Biota Environmental Sciences

West Pilbara Iron Ore Project Mine Areas Seasonal Fauna Survey

Prepared for API Management

November 2009

Biota Environmental Sciences

ABN 49 092 687 119
Level 1, 228 Carr Place
Leederville Western Australia 6007
Ph: (08) 9328 1900 Fax: (08) 9328 6138

Project No.: 409

Prepared by: Dan Kamien, Erin Harris

Checked by: Garth Humphreys

Approved for Issue: Garth Humphreys

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West Pilbara Iron Ore Project Mine Areas

Contents

Tables

Figures

Plates

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1.0 Introduction

1.1 Project Background

API Management (API) proposes to develop the West Pilbara Iron Ore Project (WPIOP). The spatial scope of this project is considerable, encompassing several mine deposits and three options for rail corridors. The project is located primarily in the vicinity of Red Hill in the western Pilbara, with the primary rail corridor extending from this locality to Anketell Point, east of Karratha. Additional infrastructure associated with the project includes haul roads, stockpiles, waste dumps, airfield options, plant and camp areas, which are planned to be located in the vicinity of the proposed mine areas.

API referred the WPIOP to the Western Australian Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986*. The EPA determined that the proposal would be formally assessed at the level of Public Environmental Review (PER). The project was also referred to the Federal Department of the Environment, Water, Heritage and the Arts (DEWHA) under the *Environment Protection and Biodiversity (EPBC) Conservation Act 1999*. DEWHA determined that the project would also be treated as a Controlled Action for the purposes of this latter act. Biota Environmental Sciences (Biota) was commissioned to complete fauna surveys of areas to be impacted by the proposed WPIOP development.

Seven ore bodies are currently being considered for mining, all of which occur on pisolitic mesa formations (Figure 1.1). The ore bodies comprise:

- Jewel and Cochrane: approximately 9 km to the northeast of Red Hill Station;
- Ken's Bore: 15 km southeast of Red Hill Station;
- Cardo Bore North: 25 km southeast of Red Hill Station;
- Upper Cane: about 30 km southeast of Red Hill Station
- Cardo Bore East: also approximately 30 km southeast of Red Hill Station;
- Trinity Bore: approximately 50 km southeast of Red Hill Station; and
- Catho Well: 52 km south-southeast of Red Hill Station.

The infrastructure associated with the West Pilbara Iron Ore Project is located toward the southern end of the project area approximately 60 km SSW of Pannawonica. The proposed infrastructure includes:

- rail corridors and loops between deposits;
- three airstrip options;
- a processing plant and stockpile areas;
- administration areas;
- a camp; and
- a tailings management area

In addition to the terrestrial fauna surveys documented here, API has undertaken various land access and engineering investigations for these rail corridors and the prospective port sites. This work has identified Anketell Point as the preferred port site for the project, with the Anketell Point corridor consequently the primary rail option for the project.

1.2 Study Area

This report addresses the terrestrial fauna of the WPIOP mine areas and associated infrastructure (hereafter the "Mine Areas") as outlined in Section 1.1. The terrestrial fauna of the project rail corridor to Anketell Point is not considered in the current report, having been addressed separately by Biota (2009a). Separate reports have been previously produced addressing the fauna of the Cape Preston (Biota 2009b) and Onslow (Biota 2009c) rail corridor options. The survey area comprised all mine areas shown in Figure 1.1 and the rail loops and associated infrastructure areas south of the Cochrane deposit rail loop (Figure 1.1).

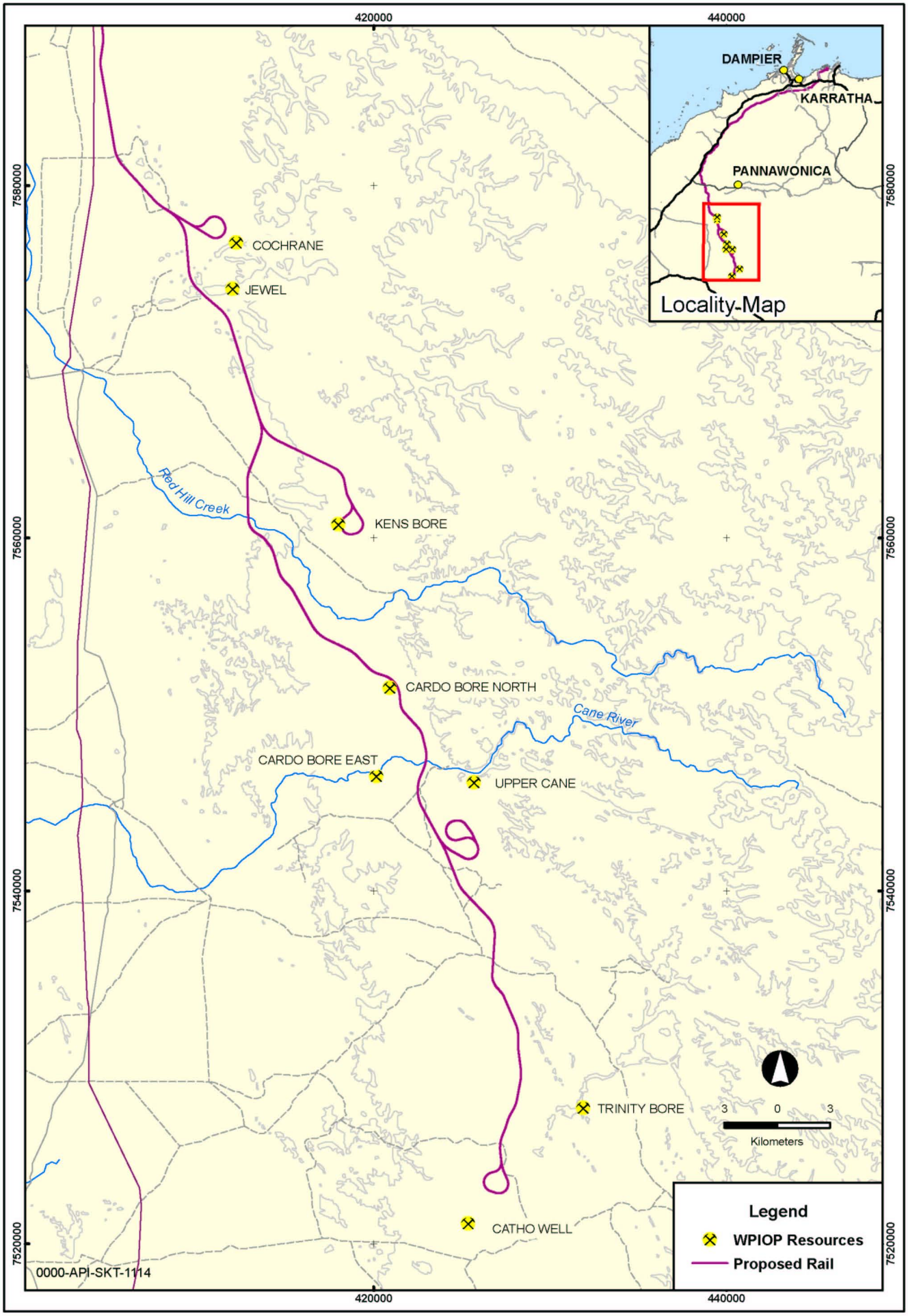

Figure 1.1: Locality map for the WPIOP Mine Areas and associated infrastructure.

1.3 Study Objectives and Scope

The survey documented in this report was planned and implemented in accordance with:

- EPA Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002);
- EPA Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2003); and
- EPA Guidance Statement No. 20 "Sampling of Short-range Endemic Fauna for Environmental Impact Assessment in Western Australia" (EPA 2009).

The scope of this study was to:

- document the vertebrate and short-range endemic (SRE) invertebrate fauna assemblage within the habitats of the study area using established sampling techniques;
- identify and assess the local and regional conservation significance of the fauna habitats, species and assemblages present in the study area;
- identify fauna (particularly Schedule and Priority listed fauna as well as potential SRE taxa) of particular conservation significance; and
- provide a generic assessment of the potential impacts the proposed development on the fauna habitats and assemblages occurring in the study area.

This report describes the methodology employed for the fauna survey of the proposed WPIOP Mine Areas. It documents the results of the surveys and discusses the potential impacts of the project on fauna habitats and assemblages. Its intended use is as a supporting document for the formal environmental assessment of the WPIOP project. Both the field surveys and this report are subject to the limitations discussed in Section 2.5.

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2.0 Methodology

2.1 Database Searches

Database searches were conducted in 2007 as part of the initial Level 1 assessment of the Mine Areas study area (Biota 2007a). A range of searches were conducted for this assessment, consisting of:

- a search of the DEC Threatened Fauna Database (Appendix 1);
- the Western Australian Museum FaunaBase database was also searched for records of vouchered fauna from the area (records now on DEC NatureMap; Appendix 2); and
- the *EPBC Act 1999* Protected Matters database was searched for fauna of national environmental significance potentially occurring in the study area.

These investigations were conducted using an area search with a 50 km buffer. The bounding coordinates for these searches were 20.7494 °S, 115.7922°E and 22.2847°S, 116.4372°E. The Biota internal database was also searched for records from the study area locality.

2.2 Survey Timing and Weather

2.2.1 Survey Timing

Due to ongoing revisions in project design, some portions of the final Mine Areas study area were sampled at different times and during different phases:

- the Phase I field survey of part of the northern section of the study area was conducted between May 24th and May 31st 2007.
- A further Phase I survey of the balance of the Mine Areas study area was conducted from June 20th to 28th 2007.
- In September 2008 additional sites were also installed and surveyed from November 7th to 16th 2008. During this November survey period the second phase of some of the original sites was also conducted.
- A fourth survey of the Mine Areas study area was conducted in 2009 from June 20th to June 24th. This survey was aborted early due to heavy rainfall restricting access to sites. During this survey period the second phase of some of the sites installed in September 2008 sites conducted and some extra sites were also installed (Section 2.4).

While occurring in somewhat different timeframes, the data from the first phases of all sites have been grouped in the balance of this report as Phase I, with Phase II data reported for seasonally sampled sites.

2.2.2 Climatological Data

2.2.2.1 May 2007

This survey was conducted over an eight-day period from May 24th to 31st 2007. Minimum temperatures during ranged from 10.2°C to 18.4°C and maximum temperatures ranged from 26.6°C to 32.6°C. Less than 3 mm of rainfall was recorded at Paraburdoo during the survey period (Table 2.1)

2.2.2.2 June 2007

This survey was conducted over a nine-day period from June 20th to 28th 2007. Minimum temperatures ranged from 5.5°C to 10.1°C and maximum temperatures ranged from 21.2°C to 26.4°C. No rainfall was recorded at Mardie, Paraburdoo or Tom Price during the survey (Table 2.1).

2.2.2.3 November 2008

This survey was conducted over a ten-day period from November 7th to 16th 2008. Minimum temperatures during the survey ranged from 16.0°C to 21.1°C and maximum temperatures ranged from 31.0°C to 36.7°C. Less than 1 mm of rainfall was recorded during the survey (Table 2.1).

2.2.2.4 June 2009

This survey was conducted in two phases: over a five-day period from June 20th to 24th 2009 and a seven-day period from the 7th to the 13th September. Minimum temperatures during the survey ranged from 6.1°C to 14.7°C and maximum temperatures ranged from 21.0°C to 24.6°C (Table 2.1). During this survey a total of 28 mm of rainfall was recorded at Cardo Camp.

Long term climate averages at nearby Pannawonica are shown for context in Figure 2.1.

Table 2.1: Daily meteorological observations averaged from Mardie, Paraburdoo and Tom Price during the WPIOP Mine Areas survey (data provided by Bureau of Meteorology).

Date	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)
May 2007			
24/5/07	32.6	17.3	0
25/5/07	32.1	18.4	0
26/5/07	31.3	14.7	0
27/5/07	28.5	17.6	0.93
28/5/07	26.6	10.4	0
29/5/07	27.7	13.8	0
30/5/07	27.9	11.4	0
31/5/07	27.7	10.2	0
Survey Average	**29.3**	**14.2**	**0.12**
June 2007			
20/6/07	21.6	10.1	0
21/6/07	21.2	5.5	0
22/6/07	22.7	5.8	0
23/6/07	23.6	7.7	0
24/6/07	23.9	8.0	0
25/6/07	24.4	8.9	0
26/6/07	24.7	6.1	0
27/6/07	25.2	6.2	0
28/6/07	26.4	7.2	0
Survey Average	**23.7**	**7.3**	**0**
November 2008			
7/11/08	31.0	17.1	0
8/11/08	35.0	17.9	0
9/11/08	36.6	16.2	0
10/11/08	36.7	18.5	0
11/11/08	36.3	21.1	0
12/11/08	34.4	21.1	0
13/11/08	35.7	16.0	0
14/11/08	33.4	21.1	0.20
15/11/08	33.3	18.1	0.07
16/11/08	33.0	19.1	0
Survey Average	**34.5**	**18.6**	**0.03**
June 2009			
20/6/09	24.3	10.4	0
21/6/09	22.7	6.5	0
22/6/09	24.6	6.1	0
23/6/09	24.5	6.7	0
24/6/09	21.0	14.7	4.2
Survey Average	**23.4**	**8.9**	**0.84**
Overall Average	**28.5**	**12.8**	**0.2**

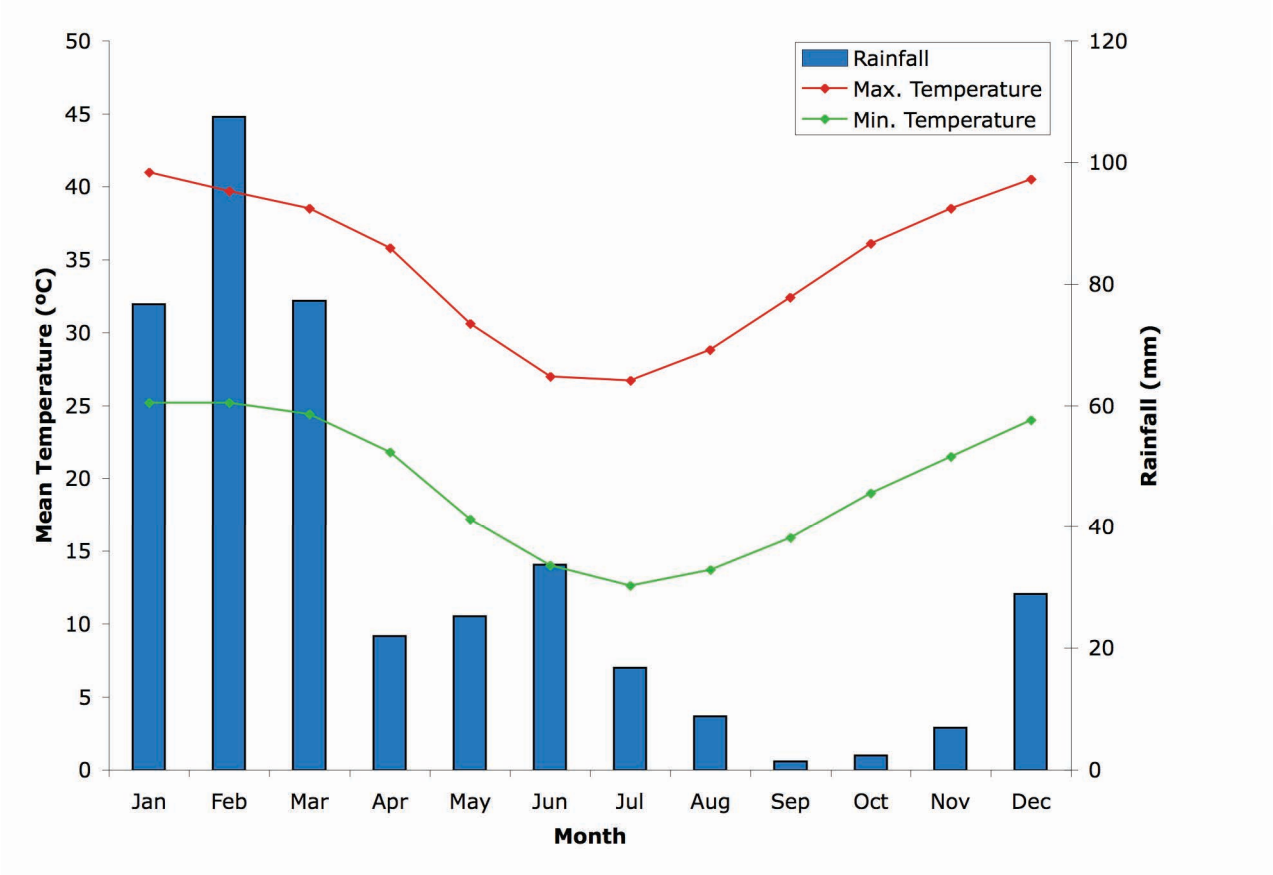

Figure 2.1: **Long-term climatological summary for nearby Pannawonica using data from 1971 to 2005** (data provided by the Bureau of Meteorology).

