecologia 1998b	Ecologia 2000	Ecologia 2001	Biota 2002	Biota 2004	Biologic 2012	This report

Note Caves AA1, AB1 are not in the vicinity of Deposit B. The Adit is due to be destroyed by the development of Deposit B, but was not included in the current survey.

P Ghost bats present (number observed in parentheses). Individuals considered possibly pregnant are shown in bold
R Recent signs of occupation from fresh scats
C Calls recorded at night (note that this was only undertaken in the most recent surveys)
O Guano accumulation but no fresh scats
N No signs of Ghost Bat occupation
- Not surveyed

5.3 Cave descriptions

5.3.1 Cave A1

Cave A1 is a large cave located at 681914mE 744280mS (WGS84). The cave is approximately 21 m deep and is situated mid-slope at the head of a horseshoe-shaped valley. The cave is reached via a vegetated talus slope from the valley floor. The entrance (Appendix B, Plate 1) faces NW, measures about 5 m across and 3.5 m high at the highest point, and is partially blocked by fallen boulders. It was not possible to reach the furthest

end of the cave as it became too narrow. The cave has one long chamber and a small side chamber on the right facing inwards. A low wall of fallen blocks 2-3 tiers high appears to have been constructed across the cave approximately 8 m in, separating the cave entrance area from the inner chamber (Plate 1). The outer chamber had a temperature of 28 °C, 25 %RH and 3000 lux. Conditions in the inner chamber were not able to be recorded.

Throughout the duration of the survey program (1997-2013), this cave appears to be consistently utilized by Ghost Bats. Surveys from 1997 to 2003 recorded the presence of Ghost Bats or recent signs of occupation in the cave. During the 2012 survey, the cave was found to contain abundant (1000+) Ghost Bat scats, including recent ones. There was also a scat pillar approximately 40 cm tall towards the rear of the cave.

In the current survey recent, fresh Ghost Bat scats (200 – 300) were found in the cave. The presence of Ghost Bat scats indicates use of the cave at least as a night feeding roost; however previous surveys have recorded animals using this as a day roost. No Ghost Bats were visually observed or recorded on ultrasonic recorders during the 2013 survey.

This cave is classified as a feeding / day roost cave and possible maternity roost. There was no indication that the cave was being used as a maternity roost during the November 2012 or November 2013 surveys; however one animal was recorded during December 2003, which is when roosts may be used for breeding.

5.3.2 Cave A2

This cave, located at 681918mE 7442857mS (WGS84), occurs mid slope on the northern side of gorge ‘A’ and faces south west (Plate 4). It extends for 14.8 m in a single chamber and has an entrance 4.5 m wide by 4 m high.

This cave has only been surveyed twice (2012 and 2013). During the 2012 survey, two recent Ghost Bat scats were found in the inner cave. In the 2013 survey, recent, fresh Ghost Bat scats (6-20) were also found in the cave. Ghost Bat calls were detected on the 12th November 2013, however

no individuals were observed. The consistent presence of small numbers of Ghost Bat scats indicates that at a minimum this cave is used as a night feeding roost. Further monitoring surveys may show it is used occasionally as a day roost.

5.3.3 Cave AA1

This cave, located at 686950mE 7434465mS (WGS84), extends for 70 m and has three chambers. The sheltered horizontal entrance is 15 m wide by 4 m high. The outer chamber had a temperature of 36 °C, 19 %RH and 4500 lux. The inner chamber had a temperature of 29.7 °C, 21 %RH and 0.00 lux.

This cave has been identified as an important maternity cave in the region, with the presence of a possibly pregnant female has recorded during 1978/9 (IES 1980) and September 1998 (ecologia, 1998b).

The cave has shown consistent presence of Ghost Bats during all surveys since monitoring commenced in 1978/9 (it wasn't surveyed during 2012). Ghost Bats have been observed in the cave on three occasions over the monitoring period (1978/9, 1998, 2013). Recent signs of occupation (scats) have also been consistently recorded (2000, 2001, 2002, 2003 and 2013).