2.3 Fauna Survey Team

The terrestrial fauna sampling for the field survey was conducted under "Licence to Take Fauna for Scientific Purposes" No. SF005841 and SF006636 issued to Mr Garth Humphreys (Appendix 4).

May 2007
The fauna survey team comprised Mr Roy Teale, Dr Phil Runham, Ms Erin Harris, Ms Jane Adcroft, Mr Ashley Johnsen (all of Biota) and Mr Greg Harold (Private Consultant). Mr Garth Humphreys, Mr Dan Kamien and Mr Luke Lovell (all of Biota) assisted with the trap installation component of this survey.

June 2007
The fauna survey team comprised Dr Phil Runham, Mr Dan Kamien, Ms Erin Harris, Ms Jane Adcroft, Mr Ashley Johnsen (all of Biota) and Mr Greg Harold (Private Consultant). Mr Roy Teale, Mr Paul Sawers and Mr Luke Lovell (all of Biota) assisted with the trap installation component of this survey.

November 2008
The fauna survey team comprised Mr Michael Greenham, Ms Erin Harris, Mr Jason Alexander, Ms Jessica Cairnes, Mr Tim Sachse (all of Biota) and Mr Greg Harold (Private Consultant). Dr Phil Runham, Mr Ashley Johnsen and Mr Sean McCulloch (all of Biota) assisted with trap installation component of this survey.

June 2009
The fauna survey team utilised to conduct the surveys comprised Dr Phil Runham, Ms Erin Harris, Mr Jason Alexander, Ms Jessica Cairnes, Mr David Keirle (all of Biota) and Mr Greg Harold (Private Consultant).

Analysis of bat recordings was completed by Dr Kyle Armstrong (of Specialised Zoological). Invertebrate identifications were undertaken by Mr. Dan Kamien and Dr Volker Framenau (WA Museum). GIS analysis and maps in this report were prepared by Mr Paul Sawers (Biota).

2.4 Fauna Sampling

2.4.1 Selection and Location of Sampling Sites

The sampling approach for this study consisted of a combination of systematic fauna sampling and targeted searches within habitats suitable for short-range endemic or threatened fauna. The systematic component of the study comprised 46 systematic sampling sites. This included 32 pit trapping sites, seven funnel trap sites and seven Elliott trap sites. These were installed in defined habitats considered to represent the range available habitats within the study area. Targeted searches were conducted in as many areas as practicable and encompassed the range of habitats available within the study area. The location of the trapping sites is shown in Figure 2.3 and Figure 2.4, along with the extent of the survey area.

Each systematic trapping site was located within a defined habitat and was selected such that equal weight was given to accessibility of the sites in terms of regular inspection of traps, or repeat targeted sampling of habitats where necessary. Tapping effort, design and location is outlined in Section 2.4.2. Representative site photos are presented in Plate 4.1 to Plate 4.20.

2.4.2 Trapping Effort and Design

An indicative layout for the West Pilbara Iron Ore Project fauna survey pit-trapping sites is shown in Figure 2.2. On this survey, pit-traps at each site were arranged in a single row of ten traps, alternating between 20 litre buckets (350 mm diameter) and PVC tubes (150 mm diameter). Pit-traps were spaced at 10 m intervals and connected by a 90 m long by 300 mm high flywire fence. Pit-traps were utilised at 32 sites during this survey. Seven additional trapping sites consisted of a further 12 -52 funnel traps and a further seven sites consisted of between 25 and 50 Elliott traps (Table 2.2). In total, 46 systematic trapping sites were utilised during the study (Table 2.2; Figure 2.3; Figure 2.4).

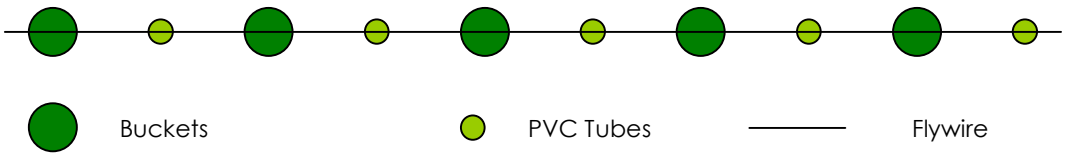

Figure 2.2: **Indicative layout of pit-trapping sites** (NB. not to scale).

Table 2.2: **Location of sites and trap effort for the terrestrial fauna survey of the WIOP Mine Areas.**

	Site	Location	Trap Type	Date Opened	Date Closed	Nights Open	No. of Traps	Trap Effort
Cochrane & Jewel	AQA12	406158mE; 7577709mN	Pit	24/5/07	30/5/07	6	10	60
	AQARL09	409110mE; 7577424mN	Pit	8/11/08	14/11/08	6	10	60
				20/6/09	24/6/09	4	10	40
	AQM24	410063mE; 7576636mN	Pit	22/6/07	28/6/07	6	10	60
				8/11/08	14/11/08	6	10	60
	AQM22	410615mE; 7575957mN	Pit	22/6/07	28/6/07	6	10	60
				8/11/08	14/11/08	6	10	60
	AQM25	410497mE; 7575160mN	Pit	22/6/07	28/6/07	6	10	60
	AQM20E	410750mE; 7574228mN	Elliott	22/6/07	27/6/07	5	50	250
	AQM21	410129mE; 7574120mN	Pit	22/6/07	28/6/07	6	10	60
				8/11/08	14/11/08	6	10	60
	AQARL08	410602mE; 7573725mN	Pit	8/11/08	14/11/08	6	10	60
				20/6/09	24/6/09	4	10	40
	AQM19F	410668mE; 7574020mN	Funnel	22/6/07	28/6/07	6	18	108
				8/11/08	14/11/08	6	20	120
	AQA19E	410216mE; 7573669mN	Elliott	22/6/09	24/6/09	2	35	70

Cochrane & Jewel	
Pit Effort	680
Elliott Effort	320
Funnel Effort	228
Trap Effort	1,228

Table 2.2: Location of sites and trap effort for the terrestrial fauna survey of the WIOP Mine Areas.

	Site	Location	Trap Type	Date Opened	Date Closed	Nights Open	No. of Traps	Trap Effort
Ken's Bore	AQA15F	410878mE; 7565685mN	Funnel	24/5/07	30/5/07	6	52	312
	AQA14	410240mE; 7565491mN	Pit	24/5/07	30/5/07	6	10	60
	AQA16	410741mE; 7564435mN	Pit	24/5/07	30/5/07	6	10	60
	AQARL06	412953mE; 7564056mN	Pit	8/11/08	14/11/08	6	10	60
				20/6/09	24/6/09	4	10	40
	AQARL07	416000mE; 7563631mN	Pit	8/11/08	14/11/08	6	10	60
				20/6/09	24/6/09	4	10	40
	AQARL10	409464mE; 7562549mN	Pit	8/11/08	14/11/08	6	10	60
				21/6/09	24/6/09	3	10	30
	AQA18	413552mE; 7562401mN	Pit	24/5/07	30/5/07	6	10	60
	AQA17	412800mE; 7561821mN	Pit	24/5/07	30/5/07	6	10	60
	AQM16	414628mE; 7562021mN	Pit	22/6/07	28/6/07	6	10	60
				10/11/08	16/11/08	6	10	60
	AQM15E	416161mE; 7561671mN	Elliott	22/6/07	27/6/07	5	25	125
	AQARL05	417937mE; 7558952mN	Pit	10/11/08	16/11/08	6	10	60
				21/6/09	24/6/09	3	10	30
	AQM12F	418830mE; 7558814mN	Funnel	22/6/07	28/6/07	6	18	108
				10/11/08	16/11/08	6	20	120
	AQM14	421038mE; 7557388mN	Pit	22/6/07	28/6/07	6	10	60
				10/11/08	16/11/08	6	10	60
	AQM31E	421721mE; 7557038mN	Elliott	23/6/09	24/6/09	1	48	48
	AQM11E	422850mE; 7557102mN	Elliott	22/6/07	27/6/07	5	50	250
Cardo North	AQARL04	421391mE; 7551568mN	Pit	10/11/08	16/11/08	6	10	60
				21/6/09	24/6/09	3	10	30
	AQM28F	419613mE; 7551268mN	Funnel	10/11/08	16/11/08	6	20	120
				21/6/09	24/6/09	3	16	48
	AQM29	418647mE; 7550947mN	Pit	10/11/08	16/11/08	6	10	60
				21/6/09	24/6/09	3	10	30
Cardo East	AQM01F	421861mE; 7545645mN	Funnel	22/6/07	28/6/07	6	12	72
	AQM02	420623mE; 7545532mN	Pit	22/6/07	28/6/07	6	10	60
				10/11/08	16/11/08	6	10	60
				21/6/09	24/6/09	3	10	30
	AQARL03	421081mE; 7544168mN	Pit	9/11/08	15/11/08	6	10	60

Ken's Bore	
Pit Effort	860
Elliott Effort	423
Funnel Effort	540
Trap Effort	**1,823**

Cardo North	
Pit Effort	180
Elliott Effort	0
Funnel Effort	168
Trap Effort	**348**

Cardo East	
Pit Effort	210
Elliott Effort	0
Funnel Effort	72
Trap Effort	**282**

Table 2.2: Location of sites and trap effort for the terrestrial fauna survey of the WIOP Mine Areas.

	Site	Location	Trap Type	Date Opened	Date Closed	Nights Open	No. of Traps	Trap Effort		
Cane & Upper Cane	AQM03E	424923mE; 7545786mN	Elliott	22/6/07	28/6/07	6	25	150		
	AQM30F	424381mE; 7545707mN	Funnel	10/11/08	16/11/08	6	20	120		
	AQM05	422915mE; 7545385mN	Pit	22/6/07	28/6/07	6	10	60	**Cane & Upper Cane**	
				10/11/08	16/11/08	6	10	60	Pit Effort	300
	AQM17	424317mE; 7540544mN	Pit	22/6/07	28/6/07	6	10	60	Elliott Effort	150
				9/11/08	15/11/08	6	10	60	Funnel Effort	120
	AQM18	425391mE; 7538330mN	Pit	22/6/07	28/6/07	6	10	60	**Trap Effort**	**570**
Trinity Bore	AQARL02	426914mE; 7536255mN	Pit	9/11/08	15/11/08	6	10	60		
				21/6/09	24/6/09	3	10	30		
	AQM27	432683mE; 7528976mN	Pit	9/11/08	15/11/08	6	10	60	**Trinity Bore**	
				21/6/09	24/6/09	3	10	30	Pit Effort	330
	AQM27E	432200mE; 7529292mN	Elliott	22/6/09	24/6/09	2	50	100	Elliott Effort	100
	AQM26	431193mE; 7527410mN	Pit	9/11/08	15/11/08	6	10	60	Funnel Effort	0
				21/6/09	24/6/09	3	30	90	**Trap Effort**	**430**
Catho Well	AQARL01	425750mE; 7522815mN	Pit	9/11/08	15/11/08	6	10	60		
	AQM06	424813mE; 7522118mN	Pit	21/6/07	27/6/07	6	10	60		
				9/11/08	15/11/08	6	10	60		
	AQM07F	425278mE; 7521736mN	Funnel	21/6/07	27/6/07	6	18	108		
				9/11/08	15/11/08	6	16	96	**Catho Well**	
	AQM08	425599mE; 7521749mN	Pit	21/6/07	27/6/07	6	10	60	Pit Effort	420
	AQM09	426292mE; 7520323mN	Pit	21/6/07	27/6/07	6	10	60	Elliott Effort	0
				9/11/08	15/11/08	6	10	60	Funnel Effort	204
	AQM10	426150mE; 7519673mN	Pit	21/6/07	27/6/07	6	10	60	**Trap Effort**	**624**
						Total Pit Effort		**2,980**		
						Total Elliott Effort		**993**		
						Total Funnel Effort		**1,332**		
						Total Trap Effort		**5,305**		

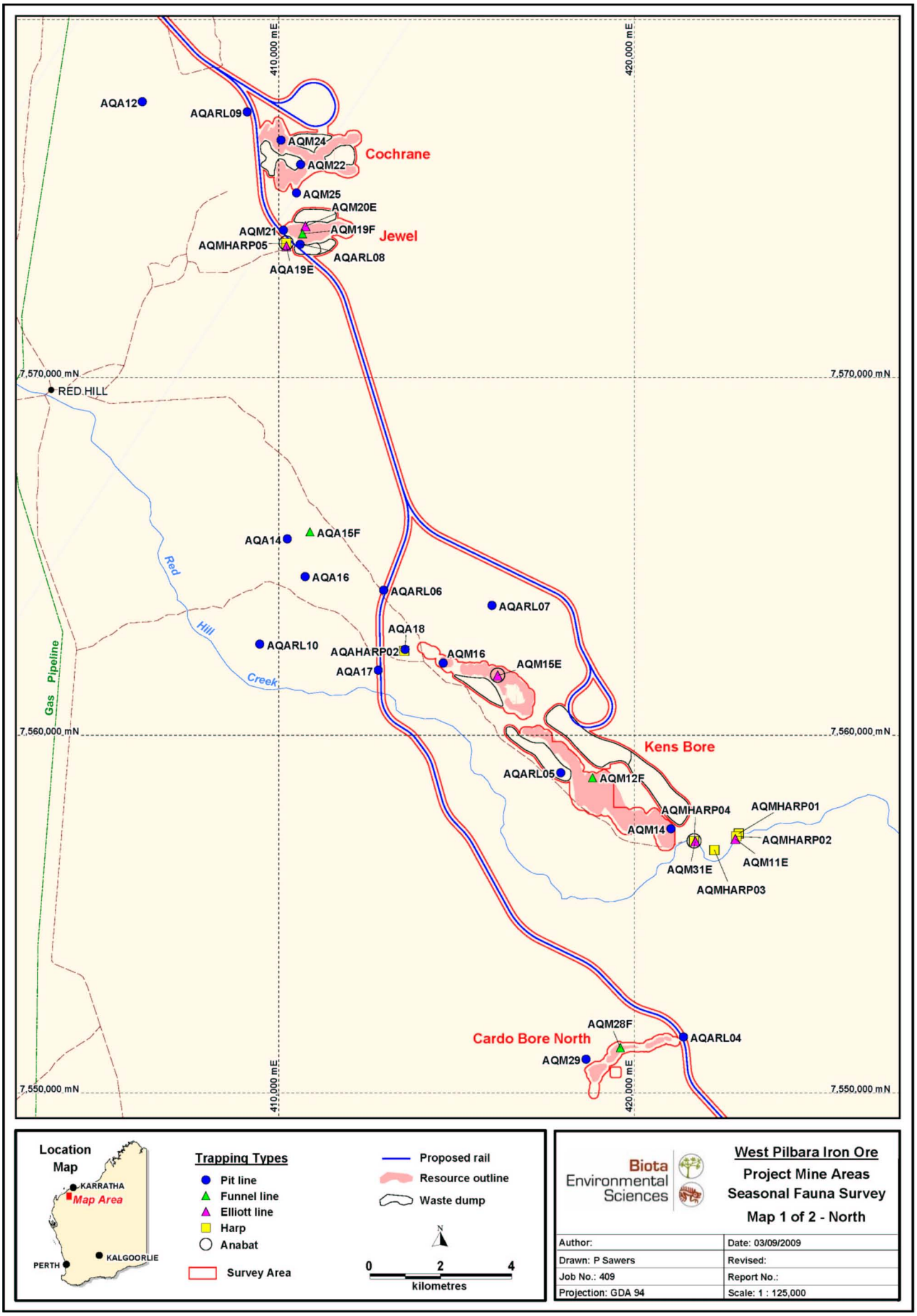

Figure 2.3: Location of survey sites and extent of survey area for the northern WPIOP deposits.

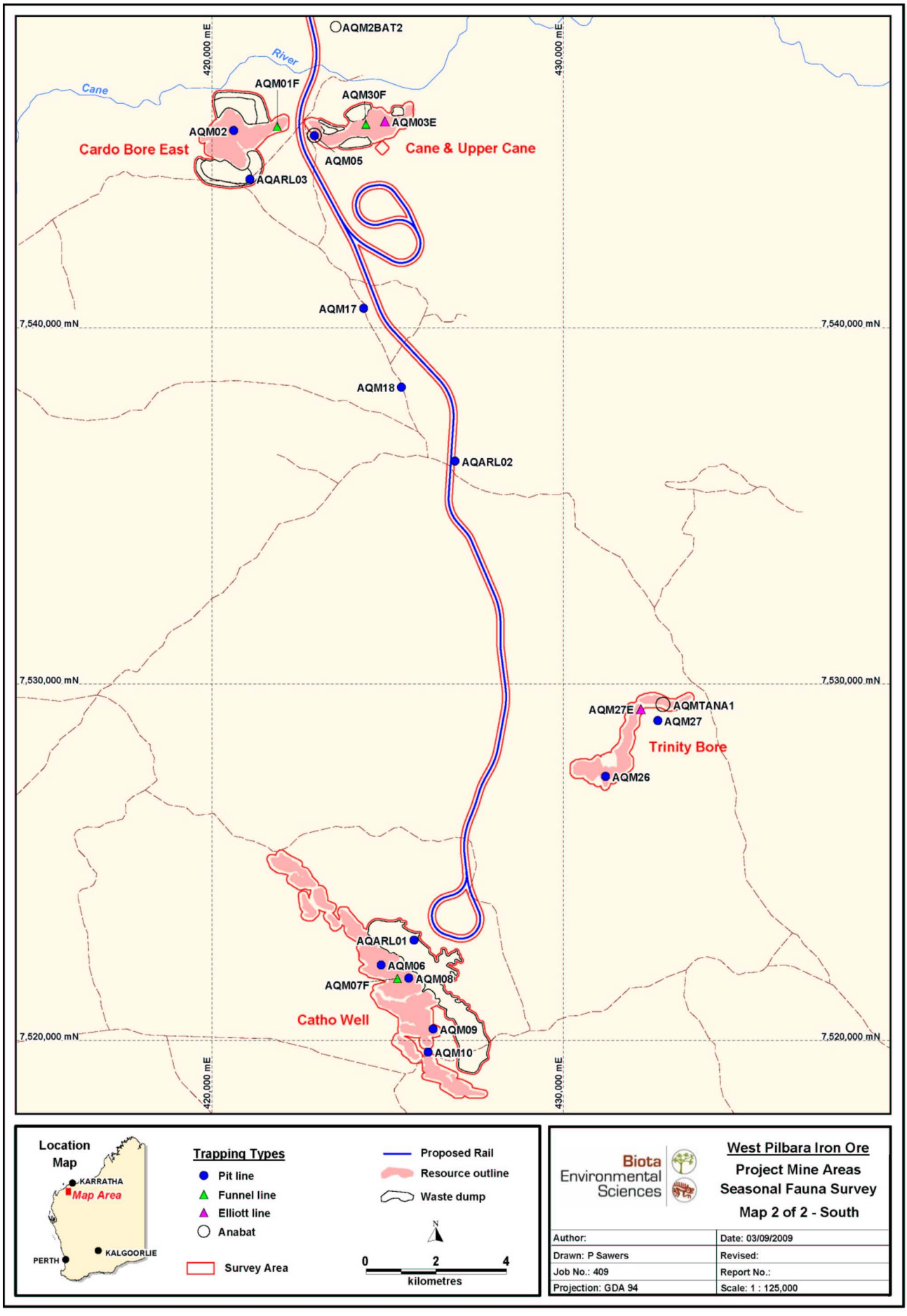

Figure 2.4: Location of survey sites and extent of survey area for the southern WPIOP deposits.

2.4.3 Avifauna Sampling

Sampling of avifauna was carried out using a combination of techniques, including:

- unbounded area censuses conducted at the systematic sampling grids;
- unbounded area censuses conducted at opportunistic locations containing habitats or microhabitats likely to support previously unrecorded species; and
- opportunistic observation of avifauna while driving around the study area.

A total of 57 avifauna censuses were completed across 32 sites during the survey period (Table 2.4). Avifauna were sampled using 30 to 40 minute censuses comprising almost 55 person-hours of dedicated avifauna sampling. Censuses were conducted between 6:30 am and 1:30 pm and were supplemented by recorded avifauna species observed opportunistically within the study area.

2.4.4 Bats

Bats were sampled using both direct capture methods via harp traps and echolocation call recordings by targeting water bodies and cave habitats (Table 2.3, Figure 2.3, Figure 2.4, Plate 2.1 and Plate 2.2). Bat echolocation calls were recorded using Anabat II and Anabat SD1 bat detector units, which detect and record ultrasonic echolocation calls emitted during bat flight. The calls were stored on a compact flash card after being processed by an Anabat CF ZCAIM. Calls were visualised on Analook 3.3f software. Only sequences containing good quality search phase calls were considered for identification. Bat echolocation calls were analysed by Dr Kyle Armstrong (of Specialised Zoological) to determine the identification of bat species (Appendix 5).

Table 2.3: Location of bat sampling during the fauna survey (locations shown in Figure 2.3 and Figure 2.4).

Trap Site	Location	Habitat	Sampling	Date Opened	Date Closed	Nights Open
AQMharp05	410210mE; 7573751mN	Cave	Harp trap	22/06/09	24/06/09	2
			Anabat	22/06/09	24/06/09	2
AQAharp02	413529mE; 7562357mN	Water body	Harp trap	24/05/07	30/05/07	6
AQM15E	416161mE; 7561671mN	Cave	Anabat	25/06/07	26/06/07	1
AQMharp04	421688mE; 7557039mN	Cave & water body	Harp trap	22/06/09	24/06/09	2
			Anabat	22/06/09	24/06/09	2
AQMharp03	422260mE; 7556795mN	Cave	Harp trap	25/06/07	27/06/07	2
			Harp trap	21/06/09	24/06/09	3
AQMharp02	422879mE; 7557173mN	Water body	Harp trap	24/06/07	27/06/07	3
AQMharp01	422947mE; 7557254mN	Cave	Harp trap	24/06/07	26/06/07	2
AQMbat02	423525mE; 7548439mN	Cave	Anabat	11/11/08	16/11/08	5
AQM05	422915mE; 7545385mN	Cave	Anabat	24/6/07	25/06/07	1
AQMana01	432828mE; 7529419mN	Cave	Anabat	22/06/09	24/06/09	2
				Total Harp Nights		**20**
				Total Anabat Nights		**13**
				Total sampling nights		**33**

Plate 2.1: Representative cave habitat on breakaway.

Plate 2.2: Representative habitat adjacent to water body.

Table 2.4: Census times for avifauna surveys (* denotes opportunistic records).

	Site	25/5/07	26/5/07	27/5/07	28/5/07	29/5/07	16/6/07	21/6/07	22/6/07	23/6/07	24/6/07	25/6/07	26/6/07	27/6/07	9/11/08	10/11/08	11/11/08	12/11/08	13/11/08	14/11/08	15/11/08	16/11/08	20/6/09	21/6/09	22/6/09	23/6/09	24/6/09	Total Census Time (mins)
Cochrane & Jewel	AQA12	1000 - 1040			0900 - 0940	1235 - 1315																					120
	AQARL09														0710 - 0740		*									0920 - 1000	*	70
	AQM24									0653 – 0733							0900 - 0930											70
	AQM22									0740 – 0820			1010 – 1015			0845 - 0915												75
	AQM25									0933 – 1023		0932 - 1012																90
	AQM20E										1020 – 1100	0827 – 0857																70
	AQM21										0935 – 1015	0740 – 0810	*			0715 - 0745												100
	AQARL08														0730 - 0810											0815 - 0855		80
	AQM19F															0750 - 0820		*										30
	AQA19E																								*			0
Ken's Bore	AQA15F		1140 - 1220	0840 - 0920																								80
	AQA14	1255 - 1335	1055 - 1135	0755 - 0835	1020 - 1100																							160
	AQA16		1005 - 1045	0940 - 1020	*	0945 - 1025																						120
	AQARL06																0805 - 0835									0900 - 0940		70
	AQARL07														*									1045 - 1125	*	*	40
	AQARL10																0720 - 0750									0745 - 0825		70
	AQA18		0900 - 0940	1055 - 1135		0845 - 0925	*																					120
	AQA17		0805 - 0845	1150 - 1230		0800 - 0840																						120
	AQM16										1055 – 1130	*	0750 – 0820				0650 - 0730											105
	AQM15E									*	1010 – 1045	0840 – 0920																75
	AQARL05																0800 - 0840							*		*	*	40
	AQM12F									1230 – 1300		1150 – 1230	0840 – 0920				0935 - 1015				*							150
	AQM14								*		0850 –						0850 -			*								70

Table 2.4: Census times for avifauna surveys (* denotes opportunistic records).

	Site	25/5/07	26/5/07	27/5/07	28/5/07	29/5/07	16/6/07	21/6/07	22/6/07	23/6/07	24/6/07	25/6/07	26/6/07	27/6/07	9/11/08	10/11/08	11/11/08	12/11/08	13/11/08	14/11/08	15/11/08	16/11/08	20/6/09	21/6/09	22/6/09	23/6/09	24/6/09	Total Census Time (mins)
											0920						0930										
	AQM11E										0745 – 0825	1040 – 1120															80
Cardo North	AQARL04																			*	0705 - 0745				*			40
	AQM28F																	0630 – 0710							*			40
	AQM29																	0720 - 0800						*				40
Cardo East	AQM01F									0920 – 0950																		30
	AQM02									0830 – 0905									0715 - 0755									75
	AQARL03																0645 - 0725											40
Cane & Upper Cane	AQM03E										0705 – 0745		*															40
	AQM30F																			0740 - 0820								40
	AQM05							*			0800 – 0840		0718 – 0748							0650 - 0730								110
	AQM17											0715 – 0745		*			0750 - 0830											70
	AQM18									0715 – 0745																		30
Trinity Bore	AQARL02															*	0850 - 0930								0755 - 0835	*		80
	AQM27															0800 - 0840					*					0745 - 0825		80
	AQM26								*							0855 - 0935									0900 - 0940	0910 - 0950		120
Catho Well	AQARL01															0640 - 0720												40
	AQM06									0850 – 0930	1050 – 1130									0720 - 0750								110
	AQM07F									*	1000 – 1040								0715 - 0745									70
	AQM08									0745 – 0820	0900 – 0940																	75
	AQM09										0810 – 0850							0655 - 0735										80
	AQM10									1050 – 1130	0720 – 0800			*														80
																								Total Census Time (min)				**3,295**

2.4.5 Non-systematic Sampling of Vertebrate Fauna

A range of non-systematic fauna survey activities was also undertaken by the survey team to supplement the trapping and investigate additional habitats identified during the course of the survey. These included:

- habitat-specific searches for Schedule and Priority listed fauna species;
- searching of microhabitats for reptile, frog and small mammal species;
- opportunistic sightings and records;
- identification of road kills and other animal remains; and
- recording and identification of secondary signs (where possible) including tracks, scats and diggings.

These methods were used at each of the systematic trapping sites (Table 2.2; Figure 2.3; Figure 2.4) and were also employed at additional non-systematic sites throughout the study area.

2.4.6 Potential SRE Invertebrate Fauna Sampling

Specific invertebrate groups were targeted using both systematic and non-systematic collection techniques during the survey. Invertebrate groups targeted during the survey were primarily those considered to potentially support SRE taxa, which included:

- Mygalomorphae (trapdoor spiders);
- Selenopidae (crab spiders)
- Diplopoda (millipedes);
- Pulmonata (land snails); and
- Pseudoscorpionida (pseudoscorpions).