During the current study, abundant, recent, fresh, old and ancient Ghost Bat scats were found in the cave. No Ghost Bat calls were recorded at this cave, however one Ghost Bat was recorded using the cave as a day roost. This bat was flushed from the roost, so an assessment of breeding status could not be made.

This cave is classified as a day roost, and maternity roost.

5.3.4 Cave L2

Cave L2, located at 683086mE 7442760mS (WGS84), has a single west-facing entrance sloping downwards from a pile of boulders from an old roof collapse. The entrance measures 5 m wide by 2.7 m high and the cave extends 25 m in a single chamber (Plate 5).

The outer chamber had a temperature of 34 °C, 24 %RH and 4000 lux. The inner end of the chamber was 33 °C, 24 %RH and 1.8 lux (light level equivalent to a moonlit night).

Recent Ghost Bat scats were recorded at this cave during the 1998 survey, however subsequent surveys have only recorded guano accumulation (2000, 2003 and 2012 surveys) or no signs of Ghost Bat occupation (2002 and this survey).

Although the cave appears to be suitable for Ghost Bat utilisation, it is possible that the downwards sloping entrance may deter them by making the exit more strenuous and difficult. The cave was therefore classified as a feeding/ night roost.

5.3.5 Cave L3

This cave is located at 683054mE 7442766mS, WGS84, extends for 29 m and has two chambers. The entrance is 12.5 m wide and 2.5 m high at the central point (Plate 8. Safe entrance is on the right hand side.

The outer chamber had a temperature of 32 °C, 26 %RH and 3800 lux. The inner chamber was 29 °C, 31 %RH and 0.15 lux. It appears to be less stable in terms of relative humidity than A1 with greater fluctuations (Figure 5.1). The inner chamber is in almost complete darkness.

This cave appears to have consistently supported Ghost Bats since monitoring commenced in 1978/9. Signs of Ghost Bat use (guano or scats) were recorded in 1998, 2000, 2002, 2003 and 2012. Ghost Bat calls were recorded during 2012 and 2013.

This cave is classified as a feeding/ night roost.

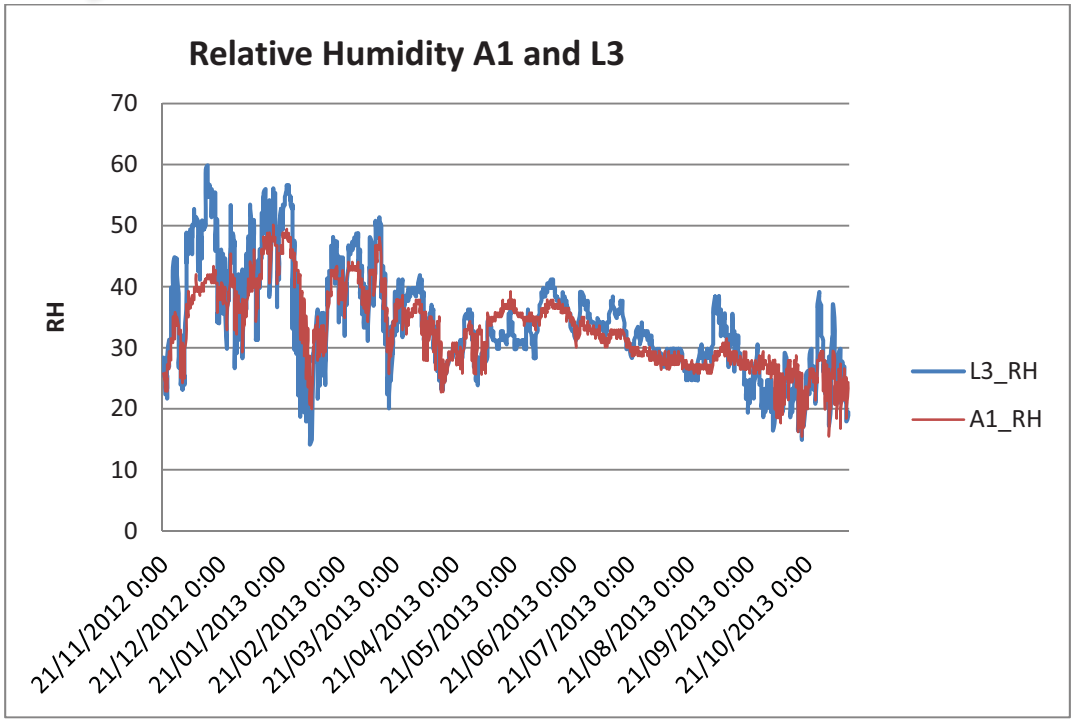
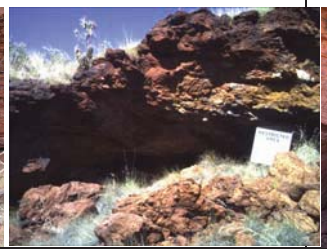