Trapdoor spiders were specifically targeted by searching for burrows and excavating them with the aim of collecting and preserving individuals in 70% ethanol. One leg was removed and placed in 100% ethanol for future molecular studies. Selenopid spiders were targeted by searching beneath flat rocks and preserved in the same manner as mygalomorph. Pseudoscorpions were specifically targeted by peeling back bark of trees and searching beneath rocks. The majority of individuals were preserved in 70% ethanol for morphological identification, with a sub-sample preserved in 100% ethanol for future molecular studies. Millipedes were searched for under leaf litter and logs. Aestivating snails were targeted by digging under spinifex hummocks and in drainage gullies.

Sampling for SRE taxa was conducted at all of the systematic survey sites, with the additional sampling effort represented by pit trapping at these locations (principally in respect of mygalomorph spiders and millipedes). Additional dedicated SRE and opportunistic fauna sites were completed during the field surveys to provide representative sampling of the range of Land Systems and habitats present and targeted toward specific locations where SREs were judged more likely to occur (e.g. larger spinifex hummocks, rock piles and drainages).

2.5 Study Limitations

The following limitations should be recognised by the reader of this report:

- Although the Mine Areas survey was undertaken over a number of phases conducted during different seasons, only 25 of the 46 systematic sites were sampled twice during different seasons. The remaining 21 trapping sites were surveyed on single phases only.
- Not all sections of the study area were ground-truthed or equally sampled for fauna. Parts of the study area were inaccessible by vehicle, hence regular checking of fauna traps in these areas would not have been possible. However, systematic fauna sampling (the primary component of the study) was completed on the basis of trapping grid installation

in habitats considered to be representative of the range of units present within the development area.

- Terrestrial invertebrate sampling was targeted at a small number of specific groups that are known to potentially harbour SRE taxa (EPA 2009).

Despite the above limitations, the survey is considered to have provided an assessment of terrestrial fauna and fauna habitats suitable to support the assessment of the proposed West Pilbara Iron Ore Mine Areas Project.

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3.0 Regional Context

3.1 Geological and Physiographic Context of the Study Area

3.1.1 Geology

A review of the geological mapping completed by Thorne and Trendall (2001) indicates that the Mine Areas study area encompasses a diverse range of formations, with 60 geological units (Table 3.1.

Table 3.1: Geological Units occurring within the study area.

Geological Unit	Description
Qr	Alluvium. Unconsolidated fluviatile sediments; beach sand; silt on high tidal flats.
Qg	Colluvium. Unconsolidated to loosely consolidated piedmont deposits; scree, talus.
Qa	Aeolian sand. Lightly vegetated white coastal dunes and sand; younger dune system; lightly vegetated fixed red inland dunes; seif dunes.
Ql	Flood deposits. Unconsolidated fluviatile and sheet-flood deposits in levees, river terraces.
Qpt	Eluvium. Residual, unconsolidated or loosely consolidated, low angle slope deposits; angular to subrounded shale and ironstone fragments; quartz and quartzite pebbles.
Qpd	Aeolian sand. Fixed, well vegetated coastal dunes and sand; older dune system.
Qo	Eluvium and alluvium. Residual 'high level' clay and sandy clay plain with gilgais; intermittent veneer of alluvium; residual deposits of sand, gravel, and pebbles; sheet kunkar in places.
Qb	Alluvium. Unconsolidated sand, gravel and pebbles; over kunkar or granite.
Qk	Kunkar. Impure earthy limestone in sheets and incrustations.
Czd	Duricrust. Indurated crust on older rocks; relict texture and structure preserved in places.
Czl	Laterite. Ferruginous, crumbly, cellular, mottled surficial deposit formed on Nanutarra Formation
Czc	Older colluvium. Consolidated ferruginous valley fill; including hematite rich conglomerate (canga), a source of Iron ore.
Czk	Calcrete. Impure earthy limestone and white porcellanite; with alluvium at base in places. Correlated in part with OAKOVER FORMATION
Tp	ROBE PISOLITE. Pisolitic, oolitic, and massive limonite goethite hematite deposits containing fossil wood fragments; Iron ore. Correlated with POONDANO FORMATION.
Kny	YARRALOOLA CONGLOMERATE. Poorly sorted conglomerate with shale, claystone lenses and interbedded sandstone; contains plant fossils.
Kn	NANUTARRA FORMATION. Shale, siltstone, micaceous siltstone; ferruginous and glauconitic quartz sandstone; some conglomerate; contains plant and marine fossils.
Ptp	TANPOOL BEDS. Massive and flaggy quartz sandstone, glauconitic sandstone, siltstone, and shale; with dolerite sill. Possible correlative of Mt. MINNIE GROUP.
Pma	WARRAMBOO SANDSTONE. Interbedded massive and flaggy quartz sandstone, and shale.
Pmw	WABCO SHALE. Brown shale with thin interbedded sandstone.
Pmk	KATANGA CONGLOMERATE. Poorly sorted conglomerate with interbedded quartz sandstone.
Pwa	ASBURTON FORMATION. Interbedded shale, fine grained sandstone, grey-wacke; ferruginous and siliceous shale, thin dolomite; phyllite, quartz-mica schist and mica schist.
Pwx	Volcanic rocks. Predominantly altered acid lava and tuff; with minor intrusive bodies, and thin intercalated dolomite containing Collenia.
Pwdc	Chert, chert breccia
Pwd	DUCK CREEK DOLOMITE. Calcitic dolomite, minor shale; with Collenia.
Pw	Undifferentiated MT. McGRATH FORMATION, BEASLEY RIVER QUARTZITE, and TUREE CREEK FORMATION. Shale, mudstone, siltstone, quartz sandstone, greywacke, pebble conglomerate, and altered lava and tuff.
Pho	BOOLGEEDA IRON FORMATION. Massive blue jaspilite, micaceous shale, siltstone.
Phw	WOONGARRA VOLCANICS. Aphanitic and porphyritic acid lava and tuff, with intercalcated jaspilite and shale.
Phj	WEELI WOLLI FORMATION. Thinly bedded jaspilite, siltstone and shale.

Geological Unit	Description
Phb	BROCKMAN IRON FORMATION. Massive laminated jaspilite with thin shale, chert, and dolomite; contains crocidolite and hematite.
Phba	Acid tuff, breccia.
Phr	MT. McRAE SHALE. White-weathering shale with chert, dolomitic shale; and jaspilite in upper part.
Phs	MT. SYLVIA FORMATION. Interbedded jaspilite and shale with dolomitic shale.
Phd	WITTENOOM DOLOMITE. Grey to blue calcitic crystalline dolomite, with chert and dolomitic shale towards top and bottom.
Phm	MARRA MAMBA IRON FORMATION. Interbedded jaspilite, ferruginous "pinch and swell" chert, and shale; contains crocidolite.
Pf	Chert, shale, dolomite. Undifferentiated members of attenuated succession which includes formations as shown.
Pfji	Roy Hill Shale Member. White-weathering shale, silicified in places; carbonaceous and pyritic when fresh.
Pfjn	Nallanaring Volcanic Member. Fine grained basic lava with pillows in places; acid volcanic rocks and volcanic pisoliths.
Pfjw	Warrie Member. Interbedded shale, chert, jaspilite and dolomite.
Pfjo	Woodiana Sandstone Member. Interbedded shale, impure sandstone, greywacke, silicified mudstone; with basal grit in places.
Pfm	MADDINA VOLCANICS. Basic, intermediate, and acid lavas with thin intercalated pyroclastic rocks; sandstone.
Pfp	PILLINGINI TUFF. Bedded tuff and tuffaceous detrital rocks; with thin jaspilite, dolomite, chert, and shale; and some lava. Contains volcanic pisoliths, and Collenia.
Pfk	KYLENA VOLCANICS. Basic, intermediate, and acid lavas, with thin intercalated pyroclastic rocks; sandstone.
Pfcl	Lyre Creek Agglomerate Member. Tuff, fine grained agglomerate tuffaceous quartzite, and calcareous beds; with volcanic pisoliths and lava "bombs"
Pfc	CLIFF SPRINGS FORMATION. Tuff and tuffaceous detrital rocks; shale, siltstone, sandstone, conglomerate; with volcanic pisoliths.
Pb	MT. ROE BASALT. Basic and intermediate lavas; thin intercalated tuffaceous sedimentary rocks; and agglomerate in places.
Am	Metamorphic rocks. Altered rocks of the Roebourne Group. Schist, paragneiss, granulite, mylonite, amphibolite, hybrid rocks.
Ae	REGAL FORMATION. Altered basic and acid volcanic rocks with intercalated sedimentary rocks; intruded by concordant bodies of porphyry and metadolerite.
As	NICKOL RIVER FORMATION. Amphibole schist; quartz-mica schist; banded chert, jaspilite, dolomite and prase; fuchsite-bearing rocks; altered basic volcanic rocks, pillow lavas.
D	Dolerite dykes
Q	Quartz Veins. Massive barren quartz commonly associated with faults and shears.
Pg	Granite. Medium grained leucocratic granite.
Pp	Porphyry dykes. Quartz-feldspar porphyry.
Pjd	Dolerite. Altered basic sill in WEELI WOLLI FORMATION.
Pdc	COOYA POOYA DOLERITE. Massive and layered, mainly concordant with local acid segregations.
Ad	Dolerite. Altered basic dykes
Agm	Grandiorite, tonalite, biotite granite, microgranite, Hornblende and biotite-bearing acid intrusive rocks.
Agb	Gabbro. Altered basic intrusive rock; epidote rich.
Ag	Granite. Leucocratic medium to coarse grained equigranular granite, porphyritic in places; granitic gneiss; migmatite
Aa	Amphibolite. Altered coarse grained basic rocks, probably comagmatic with MUNNI MUNNI COMPLEX.
Abm	MUNNI MUNNI BASIC COMPLEX. Fresh to altered gabbro, pyrxenite, serpentinite.

3.1.2 IBRA Bioregion and Subregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (Environment Australia 2000). The Mine Areas study area is located within the Pilbara IBRA bioregion. There are four biological subregions within the Pilbara bioregion (Environment Australia 2000): Hamersley, Fortescue Plains, Chichester and Roebourne. The Mine Areas study area is located within the Hamersley subregion (PIL3):

Hamersley: Mountainous area of proterozoic sedimentary ranges and plateaux with Mulga (*Acacia aneura*) low woodland over bunch grasses on fine textured soils and Snappy Gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on skeletal sandy soils of the ranges.

For further discussion of the Hamersley subregion, see Kendrick (2001).

3.1.3 Land Systems

Land Systems (Rangelands) mapping covering the study area has been prepared to a draft stage by the Western Australian Department of Agriculture (Payne et al 1988 and van Vreeswyk et al. 2004). Land Systems are comprised of repeating patterns of topography, soils, and vegetation (Christian and Stewart 1953) (ie. a series of "land units" that occur on characteristic physiographic types within the Land System). A total of 107 Land Systems occur in the Pilbara bioregion.

Table 3.2 provides a summary of the Land Systems present in the Mine Areas study area and their status in the Hamersley subregion. The distribution of these units within the study area relative to the systematic survey sites is shown in Figure 3.1 and Figure 3.2.

Table 3.2: Land Systems occurring within the study area and their extent within the Hamersley subregion (data from Payne et al. 1988 and van Vreeswyk et al. 2004).

Land System	Description	Extent within subregion (ha)	Extent within study area (ha)	% of total within subregion
Boolgeeda (RGEBGD)	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	961,635	666	0.07%
Capricorn (RGECPN)	Hills and ridges of sandstone and dolomite supporting low shrublands or shrubby spinifex grasslands.	698,531	672	0.10%
Newman (RGENEW)	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,742	119	0.01%
Robe (RGEROB)	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	128,859	2,846	2.21%
Rocklea (RGEROC)	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2,881,200	578	0.02%
Stuart (STT)	Gently undulating stony plains supporting hard and soft spinifex grasslands and snakewood shrublands.	276,685	60	0.02%
Urandy (URY)	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands.	131,976	799	0.61%
		7,072,628	**5,740**	

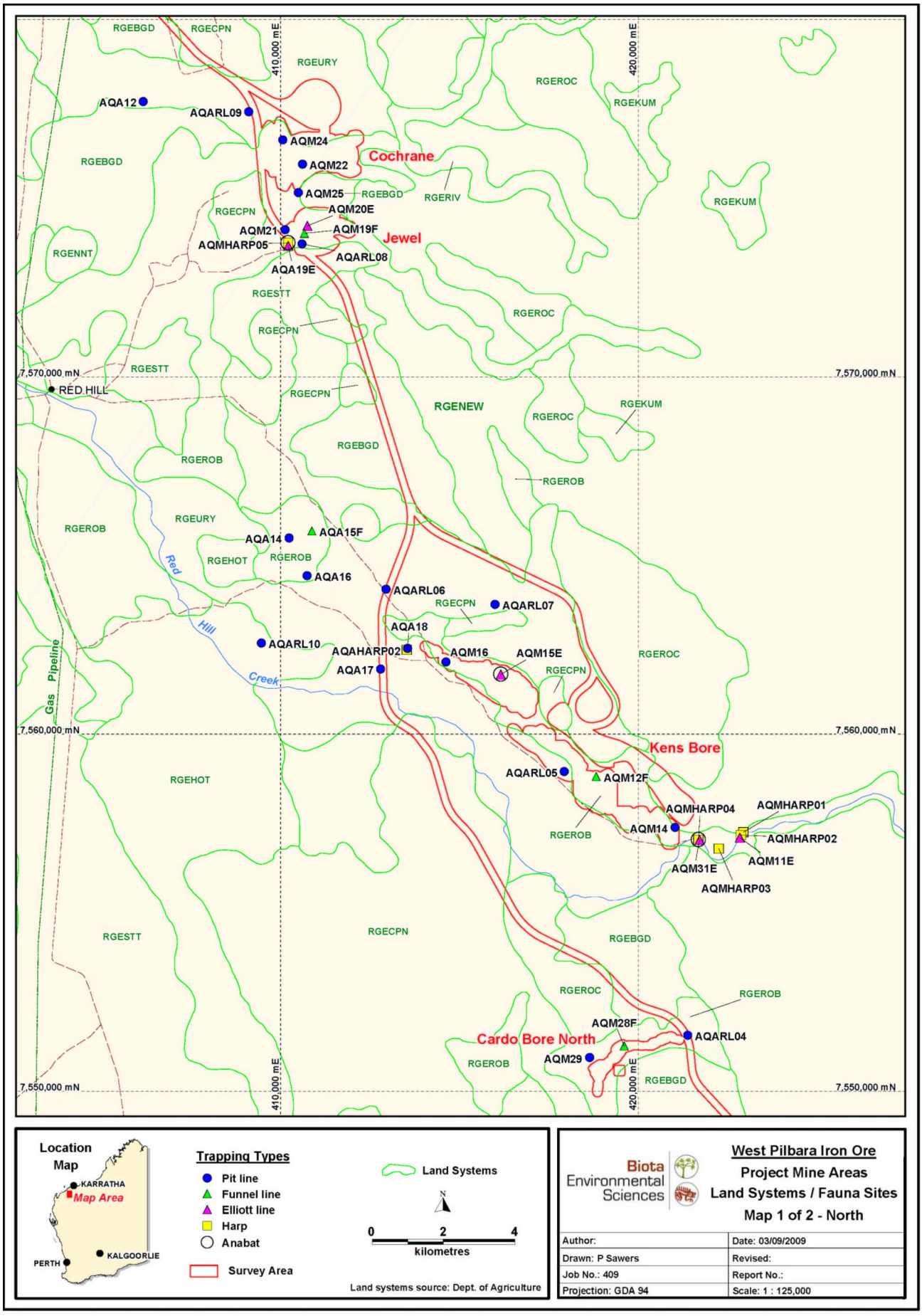

Figure 3.1: Rangelands and fauna trapping sites in the northern part of the Mine Areas study area.

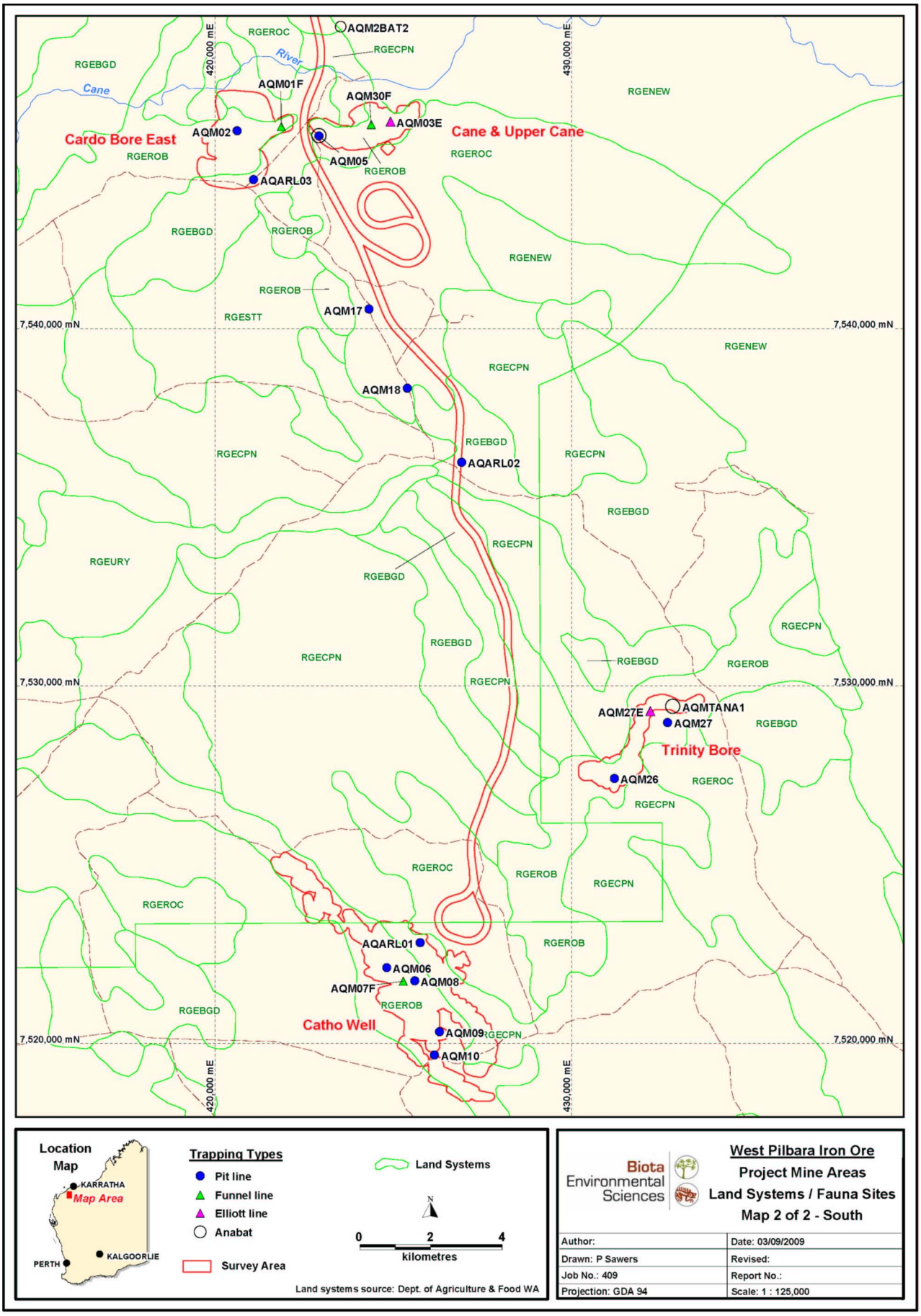

Figure 3.2: Rangelands and fauna trapping sites in the southern part of the Mine Areas study area.

3.1.4 Vegetation Mapping

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The study area lies entirely within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts. Given the broad nature of Beard's mapping, these units are only broadly applicable to the vegetation occurring on site.

A systematic study of the vegetation within the Mine Areas study area is currently being completed by Western Botanical (2009). This will provide a more detailed and site-specific analysis of vegetation values in the study area.

3.1.5 Conservation Reserves in the Locality

Three conservation reserves are found in the vicinity of the Mine Areas study area, two of which are formally gazetted:

- Millstream-Chichester National Park is located ~100 km north-east of the study area and extends over approximately 200,000 ha;
- Karijini National Park is located ~170 km west of the study area and extends over approximately 650,000 ha; and
- Cane River Conservation Park is located ~100 km northeast of the study area (not formally gazetted). Extends over approximately 148,000 ha.

Due to the limited representation of the area in conservation reserves, land purchases in the Pilbara Bioregion are listed as medium priority for funding under the National Reserves System Co-operative Program. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015, when the leases are due for renewal. Many of the submissions are from the Department of Environment and Conservation (DEC), with the intention of adding these areas to the existing conservation estate in order to provide a comprehensive, adequate and representative reserve system.

3.2 Previous Fauna Studies

Previous fauna studies completed in the vicinity of the Mine Areas study area include:

- West Pilbara Iron Ore Project Transport Corridor Seasonal Fauna Survey (Biota report pending);
- West Pilbara Iron Ore Project Level 1 Fauna Assessment (Biota 2007a);
- Mesa K Targeted Fauna Survey (Biota 2007b);
- Bungaroo Creek Trial Pits and Transport Corridor to Mesa J near Pannawonica: Fauna Habitats and Fauna Assemblages Survey (Biota 2006a);
- Fauna habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo (Biota 2006b); and
- Mesa J Extension Vegetation, Flora and Fauna Assessment (Biota 2003).

4.0 Results

4.1 Fauna Habitats

The Mine Areas study area included 15 main habitat units, distinguished on the basis of differences in substrate, vegetation, soils and landform (Table 4.1). The vegetation type present at each of these sites in the context of the vegetation types mapped by Western Botanical (2009) is also provided in Table 4.1. Representative photographs of each habitat are provided in Plate 4.1 to Plate 4.20.

Table 4.1: Fauna habitats sampled at systematic survey sites within West Pilbara Iron Ore Mine Areas.

Landform and soils	Vegetation	Location	Sites
Clay loam plain	*Acacia xiphophylla* tall shrubland over *Triodia* sp. open hummock grassland.	Cochrane & Jewel	AQA12
	Acacia sp. open shrubland over *Triodia* sp. hummock grassland.	Cochrane & Jewel	AQM21
	Acacia xiphophylla open shrubland over *Triodia* sp. very open hummock grassland.	Cochrane & Jewel	AQM24
	Eucalyptus sp. scattered low trees over *Acacia* spp. open shrubland over *Triodia* sp. hummock grassland	Cochrane & Jewel	AQM22
	Acacia xiphophylla tall shrubland.	Ken's Bore	AQA16
	Acacia sp. open shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQA18
	Acacia sp. scattered shrubs over *Triodia* sp. hummock grassland.	Ken's Bore	AQARL10
	Acacia xiphophylla open shrubland and Acacia spp. open shrubland over *Triodia* sp. open hummock grassland.	Cardo North	AQM29
	Acacia sp. open shrubland over *Triodia* sp. hummock grassland.	Catho Well	AQARL01
Stony loam plain	*Grevillea pyramidalis* scattered shrubs over *Acacia* spp. scattered shrubs over *Triodia* sp. hummock grassland.	Cochrane & Jewel	AQARL09
	Acacia sp. scattered shrubs over *Triodia* sp. hummock grassland.	Ken's Bore	AQA17
	Acacia spp. open shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQARL05
	Acacia spp. scattered shrubs over *Triodia* sp. hummock grassland	Ken's Bore	AQARL07
	Acacia spp. scattered shrubs over *Triodia* sp. hummock grassland.	Catho Well	AQM10
	Acacia sp. scattered shrubs over *Triodia* sp. hummock grassland.	Trinity Bore	AQM27
	Acacia spp. scattered low shrubs over scattered *Triodia* sp. hummock grassland	Cardo East	AQARL03
Mesa top laterite	*Acacia bivenosa* shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQA15F
	Acacia spp. open shrubland over *Triodia* sp. hummock grassland.	Cardo East	AQM01F
	Eucalyptus leucophloia scattered trees over *Triodia* sp. open hummock grassland.	Ken's Bore	AQM12F
	Acacia spp. open shrubland over *Triodia* sp. open hummock grassland.	Cardo North	AQM28F
	Acacia inaequilatera scattered shrubs over *Triodia* sp. hummock grassland.	Cane & Upper Cane	AQM30F
	Acacia spp. open shrubland over *Triodia* sp. open hummock grassland.	Cochrane & Jewel	AQM19F
	Acacia spp. shrubland over *Triodia* sp. hummock grassland.	Catho Well	AQM07F
Mesa top stony loam	*Acacia* spp. scattered shrubs over *Triodia* sp. hummock grassland.	Catho Well	AQM06

	Acacia spp. scattered shrubs over *Triodia* sp. hummock grassland.	Catho Well	AQM08
	Acacia spp. open shrubland over Triodia sp hummock grassland.	Cardo East	AQM02
	Acacia spp. open shrubland over closed *Triodia* sp. hummock grassland.	Ken's Bore	AQM16
	Acacia spp. open shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQM14
	Grevillea wickhamii scattered shrubs over *Acacia* spp. open shrubland over *Triodia* sp. hummock grassland.	Trinity Bore	AQM26
Gravely loam slope	*Triodia* sp. hummock grassland.	Cochrane & Jewel	AQM25
	Triodia sp. hummock grassland.	Catho Well	AQM09
Sandy loam plain	*Acacia* spp. scattered shrubs over *Triodia* sp. hummock grassland.	Cane & Upper Cane	AQM18
Minor drainage with clay loam	*Acacia tumida* shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQA14
	Eucalyptus sp. scattered trees over Acacia spp. open shrubland over Triodia sp. hummock grassland	Cardo North	AQARL04
Major drainage stony alluvial bed	*Eucalyptus vitirx* and *E. camaldulensis* scattered trees over *Acacia* spp. open shrubland over native tussock spp.	Ken's Bore	AQM11E
Mesa rocky breakaway	*Acacia* spp. scattered shrubs over *Triodia* sp. hummock grassland.	Ken's Bore	AQM15E
	Eucalyptus sp. scattered low trees over *Acacia* spp. open shrubland over *Triodia* sp open hummock grassland.	Cane & Upper Cane	AQM03E
	Acacia spp. open shrubland over *Triodia* sp. hummock grassland.	Cochrane & Jewel	AQA19E
	Eucalyptus leucophloia scattered trees over *Acacia* spp. shrubland over *Triodia* sp. hummock grassland.	Cochrane & Jewel	AQM20E
	Acacia spp. open shrubland over *Triodia* sp. hummock grassland.	Trinity Bore	AQM27E
Mesa rocky breakaway/broad drainage	Eucalyptus *vitrix* and E. *camaldulensis* over *Acacia* spp. open shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQM31E
Stony clay loam slope	*Acacia xiphophylla* open shrubland over *Triodia* sp. open hummock grassland.	Cane & Upper Cane	AQM05
Gilgai clay plain	*Triodia* sp. closed hummock grassland.	Cane & Upper Cane	AQM17
Sandy loam plain	Acacia spp. scattered low shrubs over *Triodia* sp. hummock grassland.	Trinity Bore	AQARL02
Clay plain	*Acacia xiphophylla* shrubland over *Triodia* sp. hummock grassland.	Ken's Bore	AQARL06
Mesa Base	*Acacia* spp. shrubland over *Triodia* sp. hummock grassland.	Cochrane & Jewel	AQARL08

Representative clay loam plain habitat

Plate 4.1: Site AQA16

Plate 4.2: Site AQM22

Representative stony loam plain habitat

Plate 4.3: Site AQARL09

Plate 4.4: Site AQA17

Representative mesa top laterite habitat

Plate 4.5: Site AQM12F

Plate 4.6: Site AQM28F

Representative mesa top stony loam habitat

Plate 4.7: Site AQM02

Plate 4.8: Site AQM16

Representative gravely loam slope habitat

Plate 4.9: Site AQM25

Representative sandy loam plain habitat

Plate 4.10: Site AQM18

Minor drainage with clay loam habitat

Plate 4.11: Site AQA14

Plate 4.12: Site AQARL04

Major drainage stony alluvial bed habitat

Plate 4.13: Site AQM11E

Representative mesa rocky breakaway habitat

Plate 4.14: Site AQM03E

Plate 4.15: Site AQA19E

Stony clay loam slope habitat

Plate 4.16: Site AQM05

Gilgai clay plain habitat

Plate 4.17: Site AQM17

Sandy loam plain habitat

Plate 4.18: Site AQARL02

Clay plain habitat

Plate 4.19: Site AQARL06

Mesa base habitat

Plate 4.20: Site AQARL08

4.2 Vertebrate Fauna Overview

The combined total of 168 vertebrate species for the Mine Areas fauna survey comprised 79 avifauna species, 26 mammal species and 60 herpetofauna species (Table 4.2).

Table 4.2: Number of vertebrate fauna species recorded during the WPIOP Mine Areas fauna survey.

Fauna Type	Number of Species		
	Phase I	Phase II	Overall
Avifauna	67	57	**79**
Native Non-volant Mammals	14	10	**14**
Bats	9	3	**9**
Introduced Mammals	1	2	**3**
Amphibians	3	2	**3**
Reptiles	50	42	**60**
Total	**144**	**116**	**168**

4.3 Avifauna

4.3.1 The Assemblage

Seventy-nine bird species were recorded from the Mine Areas study area, comprising 25 non-passerine species and 54 passerine species from 35 families (Table 4.3).

The Masked Woodswallow (*Artamus personatus*) was the most abundant species recorded (1,118 records), representing over 24% of recorded avifauna. The most speciose family of birds was the Meliphagidae (honey eaters and chats) with 12 species recorded (Table 4.3).