Figure 5.1: Comparison of relative humidity between A1 and L3 from November 2012 to October 2013.

Table 5-2 Characteristics of Ghost Bat caves surveyed in November 2013.

Cave	A1	A2	AA1	L2	L3
Observed Ghost Bat usage	Ghost Bat scats (fresh, recent)	Ghost Bat scats (fresh, recent)	Abundant (2 x 1000+) Ghost Bat scats (fresh, recent, old and ancient) one with pillar.	No Ghost Bat scat seen.	No Ghost Bat scats seen.
Coordinates UTM Zone 50K, WGS84	681914mE 7442820mS	681918mE 7442857mS	686950mE 7434465mS	683086mE 7442760mS	683054mE 7442766mS
Basic Geology	Marra Mamba Iron formation	Marra Mamba Iron formation	Marra Mamba Iron formation	Marra Mamba Iron formation	Marra Mamba Iron formation
Entrance description	Single horizontal entrance at head of horseshoe-shaped gully	Single horizontal entrance on north side of horseshoe shaped gully	Entrance is open, wide but fairly low and horizontal in aspect.	Single entrance sloping down from boulders from old roof collapse.	Single horizontal entrance at head of horseshoe shaped gully
Entrance dimensions W x H (m)	5 m X 3.2 m	4.5 m X 4 m	15 m x 4 m	5 m X 2.7 m	12 m x 2.5 m
Cave depth	21 m	14.8 m	70 m	25 m	29 m
Entrance collapsed, tight or open	Open	Open	Open	Collapsed	Open
Entrance orientation	NW	WSW	W	W	S
Cave grouping	Loose group of caves and overhangs	Loose group of caves and overhangs	Unknown	Tight group of three caves in gully	Tight group of three caves in gully
Location on slope	Mid slope	Mid slope	Mid slope	Mid slope	Mid slope
Cave interior description	One long chamber with small side chamber	One chamber	Three chambers	One long chamber	One long chamber with smaller side chamber
Rear passages that may have Ghost Bat roosts	Yes	No	Yes	No	Yes

Cave	A1	A2	AA1	L2	L3
Distance from proposed mining operations	440 m	470 m	900+ m	75 m	67 m
Local Ghost Bat foraging opportunities	Eucalypt woodland and ephemeral pools in gorge gully.	Eucalypt woodland and ephemeral pools in gorge gully.		Eucalypt woodland and ephemeral pools in gorge gully.	Eucalypt woodland and ephemeral pools in gorge gully.
Entrance chamber temperature, relative humidity and light level	28 °C 25 % 3000 lux	28 °C 25 % 3000 lux	36 °C 19 % 4500 lux	34 °C 24 % 4000 lux	32 °C 26 % 3800 lux
Internal temperature, relative humidity and light level	-	-	29.7 °C 21 % 0.00 lux	33 °C 24 % 1.8 lux	29 °C 31 % 0.15 lux
Type of Ghost Bat roost assessed	Feeding cave / day roost Possible maternity roost	Feeding cave / night roost	Feeding cave/ day roost /maternity roost	Feeding cave / night roost	Feeding cave/ night roost
Other bats present	*Vespadelus finlaysoni*	*Vespadelus finlaysoni* *Taphozous georgianus*	*Taphozous georgianus*	*Vespadelus finlaysoni*	*Taphozous georgianus,*
Notes	Cave contained three sheets, however one sheet had been disturbed and could not be used. The other two sheets had an estimated 200-300 Ghost Bat scats.	No sheets present. Estimated 6-20 fresh/ recent Ghost Bat scats in cave. Ghost bat calls detected on 12th November.	Numerous large scat piles (2 x 100+) and 2-3 areas of 100's scats. Ghost bat flushed from the cave when entering on 14th November. Cave was not suitable for video monitoring as the entrance was so wide.	No Ghost Bat scat seen.	No Ghost Bat scats on three sheets. Some *T. georgianus* scats.