4.3.2 Avifauna of Conservation Significance

Two avifauna species of elevated conservation significance were recorded during the Mine Areas survey: the Grey Falcon, *Falco hypoleucos* (Priority 4), and the Australian Bustard, *Ardeotis australis* (Priority 4). A further five species of avifauna of conservation significance may occur within the study area, this includes two Schedule listed species and three Priority listed species (see Section 4.3). One species listed as a migratory under the Commonwealth *EPBC Act 1999* (*Merops ornatus*) was also recorded during the survey (see Section 5.3).

Table 4.3: Avifauna records from the northern deposits in the WPIOP Mine Areas study area (numbers=Phase 1/Phase 2; - denotes not sampled on that phase).

FAMILY Common name	Species Name	Cochrane & Jewel										Ken's Bore													
		AQA 12	AQARL 09	AQM 24	AQM 22	AQM 25	AQM 20E	AQM 21	AQARL 08	AQM 19F	AQA 19E	AQA 15F	AQA 14	AQA 16	AQARL 06	AQARL 07	AQARL1 0	AQA 18	AQA 17	AQM 16	AQM 15E	AQARL0 5	AQM 12F	AQM 14	AQM 11E
CASUARIIDAE																									
Emu	*Dromaius novaehollandiae*	3/-						2/0									0/1								
PHASIANIDAE																									
Brown Quail	*Coturnix ypsilophora*																	2/-							
ARDEIDAE																									
White-necked Heron	*Ardea pacifica*																								2/-
THRESKIORNITHIDAE																									
Straw-necked Ibis	*Threskiornis spinicollis*																								4/-
ACCIPITRIDAE																									
Whistling Kite	*Haliastur sphenurus*																								
Brown Goshawk	*Accipiter fasciatus*		0/1																						
Wedge-tailed Eagle	*Aquila audax*					1/-	1/-	2/0										1/-			4/-	0/1	1/2	1/0	
Spotted Harrier	*Circus assimilis*														0/1		0/1						0/1	0/1	
FALCONIDAE																									
Brown Falcon	*Falco berigora*	1/-			0/1			3/0				1/-			0/1	0/1	0/2		1/-				2/0	2/0	
Australian Kestrel	*Falco cenchroides*		0/1					1/0						1/-		1/1									
Australian Hobby	*Falco longipennis*																								
Grey Falcon	*Falco hypoleucos*																								
OTIDIDAE																									
Australian Bustard	*Ardeotis australis*		0/2													0/3									
TURNICIDAE																									
Little Button-quail	*Turnix velox*																0/2					0/2			
SCOLOPACIDAE																									
Little Curlew	*Numenius minutus*																								
COLUMBIDAE																									
Common Bronzewing	*Phaps chalcoptera*													1/-	1/0					1/0			2/0		2/-
Crested Pigeon	*Ocyphaps lophotes*		0/4					0/1				1/-	80/-	28/-	0/3	3/0	2/0	1/-	2/-				5/0		30/-
Spinifex Pigeon	*Geophaps plumifera*			0/2	1/4								1/-		0/7	0/2			2/-	24/14		6/0	0/8	12/20	20/-
Diamond Dove	*Geopelia cuneata*			0/1				0/1	0/1	–/1							1/0	1/-		0/4		1/25	0/4	0/6	
Peaceful Dove	*Geopelia striata*		8/0						3/0																4/-
PSITTACIDAE																									
Galah	*Cacatua roseicapilla*		12/0		1/0				3/0			60/-	3/-	62/-		2/0	5/0	18/-	8/-	0/34		2/0			
Little Corella	*Cacatua sanguinea*		0/3										7/-						2/-						15/-
Cockatiel	*Nymphicus hollandicus*		0/3												0/2		40/0								
Australian Ringneck	*Platycercus zonarius*						3/-						2/-				4/2		2/-		4/-				
Budgerigar	*Melopsittacus undulatus*		12/0			5/-								24/-	0/19		0/4	4/-	1/-						
CUCULIDAE																									
Pallid Cuckoo	*Cuculus pallidus*								1/0							0/1		4/-	1/-						1/-
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*								0/1							0/1						1/0			
CAPRIMULGIDAE																									
Spotted Nightjar	*Eurostopodus argus*									–/1	2/-														
AEGOTHELIDAE																									
Australian Owlet-nightjar	*Aegotheles cristatus*																								
HALCYONIDAE																									
Blue-winged Kookaburra	*Dacelo leachii*																								4/-
Red-backed Kingfisher	*Todiramphus pyrrhopygia*													1/-			0/1	1/-	2/-						
MEROPIDAE																									
Rainbow Bee-eater	*Merops ornatus*				5/0			3/0				2/-	6/-	2/-				12/-	18/-		2/-		4/0	5/2	11/-
MALURIDAE																									
Variegated Fairy-wren	*Malurus lamberti*	7/-			2/0			2/0				6/-		3/-			0/5	7/-		7/2			3/0		14/-

Table 4.3: Avifauna records from the northern deposits in the WPIOP Mine Areas study area (numbers=Phase 1/Phase 2; - denotes not sampled on that phase).

FAMILY Common name	Species Name	Cochrane & Jewel										Ken's Bore													
		AQA 12	AQARL 09	AQM 24	AQM 22	AQM 25	AQM 20E	AQM 21	AQARL 08	AQM 19F	AQA 19E	AQA 15F	AQA 14	AQA 16	AQARL 06	AQARL 07	AQARL10	AQA 18	AQA 17	AQM 16	AQM 15E	AQARL05	AQM 12F	AQM 14	AQM 11E
White-winged Fairy-wren	*Malurus leucopterus*							2/0										3/-	2/-					1/0	
Rufous-crowned Emu-wren	*Stipiturus ruficeps*																								
Striated Grasswren	*Amytornis striatus*																								
PARDALOTIDAE																									
Red-browed Pardalote	*Pardalotus rubricatus*		0/1									1/-	1/-	1/-				1/-							
Striated Pardalote	*Pardalotus striatus*																								
ACANTHIZIDAE																									
Weebill	*Smicrornis brevirostris*	5/-		1/0	1/2		1/-											22/-		2/4	1/-		5/5	5/0	13/-
Western Gerygone	*Gerygone fusca*								1/0																
MELIPHAGIDAE																									
Brown Honeyeater	*Lichmera indistincta*				3/0	2/-	2/-	1/0					9/-	3/-	2/0	0/1	0/15	12/-	13/-		8/-				
Black Honeyeater	*Certhionyx niger*															0/2	0/3								
Singing Honeyeater	*Lichenostomus virescens*	22/-	4/2		1/0		1/-	1/0	8/1			5/-	27/-	21/-	2/4	1/2	0/9	18/-	37/-	6/0	11/-		7/3	4/2	1/-
Grey-headed Honeyeater	*Lichenostomus keartlandi*								0/9				10/-							3/0	4/-		4/0	1/0	
Grey-fronted Honeyeater	*Lichenostomus plumulus*					1/-																	0/1		
White-plumed Honeyeater	*Lichenostomus penicillatus*	2/-											11/-					24/-	18/-		15/-		3/0		21/-
Black-chinned Honeyeater	*Melithreptus gularis*												3/-												
White-fronted Honeyeater	*Phylidonyris albifrons*																0/3								
Grey Honeyeater	*Lacustroica whitei*																						0/1	0/1	
Yellow-throated Miner	*Manorina flavigula*				3/0			0/2				3/-	13/-		0/5		0/7	24/-	30/-	4/2	6/-		1/0	12/0	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*												1/-	1/-			0/9	1/-							
Crimson Chat	*Epthianura tricolor*												5/-			2/0									
PETROICIDAE																									
Hooded Robin	*Petroica cucullata*								0/1				3/-	1	1/3		0/1								
POMATOSTOMIDAE																									
Grey-crowned Babbler	*Pomatostomus temporalis*													7/-					1/-						5/-
CINCLOSOMATIDAE																									
Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*													1/-											
PACHYCEPHALIDAE																									
Crested Bellbird	*Oreoica gutturalis*		1/1	1/1	0/1				2/2			1/-	7/-	2/-	0/2	0/4	2/3	2/-	5/-	0/1		1/0	1/1	1/0	
Rufous Whistler	*Pachycephala rufiventris*												2/-	1/-			0/1	3/-	1/-		3/-				3/-
Grey Shrike-thrush	*Colluricincla harmonica*								2/0				1/-					1/-			2/-				1/-
DICRURIDAE																									
Willie Wagtail	*Rhipidura leucophrys*	2/-		1/0			3/-	2/1	1/1			2/-	8/-	7/-				7/-	8/-	4/0	9/-		3/3	2/0	12/-
Magpie-lark	*Grallina cyanoleuca*													2/-				3/-		1/0			3/0		7/-
CAMPEPHAGIDAE																									
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*													2	0/1					4/1		3/0			
White-winged Triller	*Lalage tricolor*							2	1/0											0/1					
ARTAMIDAE																									
Masked Woodswallow	*Artamus personatus*														0/407	0/56	0/30					0/150			
Black-faced Woodswallow	*Artamus cinereus*	2/-	2/0					11/0					13/-						7/-				2/0		
Little Woodswallow	*Artamus minor*							0/2	2/0																
CRACTICIDAE																									
Grey Butcherbird	*Cracticus torquatus*	1/-																							
Pied Butcherbird	*Cracticus nigrogularis*							2/0	0/2						0/4		0/2	1/-	1/-	0/1		1/0	2/1		
Australian Magpie	*Cracticus tibicen*		4/0											4										4/0	
CORVIDAE																									
Torresian Crow	*Corvus orru*	2/-		2/0		1/-		3/0								1/1	0/1	3/-	4/-	3/4			1/0	2/0	
Little Crow	*Corvus bennetti*			3/0		1/-																			

Table 4.3: Avifauna records from the northern deposits in the WPIOP Mine Areas study area (numbers=Phase 1/Phase 2; - denotes not sampled on that phase).

FAMILY Common name	Species Name	Cochrane & Jewel										Ken's Bore													
		AQA 12	AQARL 09	AQM 24	AQM 22	AQM 25	AQM 20E	AQM 21	AQARL 08	AQM 19F	AQA 19E	AQA 15F	AQA 14	AQA 16	AQARL 06	AQARL 07	AQARL10	AQA 18	AQA 17	AQM 16	AQM 15E	AQARL05	AQM 12F	AQM 14	AQM 11E
PTILONORHYNCHIDAE																									
Western Bowerbird	*Ptilonorhynchus maculatus*																								2/-
HIRUNDINIDAE																									
Tree Martin	*Hirundo nigricans*																								
SYLVIIDAE																									
Spinifex-bird	*Eremiornis carteri*							1/0	0/1								0/2	2/-	4/-						3/-
Rufous Songlark	*Cincloramphus mathewsi*																								
Brown Songlark	*Cincloramphus cruralis*																								
DICAEIDAE																									
Mistletoebird	*Dicaeum hirundinaceum*																								1/-
PASSERIDAE																									
Zebra Finch	*Taeniopygia guttata*		0/33						0/23				6/-	2/-	0/19	0/11	0/33	2/-	3/-		8/-				
Painted Finch	*Emblema pictum*								0/4			2/-													
MOTACILLIDAE																									
Australian Pipit	*Anthus australis*											1/-													
Number of individuals:		**47/-**	**43/51**	**14/4**	**17/8**	**11/-**	**11/-**	**38/7**	**24/46**	**–/2**	**2/-**	**85/-**	**219/-**	**177/-**	**6/478**	**10/86**	**54/137**	**180/-**	**173/-**	**69/68**	**77/-**	**15/178**	**49/30**	**52/32**	**176/-**
Number of species:		**10/-**	**7/10**	**6/3**	**8/4**	**6/-**	**6/-**	**15/5**	**10/11**	**–/2**	**1/-**	**12/-**	**22/-**	**22/-**	**4/14**	**6/13**	**6/22**	**27/-**	**24/-**	**12/11**	**13/-**	**7/4**	**17/11**	**13/6**	**22/-**
Total Number of species:		**10**	**15**	**7**	**10**	**7**	**6**	**19**	**18**	**2**	**1**	**12**	**22**	**22**	**16**	**16**	**6**	**27**	**24**	**16**	**13**	**10**	**22**	**16**	**22**

Table 4.4: Avifauna records from the southern deposits in the WPIOP Mine Areas, and totals for the entire survey (numbers=Phase 1/Phase 2; – denotes not sampled on that phase).

FAMILY Common Name	Species	Cardo North			Cardo East			Cane & Upper Cane					Trinity Bore			Catho Well							Total P1	Total P2	Opp	Overall Total
		AQARL 04	AQM 28F	AQM 29	AQM 01F	AQM 02	AQARL 03	AQM 03E	AQM 30F	AQM 05	AQM 17	AQM 18	AQARL 02	AQM 27	AQM 27E	AQM 26	AQARL 01	AQM 06	AQM 07F	AQM 08	AQM 09	AQM 10				
CASUARIIDAE																										
Emu	*Dromaius novaehollandiae*											1/-	2/1	2/0						1/-			**13**	**2**	**9**	**24**
PHASIANIDAE																										
Brown Quail	*Coturnix ypsilophora*																						**2**		**0**	**2**
ARDEIDAE																										
White-necked Heron	*Ardea pacifica*																						**2**		**0**	**2**
THRESKIORNITHIDAE																										
Straw-necked Ibis	*Threskiornis spinicollis*																						**4**		**0**	**4**
ACCIPITRIDAE																										
Whistling Kite	*Haliastur sphenurus*																					1/-	**1**		**0**	**1**
Brown Goshawk	*Accipiter fasciatus*																							**1**	**2**	**3**
Wedge-tailed Eagle	*Aquila audax*										1/0				2/-	0/1							**14**	**4**	**0**	**18**
Spotted Harrier	*Circus assimilis*																				0/1		**1**	**5**	**1**	**7**
FALCONIDAE																										
Brown Falcon	*Falco berigora*					0/1						2/-				0/1		1/0		1/-			**14**	**7**	**0**	**21**
Australian Kestrel	*Falco cenchroides*			1/0			1/-				1/0		0/2										**6**	**4**	**0**	**10**
Australian Hobby	*Falco longipennis*																								**1**	**1**
Grey Falcon	*Falco hypoleucos*																								**1**	**1**
OTIDIDAE																										
Australian Bustard	*Ardeotis australis*			0/1																				**6**	**17**	**23**
TURNICIDAE																										
Little Button-quail	*Turnix velox*															0/1						1/-	**1**	**5**	**0**	**6**
SCOLOPACIDAE																										
Little Curlew	*Numenius minutus*																								**1**	**1**
COLUMBIDAE																										
Common Bronzewing	*Phaps chalcoptera*	1/0	0/1																	2/-			**10**	**1**	**0**	**11**
Crested Pigeon	*Ocyphaps lophotes*	1/0					2/-		5/-	29/7	0/2		0/2	1/2		1/0	7/-				0/4		**198**	**25**	**0**	**223**

Table 4.4: Avifauna records from the southern deposits in the WPIOP Mine Areas, and totals for the entire survey (numbers=Phase 1/Phase 2; – denotes not sampled on that phase).

FAMILY Common Name	Species	Cardo North			Cardo East			Cane & Upper Cane					Trinity Bore			Catho Well							Total P1	Total P2	Opp	Overall Total
		AQARL 04	AQM 28F	AQM 29	AQM 01F	AQM 02	AQARL 03	AQM 03E	AQM 30F	AQM 05	AQM 17	AQM 18	AQARL 02	AQM 27	AQM 27E	AQM 26	AQARL 01	AQM 06	AQM 07F	AQM 08	AQM 09	AQM 10				
Spinifex Pigeon	*Geophaps plumifera*	1/0		3/0		12/7	1/-			5/4	2/0	40/-	3/2	3/1					–/2	10/-	80/2	15/-	**243**	**75**	**2**	**320**
Diamond Dove	*Geopelia cuneata*	1/0					12/-		1/-	0/3							2/-	0/2			0/2		**19**	**50**	**0**	**69**
Peaceful Dove	*Geopelia striata*																						**15**		**0**	**15**
PSITTACIDAE																										
Galah	*Cacatua roseicapilla*						11/-	1/-		3/0	1/0		1/0	12/0			2/-	0/3	–/7		0/17		**213**	**61**	**0**	**274**
Little Corella	*Cacatua sanguinea*								2/-										–/5				**26**	**8**	**0**	**34**
Cockatiel	*Nymphicus hollandicus*																						**40**	**5**	**0**	**45**
Australian Ringneck	*Platycercus zonarius*	1/0											0/5								3/0		**19**	**7**	**0**	**26**
Budgerigar	*Melopsittacus undulatus*												0/3			0/13	190/-						**236**	**39**	**0**	**275**
CUCULIDAE																										
Pallid Cuckoo	*Cuculus pallidus*									0/1		1/-											**8**	**2**	**0**	**10**
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*	1/0	2/0				1/-	1/-	1/-														**8**	**2**	**1**	**11**
CAPRIMULGIDAE																										
Spotted Nightjar	*Eurostopodus argus*																						**2**	**1**	**9**	**12**
AEGOTHELIDAE																										
Australian Owlet-nightjar	*Aegotheles cristatus*																								**1**	**1**
HALCYONIDAE																										
Blue-winged Kookaburra	*Dacelo leachii*					0/1																	**4**	**1**	**0**	**5**
Red-backed Kingfisher	*Todiramphus pyrrhopygia*						1/-			1/0				1/0									**7**	**1**	**0**	**8**
MEROPIDAE																										
Rainbow Bee-eater	*Merops ornatus*	0/2		1/0				8/-			0/2					0/4						2/-	**95**	**10**	**4**	**109**
MALURIDAE																										
Variegated Fairy-wren	*Malurus lamberti*				4/-	4/0		3/-			2/5			4/0		6/0	8/-				0/2		**82**	**14**	**0**	**96**
White-winged Fairy-wren	*Malurus leucopterus*												0/2	3/0									**11**	**2**	**0**	**13**
Rufous-crowned Emu-wren	*Stipiturus ruficeps*													0/2										**2**	**0**	**2**
Striated Grasswren	*Amytornis striatus*													0/1	1/-	2/0							**3**	**1**	**0**	**4**
PARDALOTIDAE																										
Red-browed Pardalote	*Pardalotus rubricatus*																						**4**	**1**	**0**	**5**
Striated Pardalote	*Pardalotus striatus*												3/0										**3**		**0**	**3**
ACANTHIZIDAE																										
Weebill	*Smicrornis brevirostris*				1/-					7/0	1/0											2/-	**67**	**11**	**0**	**78**
Western Gerygone	*Gerygone fusca*			2/0													2/-						**5**		**0**	**5**
MELIPHAGIDAE																										
Brown Honeyeater	*Lichmera indistincta*	0/3						1/-		1/2	0/3		1/11			0/15					0/1		**69**	**51**	**11**	**131**
Black Honeyeater	*Certhionyx niger*															0/7								**12**	**0**	**12**
Singing Honeyeater	*Lichenostomus virescens*	3/0	1/0	2/0	2/-	1/0	1/-	3/-	1/-	5/5	1/0	4/-	2/8	4/0		1/9	3/-	0/1			1/1		**212**	**47**	**0**	**259**
Grey-headed Honeyeater	*Lichenostomus keartlandi*								16/-		2/0	1/-		2/2		5/57			–/7		5/0	20/-	**73**	**75**	**0**	**148**
Grey-fronted Honeyeater	*Lichenostomus plumulus*																						**1**	**1**	**0**	**2**
White-plumed Honeyeater	*Lichenostomus penicillatus*																						**95**		**1**	**96**
Black-chinned Honeyeater	*Melithreptus gularis*																						**3**		**0**	**3**
White-fronted Honeyeater	*Phylidonyris albifrons*															0/2								**5**	**0**	**5**
Grey Honeyeater	*Lacustroica whitei*																							**2**	**0**	**2**
Yellow-throated Miner	*Manorina flavigula*	4/0		3/0			3/-				0/4	1/-	5/0			0/4						3/-	**115**	**24**	**0**	**139**
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	0/3											0/13			0/6							**6**	**31**	**3**	**40**
Crimson Chat	*Epthianura tricolor*								2/-														**9**		**2**	**11**
PETROICIDAE																										
Hooded Robin	*Petroica cucullata*	1/0				1/0											4/-						**11**	**5**	**0**	**16**
POMATOSTOMIDAE																										
Grey-crowned Babbler	*Pomatostomus temporalis*										0/1												**13**	**1**	**0**	**14**
CINCLOSOMATIDAE																										
Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*																						**1**		**0**	**1**

Table 4.4: Avifauna records from the southern deposits in the WPIOP Mine Areas, and totals for the entire survey (numbers=Phase 1/Phase 2; – denotes not sampled on that phase).

FAMILY Common Name	Species	Cardo North			Cardo East			Cane & Upper Cane					Trinity Bore			Catho Well							Total P1	Total P2	Opp	Overall Total
		AQARL 04	AQM 28F	AQM 29	AQM 01F	AQM 02	AQARL 03	AQM 03E	AQM 30F	AQM 05	AQM 17	AQM 18	AQARL 02	AQM 27	AQM 27E	AQM 26	AQARL 01	AQM 06	AQM 07F	AQM 08	AQM 09	AQM 10				
PACHYCEPHALIDAE																										
Crested Bellbird	*Oreoica gutturalis*	2/1	1/0	1/0		0/1	4/-	1/-		1/6	0/5		2/2	5/3		3/3	4/-			1/-	0/1	2/-	**53**	**38**	**0**	**91**
Rufous Whistler	*Pachycephala rufiventris*								1/-		0/1		1/0			0/1		0/1			0/1		**15**	**5**	**0**	**20**
Grey Shrike-thrush	*Colluricincla harmonica*					0/1										2/2		1/0				1/-	**11**	**3**	**0**	**14**
DICRURIDAE																										
Willie Wagtail	*Rhipidura leucophrys*	2/0	1/0	2/0		1/3		4/-	1/-	6/1	2/1	1/-		1/1		0/1	2/-						**95**	**12**	**1**	**108**
Magpie-lark	*Grallina cyanoleuca*							1/-	4/-					0/1									**21**	**1**	**0**	**22**
CAMPEPHAGIDAE																										
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			2/0							0/4		4/0										**16**	**6**	**1**	**23**
White-winged Triller	*Lalage tricolor*																						**3**	**1**	**0**	**4**
ARTAMIDAE																										
Masked Woodswallow	*Artamus personatus*												0/225										**0**	**868**	**250**	**1118**
Black-faced Woodswallow	*Artamus cinereus*					0/3							3/0	4/2								2/-	**46**	**5**	**0**	**51**
Little Woodswallow	*Artamus minor*	2/0												0/1		3/0							**7**	**3**	**0**	**10**
CRACTICIDAE																										
Grey Butcherbird	*Cracticus torquatus*																						**1**		**0**	**1**
Pied Butcherbird	*Cracticus nigrogularis*	2/0	1/0						2								1/-		–/2				**13**	**14**	**0**	**27**
Australian Magpie	*Cracticus tibicen*					3/0		2/-															**17**		**0**	**17**
CORVIDAE																										
Torresian Crow	*Corvus orru*						7/-	3		3/2	3/1	1/0	4/3	0/2		0/1			–/1				**43**	**16**	**0**	**59**
Little Crow	*Corvus bennetti*																						**4**		**0**	**4**
PTILONORHYNCHIDAE																										
Western Bowerbird	*Ptilonorhynchus maculatus*																						**2**		**0**	**2**
HIRUNDINIDAE																										
Tree Martin	*Hirundo nigricans*															0/1								**1**	**0**	**1**
SYLVIIDAE																										
Spinifex-bird	*Eremiornis carteri*												0/1										**10**	**4**	**0**	**14**
Rufous Songlark	*Cincloramphus mathewsi*												0/2											**2**	**0**	**2**
Brown Songlark	*Cincloramphus cruralis*													2/0		1/0							**3**		**0**	**3**
DICAEIDAE																										
Mistletoebird	*Dicaeum hirundinaceum*																						**1**		**0**	**1**
PASSERIDAE																										
Zebra Finch	*Taeniopygia guttata*					0	58/-			1/0			1/1	0/1		0/9	24/-						**139**	**136**	**34**	**309**
Painted Finch	*Emblema pictum*												0/3	0/5		0/21							**2**	**33**	**0**	**35**
MOTACILLIDAE																										
Australian Pipit	*Anthus australis*																						**1**		**0**	**1**
Number of individuals:		**22/9**	**6/1**	**17/1**	**7/-**	**22/23**	**102/-**	**28/-**	**36/-**	**63/33**	**16/29**	**52/-**	**32/286**	**44/24**	**3/-**	**24/159**	**249/-**	**2/7**	**–/24**	**15/-**	**89/32**	**49/-**	**2,487**	**1,755**	**352**	**4,594**
Number of species:		**13/4**	**5/1**	**9/1**	**3/-**	**6/8**	**12/-**	**11/-**	**11/-**	**12/10**	**10/11**	**9/-**	**13/17**	**13/13**	**2/-**	**9/20**	**12/-**	**2/4**	**–/6**	**5/-**	**4/10**	**10/-**	**67**	**57**	**20**	**79**
Total Number of species:		**16**	**6**	**10**	**3**	**12**	**12**	**11**	**11**	**14**	**18**	**9**	**23**	**20**	**2**	**25**	**12**	**6**	**6**	**5**	**12**	**10**				

4.4 Mammals

4.4.1 The Assemblage (Non-volant Mammals)

A total of 23 native mammal species was recorded from the study area (Table 4.5, Table 4.6 and Table 4.7). Fourteen non-volant (ground-dwelling) native mammal species were recorded during the survey, comprising six dasyurids (carnivorous marsupials), two macropods (kangaroos and wallabies), five murids (murid rodents) and one canine (dingo). Three introduced mammal species were recorded: one feline (cat), one bovid (horned ruminants) and one equine (horses), (Table 4.5 and Table 4.6).

The most commonly recorded non-volant mammal species were the Common Rock Rat *Zyzomys argurus* and the Sandy Inland Mouse *Pseudomys hermannsburgensis* each with 49 records representing 19% of the non-volant mammal records noted during the survey. *Zyzomys argurus* was recorded from rocky breakaway habitat in Elliott traps, while the majority of *P hermannsburgensis* were recorded from six trapping sites throughout the Mine Areas study area.

The Pilbara Ningaui (*Ningaui timealeyi;* n=47) and The Euro Kangaroo (*Macropus robustus;* n=46) were also commonly recorded throughout the Mine Areas study area (at 21 and 18 systematic sites respectively).

4.4.2 The Assemblage (Non-volant Mammals)

Nine bat species were recorded within the study area, including two emballonurids (sheathtail bats), four vespertilionids (evening bats), one Molossid (freetail bat), one megardematid (ghost bat) and one hipposiderid (leaf-nosed bat) (Table 4.7 and Appendix 5).

4.4.3 Mammals of Conservation Significance

Five mammal species of conservation significance were recorded during the Mine Areas fauna survey. These were:

- Pilbara Orange Leaf-nosed Bat *Rhinonicteris aurantius* (Schedule 1 and Vulnerable *EPBC Act*);
- Northern Quoll *Dasyurus hallucatus* (Schedule 1 and Vulnerable *EPBC Act*);
- *Sminthopsis longicaudata* (Priority 4);
- Ghost Bat *Macroderma gigas* (Priority 4); and
- Western Pebble-mound Mouse *Pseudomys chapmani* (Priority 4).

A further one mammal species of elevated conservation significance may occur within the study area (Section 5.3).

Table 4.5: Non-volant mammal species recorded from northern deposits in the WPIOP Mine Areas fauna survey (number=Phase 1/Phase 2; - denotes not sampled that phase).

FAMILY *Species Name*	Common Name	Cochrane & Jewel										Ken's Bore														
		AQA 12	AQARL 09	AQM 24	AQM 22	AQM 25	AQM 02E	AQM 21	AQARL 08	AQM 19F	AQA 19E	AQA 15F	AQA 14	AQA 16	AQARL 06	AQARL 07	AQARL 10	AQA 18	AQA 17	AQM 16	AQM 15E	AQARL 05	AQM 12F	AQM 14	AQM 31E	AQM 11E
DASYURIDAE																										
Dasykaluta rosamondae	Little Red Kaluta											2/-					1/1		1/-					3/1		
Dasyurus hallucatus	Northern Quoll				0/T						1/-															
Ningaui timealeyi	Pilbara Ningaui		0/1		0/1	1/-		2/0	0/1	1/0								5/-	1/-	1/0		0/1		1/2		
Planigale ingrami	Long-tailed Planigale		0/2		0/2			1/0	0/1							0/2	0/1									1/-
Sminthopsis longicaudata	Long-tailed Dunnart																									
Sminthopsis macroura	Stripe-faced Dunnart		0/1											1/-					1/-							
MACROPODIDAE																										
Macropus robustus	Euro		2/0							0/1									1/-	4/2	3/-	0/2	5/0	1/3		
Macropus rufus	Red Kangaroo											1/-											1/0			
MURIDAE																										
Pseudomys chapmani	Western Pebble-mound Mouse											T/-														
Pseudomys delicatulus	Delicate Mouse																									
Pseudomys desertor	Desert Mouse		0/3													0/1		2/-								
Pseudomys hermannsburgensis	Sandy Inland Mouse	10/-	0/4			5/-		3/0							0/1	0/1		2/-		1/0		2/0		3/0		
Zyzomys argurus	Common Rock-rat						15/-														6/-				5/-	11/-
CANIDAE																										
Canis lupus dingo	Dingo							T/0														0/1	5/0			
FELIDAE																										
**Felis catus*	Cat							0/T																		
EQUIDAE																										
**Equus asinus*	Donkey																									
BOVIDAE																										
**Bos taurus*	European Cattle																									
Number of individuals:		10/-	2/11	0/0	0/3+T	6/-	15/-	6+T/T	0/2	1/1	1/-	3+T/-	0/-	1/-	0/1	0/4	1/2	9/-	4/-	6/2	9+2C/-	2/4	11/0	8/6	5/-	12/-
Number of species:		1/-	1/5	0/0	0/3	2/-	1/-	4/1	0/2	1/1	1/-	3/-	0/-	1/-	0/1	0/3	1/2	3/-	4/-	3/1	4/-	1/3	3/0	4/3	1/-	2/-
Total number of species:		1	6	0	3	2	1	5	2	2	1	3	0	1	1	3	2	3	4	3	4	4	3	4	1	2

Table 4.6: Non-volant mammal species recorded from southern deposits in the WPIOP Mines Area fauna study area, and overall survey totals (numbers=Phase 1/Phase 2; - denotes not sampled).