Cave	A1	A2	AA1	L2	L3
Photo					

5.4 Survey Limitations

The survey team was adequately experienced and resourced to achieve the project scope. The field survey was undertaken by two Senior Zoologists (Tom Rasmussen and Drew Gardner), both with extensive experience undertaking bat surveys. The same field team was used during the 2012 and 2013 surveys to provide a consistent approach to data collection and interpretation.

The survey intensity was appropriate for the scope and was conducted during the appropriate season to record breeding.

Previous Ghost Bat presence data from a number of sources were available prior to the study, including the previous monitoring reports at West Angelas. Availability of contextual information of the target species' ecology in the Pilbara is limited. Much of the ecological knowledge is inferred from the tropical forms. While this published knowledge was used to complement the field experience of the senior members of the team, all had adequate previous experience with the target species in the Pilbara. Data availability therefore is not considered a limitation to this survey.

Assessing the type of use by, and importance of caves to, Ghost Bats is extremely difficult, even for experienced zoologists. Bats are shy and cryptic, and generally roost in areas of the cave inaccessible to people. The survey techniques used for the monitoring are best practice, taking into account the survey outcomes and animal ethics. Mist netting or harp trapping can be use to catch animals exiting caves, but this is considered extremely stressful to the animals, particularly during the breeding season. Additional survey techniques that could be used to improve the outcomes of the monitoring are discussed in Section 6.

6 DISCUSSION

As Ghost Bats appear to utilise a variety of different caves at different times of the day and year and for different purposes, every suitable roost cave must be considered of some importance to this species. The November 2013 survey confirmed the importance of the Study Area for foraging and roosting Ghost Bats during the breeding season. Evidence of Ghost Bat usage was found in four of the five caves surveyed (caves A1, A2, AA1 and L3).

The impact of existing and future mining operations in the vicinity of the caves is of potential significance to local Ghost Bat populations and it is appropriate that monitoring is undertaken to understand these impacts. Caves L2 (75 m from pit wall) and L3 (67 m from pit wall) are in closest proximity to the Deposit B pit and therefore most likely to be impacted by mining activities.

Ghost Bat presence has been consistently recorded at cave L3 since the survey program began in 1978. It is classified as a feeding cave/ night roost cave; however, the size and complexity of this cave suggest that it could be utilised as a possible day roost. The importance of night roosts for Ghost Bats shouldn't be downplayed. Ghost Bats require a number of roosts within their home range. They provide shelter and rest to the bats whilst out foraging, and although removal of these roosts would not impact on the bats to the extent that removal of a day roost would, they still are of value to the Ghost Bat population. Cave L3 is oriented away from the pit wall so this may provide some level of protection from dust entering the cave. Its close proximity to the pit however may make it subject to collapse (or partial collapse) due to vibrations from blasting and/or heavy machinery.

Cave L2 is classified as a feeding/ night roost. There was no indication that this cave was used during the survey, or during the months preceding it. This cave has the lowest conservation value of all the caves in the monitoring programme.

There are insufficient data to determine if mining at West Angelas has affected use of these caves by Ghost Bats (i.e. if they were previously used as day roosts but are now used as night roosts); however these caves have consistently shown low levels of use since they were first surveyed during 1998 (cave L2) and 2000 (L3) and there has been no change in the patterns of use since they have been monitored.

Caves A1 and A2 are located in a gully approximately 400-500 m north of the Deposit B pit boundary. Cave A1 has been surveyed for Ghost Bats from 1997 to present and has consistently shown evidence of Ghost Bat use. Cave A2 has only been monitored during the past two years, but during both surveys has shown presence of recent and continual use. Both caves are classified as day roosts, and are therefore of significance to the local Ghost Bat population. There is currently insufficient data to determine if they are being used as maternity roosts, but this is considered possible. The monitoring results to date suggest that currently mining at West Angelas isn't impacting these caves.

Cave AA1 is considered to have the highest value of all the monitoring caves. During two surveys (1978/9 and 1998 a female was captured that was considered to be possibly pregnant. These caves are also shown to be consistently used by Ghost Bats as day roosts. Cave AA1 is located 900+ m from the pit boundary and should remain unaffected by mining activities (such as vibrations or dust).

Given the likely impact on caves within the Study Area, particularly those in closest proximity to the pit wall (L2 and L3), it is recommended that a monitoring and mitigation plan be developed to be implemented during and continue after the completion of mining operations at the Deposit B pit. The plan should consider, but not be limited to the following.

- Continue to monitor usage of the monitoring caves for changes in Ghost Bat use during and after the completion of mining operations. This will provide useful information regarding the impact of vibration on Ghost Bat activity and ultimately whether caves L2 and L3 will be used as day roosts following the completion of operations.

- Monitor dust levels and employ dust suppression techniques to minimise the impact of dust on foraging habitat. High dust levels reduce the quality of the nearby Ghost Bat foraging habitat, forcing the species to travel further to find more suitable grounds.
- Undertake blasting as far from the caves as possible. Various blasting patterns and types should be investigated and those with minimal potential impact employed.
- Check caves for structural integrity prior to, throughout and at the completion of the blasting operations. If caves appear unstable and the likelihood of collapse is high, install exclusion sheeting across the caves entrance so that no Ghost Bats are inside during blasting. Sheeting must be in place two hours after sunset to ensure that all bats have left the cave and that none are able to return. Sheeting can be removed once the risk of collapse has passed.

As previous noted (Biologic 2012), the significance of the Deposit B caves to the Pilbara populations of Ghost Bats is difficult to determine. However given the estimated small size of the Hamersley Range Ghost Bat population (Mr Robert Bullen, *unpub. data*), the genetic uniqueness of this population (Biota Environmental Services, 2004a), and the bats apparent need to utilise a variety of caves at different times and for different purposes, every suitable roost cave must be of some importance to the population. None of the caves fall within the proposed pit area, but it is important to protect the cave sites from indirect disturbance. Continued, consistent and informative monitoring of Ghost Bat numbers in the vicinity of the pit area will contribute to the understanding of cave usage by Ghost Bats in the area, their tolerance to disturbance associated with mining operations and resilience following disturbance.

Determining if caves are used as maternity roosts is extremely difficult, even if the bats are in the hand. During 2014/ 2015 Biologic will be undertaking research to see if juvenile bats emit different calls to adults, and this can be then used to see if caves are used as maternity roosts. Undertaking surveys during the dry season/ winter may also be useful to determine the value of caves. Caves used during this time would have the

least variation in temperature and humidity, and provide a warm environment.

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APPENDICES

Appendix A: Explanation of Conservation Codes

International Union for Conservation of Nature

Category	Definition
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), and 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), and 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 (CE)	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	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
Data Deficient	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.

Department of Environment and Conservation Priority Fauna Codes

Category	Definition
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix B: Photographs of monitoring caves

Plate 1 Cave A1 entrance

Plate 2 Cave A1 showing low wall across cave

Plate 3 Cave A1, inner cave with scat pile and scat collection sheets

Plate 4 Cave A2 Entrance

Plate 5 Cave L2, looking down entrance talus slope

Plate 6 View across gully ‘L’ from L2 towards L1 (left) and L3 (upper right)

Plate 7 Cave L3 entrance

Plate 8 Cave L3 inner chamber showing new scat sheets and old plastic

sheeting

Plate 9 Cave L3. Domed roof of inner chamber showing i-button datalogger (arrowed) placed on ledge.

Appendix C Review of Bat Monitoring at West Angelas