FAMILY *Species Name*	Common Name	Cardo North			Cardo East			Cane & Upper Cane					Trinity Bore				Catho Well									
		AQARL 04	AQM 28F	AQM 29	AQM 01F	AQM 02	AQARL 03	AQM 03E	AQM 30F	AQM 05	AQM 17	AQM 18	AQARL 02	AQM 27	AQM 27E	AQM 26	AQARL 01	AQM 06	AQM 07F	AQM 08	AQM 09	AQM 10	Total P1	Total P2	Total P3	Opp	Overall Total
DASYURIDAE																											
Dasykaluta rosamondae	Little Red Kaluta																				1/0		**8**	**2**			**10**
Dasyurus hallucatus	Northern Quoll																						**1**	**1**		**1**	**3**
Ningaui timealeyi	Pilbara Ningaui	0/2		5/1		1/0/0				1/0	1/1	3/-				6/1		1/0		3/-	2/1		**35**	**12**			**47**
Planigale ingrami	Long-tailed Planigale									1/0			0/1			0/1							**3**	**10**			**13**
Sminthopsis longicaudata	Long-tailed Dunnart																				1/0		**1**				**1**
Sminthopsis macroura	Stripe-faced Dunnart	0/1									1/0											1/-	**4**	**2**			**6**
MACROPODIDAE																											
Macropus robustus	Euro	1/2			2/-	2/0/0	1/-	1/-			1/0	1/-		0/5		1/0				1/-			**27**	**15**		**4**	**46**
Macropus rufus	Red Kangaroo		3/0																				**5**				**5**
MURIDAE																											
Pseudomys chapmani	Western Pebble-mound Mouse															0/5T			T/0	T/-	0/T		**3**	**6**			**9**
Pseudomys delicatulus	Delicate Mouse						1/-																**1**				**1**
Pseudomys desertor	Desert Mouse	1/0																					**3**	**4**			**7**
Pseudomys hermannsburgensis	Sandy Inland Mouse	0/2		0/1		0/0/2	1/-					1/-	0/1	0/1				1/0			2/0	5/-	**36**	**11**	**2**		**49**
Zyzomys argurus	Common Rock-rat							8/-							4/-								**49**				**49**
CANIDAE																											
Canis lupus dingo	Dingo												0/2T										**7**	**3**		**1**	**11**
FELIDAE																											
**Felis catus*	Cat																							**1**			**1**
EQUIDAE																											
**Equus asinus*	Donkey					1/0/0																	**1**				**1**
BOVIDAE																											
**Bos taurus*	European Cattle												0/2T	0/1										**3**		**2**	**5**
Number of individuals:		**2/7**	**3/0**	**5/2**	**2/-**	**4/0/2**	**3/-**	**9/-**	**0/-**	**2/0**	**3/1**	**5/-**	**0/2+4T**	**0/7**	**4/-**	**7/2+5T**	**0/-**	**2/0**	**T/0**	**4+T/-**	**6/1+T**	**6/-**	**184**	**70**	**2**	**8**	**264**
Number of species:		**2/4**	**1/0**	**1/2**	**1/-**	**3/0/1**	**3/-**	**2/-**	**0/-**	**2/0**	**3/1**	**3/-**	**0/4**	**0/3**	**1/-**	**2/3**	**0/-**	**2/0**	**1/0**	**3/-**	**4/2**	**2/-**	**15**	**12**	**1**	**3**	**17**
Total number of species:		**5**	**1**	**2**	**1**	**3**	**3**	**2**	**0**	**2**	**3**	**3**	**4**	**3**	**1**	**4**	**0**	**2**	**1**	**3**	**5**	**2**					

Table 4.7: Volant mammal species (bats) recorded during the WPIOP Mine Areas fauna survey (Phase 1/Phase 2; - denotes not sampled).

FAMILY *Species Name*	**Common Name**	**AQM 05**	**AQM 15E**	**AQM harp05**	**AQA harp02**	**AQM harp04**	**AQM harp03**	**AQM harp02**	**AQM harp01**	**AQM bat02**	**AQM Ana01**	**Records P1**	**Records P2**	**Opp**	**Ov To**
EMBALLONURIDAE															
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat									1/-		1			
Taphozous georgianus	Common Sheathtail-bat			16/-		1/-	18/42		5/-	1/-		41	42		8
MEGADERMATIDAE															
Macroderma gigas	Ghost Bat			1/-								1		1	
HIPPOSIDERIDAE															
Rhinonicteris aurantius	Pilbara Orange Leaf-nosed Bat					1/-	1/1	1/-	1/-	1/-	1/-	6	1		
VESPERTILIONIDAE															
Chalinolobus gouldii	Gould's Wattled Bat		1/-	1/-		3/-				1/-		7			
Scotorepens balstoni	Inland Broad-nosed Bat							1/-				1			
Scotorepens greyii	Little Broad-nosed Bat		1/-			1/-				1/-	1/-	5			
Vespadelus finlaysoni	Finlayson's Cave Bat			4/-		1/-	19/31	3/-	10/-	1/-	1/-	39	31		7
MOLOSSIDAE															
Tadarida australis	White-striped Freetail-bat			1/-		1/-					1/-	3			
	Number of species:	**0/-**	**2/-**	**5/-**	**0/-**	**6/-**	**3/3**	**3/-**	**3/-**	**6/-**	**4/-**	**9**	**3**	**1**	
	Total number of species:	**0**	**2**	**5**	**0**	**6**	**3**	**3**	**3**	**6**	**4**				

4.5 Herpetofauna

4.5.1 The Assemblage

The survey yielded a combined total of 63 herpetofauna species from the Mine Areas study area (Table 4.8 and Table 4.9). This total comprised two tree frogs (Hylidae), one ground frog (Myobatrachidae), 13 geckos (Gekkonidae), five legless lizards (Pygopodidae), 20 skinks (Scincidae), six dragons (Agamidae), five monitors (Varanidae), three blind snakes (Typhlopidae), one python (Pythonidae) and seven front-fanged snakes (Elapidae).

The most common herpetofauna species was the skink *Ctenotus saxatilis* with 96 individuals recorded across 13 systematic sites, accounting for over 14% of the herpetofauna records (Table 4.8 and Table 4.9). The frog *Litoria rubella* was also abundant with 84, mostly opportunistic records from areas were fresh water was present. As is commonly the case, the Scincidae was the most speciose herpetofauna family with 20 species (over 30% of all herpetofauna species recorded).

4.5.2 Herpetofauna of Conservation Significance

The Pilbara Olive Python *Liasis olivaceus barroni* (Schedule 1 and Vulnerable *EPBC Act 1999*) is the only species of conservation significance that was recorded during the Mine Areas fauna survey. A further two herpetofauna species of elevated conservation significance may occur within the study area (Section 5.3).

In addition to formally listed species, the skink *Eremiascincus* sp. nov. was recorded from a single individual at site AQM15E at Ken's Bore (Table 4.8). The specimen is apparently the same taxon as the undescribed previously *Eremiascincus* collected at Mesa A (Biota 2006). Further work to describe this species and assess its wider status is being completed as an ongoing project by the Western Australian Museum.

Table 4.8: Herpetofauna species recorded from northern deposits in the WPIOP Mine Areas fauna study area (Phase 1/Phase 2; - denotes not sampled).

FAMILY *Species Name*	Cochrane & Jewel										Ken's Bore														
	AQA12	**AQARL09**	**AQM24**	**AQM22**	**AQM25**	**AQM20E**	**AQM21**	**AQARL08**	**AQMF19**	**AQA19E**	**AQA15F**	**AQA14**	**AQA16**	**AQARL06**	**AQARL07**	**AQARL10**	**AQA18**	**AQA17**	**AQM16**	**AQM15E**	**AQARL05**	**AQMF12**	**AQM14**	**AQM31E**	**AQME11**
HYLIDAE																									
Cyclorana maini		0/3																							
Litoria rubella																					0/1				
MYOBATRACHIDAE																									
Uperoleia russelli																								6/-	
GEKKONIDAE																									
Lucasium stenodactylum														1/0											
Lucasium wombeyi			0/1																				0/1		
Crenadactylus ocellatus																									
Diplodactylus conspicillatus															5/1	1/0					3/0				
Diplodactylus savagei																						0/1			
Gehyra punctata																						0/2	0/1		
Gehyra variegata	1/-			0/1					0/1					2/0		3/0						0/1			
Heteronotia binoei				0/2			0/1	2/2								1/0	1/-	1/-	0/2						
Heteronotia spelea																									
Nephrurus wheeleri																									
Oedura marmorata																				1/-					
Rhynchoedura ornata	1/-																								
Strophurus elderi				1/0			0/1						2/-				1/-								
PYGOPODIDAE																									
Delma elegans																									
Delma nasuta																			0/1						
Delma pax		1/2		1/0																	1/0				
Lialis burtonis																				1/-					
Pygopus nigriceps		0/1												1/0											
SCINCIDAE																									
Carlia munda		0/2		1/0				1/0				2/-										0/1			
Cryptoblepharus ustulatus																									
Ctenotus aff. helenae				0/1																	2/0	0/1			
Ctenotus duricola		1/0														3/0		1/-			0/1		0/2		
Ctenotus grandis		0/1					0/3								2/0	0/1	6/-				4/0				
Ctenotus hanloni							0/2							1/0	2/0	1/0					1/0				
Ctenotus helenae		4/0												1/0											
Ctenotus pantherinus		1/1		0/1				0/1			9/-			1/1				1/-	0/3		1/0		0/4		
Ctenotus rubicundus									1/0													1/0			
Ctenotus saxatilis				0/1				1/0	0/15										0/2			1/10			
Cyclodomorphus melanops																			0/1						
Eremisacincsus sp. nov.																				1/0					
Lerista clara		1/0																							
Lerista flammicauda																								1/-	
Lerista muelleri																								4/-	
Lerista zietzi																									1/-
Menetia greyii														2/0				1/-	0/1						
Morethia ruficauda exquisita																				1/-		0/1	1/0	1/-	
Notoscincus ornatus		1/0																			2/0				
Tiliqua multifasciata				0/1																					
AGAMIDAE																									
Caimanops amphiboluroides																									
Ctenophorus caudicinctus			0/12					2/0	0/2		1/-		3/-	4/0					0/1			1/2	0/2	1/-	
Ctenophorus isolepis		1/2						1/0			2/-	4/-	3/-	3/0	7/4	3/0	2/-	1/-			4/0	0/1			
Ctenophorus nuchalis		1/0	0/1																						

Table 4.8: Herpetofauna species recorded from northern deposits in the WPIOP Mine Areas fauna study area (Phase 1/Phase 2; - denotes not sampled).

FAMILY *Species Name*	Cochrane & Jewel										Ken's Bore													
	AQA12	**AQARL09**	**AQM24**	**AQM22**	**AQM25**	**AQM20E**	**AQM21**	**AQARL08**	**AQMF19**	**AQA19E**	**AQA15F**	**AQA14**	**AQA16**	**AQARL06**	**AQARL07**	**AQARL10**	**AQA18**	**AQA17**	**AQM16**	**AQM15E**	**AQARL05**	**AQMF12**	**AQM14**	**AQM31E**	**AQME11**
Amphibolurus longirostris		0/1										5/-					1/-					0/1			
Pogona minor														1/0		1/0									
VARANIDAE																									
Varanus acanthurus							0/1		0/1						1/0							0/3			
Varanus brevicauda		1/0					0/1							1/0	1/0						1/0		0/1		
Varanus eremius							1/2	0/1				1/-			1/0										
Varanus giganteus																							0/1		
Varanus gilleni											1/-		1/-				1/-								
TYPHLOPIDAE																									
Ramphotyphlops ammodytes		1/0					0/1								1/0										
Ramphotyphlops grypus	2/-																						0/2		
Ramphotyphlops pilbarensis															1/0										
PYTHONIDAE																									
Liasis olivaceus barroni																			1/0	1/-					
ELAPIDAE																									
Acanthophis wellsi								0/1																	
Brachyurophis approximans																							0/1		
Demansia psammophis	1/-																								
Furina ornata									0/2								1/-								
Parasuta monachus																							2/0		
Pseudechis australis																									
Pseudonaja modesta					1/-																				
Number of Individuals:	**5/-**	**13/13**	**0/14**	**3/7**	**1/-**	**0/-**	**1/12**	**7/5**	**1/21**	**0/-**	**13/-**	**12/-**	**9/-**	**18/1**	**21/5**	**13/1**	**13/-**	**5/-**	**1/11**	**5/-**	**19/2**	**3/24**	**3/15**	**13/-**	**1/-**
Number of Species:	**4/-**	**10/8**	**0/3**	**3/6**	**1/-**	**0/-**	**1/8**	**5/4**	**1/5**	**0/-**	**4/-**	**4/-**	**4/-**	**11/1**	**9/2**	**7/1**	**7/-**	**5/-**	**1/7**	**5/-**	**9/2**	**3/11**	**2/9**	**5/-**	**1/-**
Total Number of Species:	**4**	**15**	**3**	**9**	**1**	**0**	**8**	**8**	**6**	**0**	**4**	**4**	**4**	**11**	**9**	**8**	**7**	**5**	**8**	**5**	**11**	**12**	**11**	**5**	**1**

Table 4.9: Herpetofauna species recorded from southern deposits in the WPIOP Mine Areas fauna study area, and overall survey totals (Phase 1/Phase 2; - denotes not sampled).

	Cardo North			Cardo East				Cane & Upper Cane				Trinity Bore					Catho Well					Total	Total	Total	Opp	Overall
FAMILY *Species Name*	**AQARL 04**	**AQM 28F**	**AQM 29**	**AQM 01F**	**AQM 02**	**AQARL 03**	**AQM 03E**	**AQM 30F**	**AQM 05**	**AQM 17**	**AQM 18**	**AQARL 02**	**AQM 27**	**AQM 27E**	**AQM 26**	**AQAR L01**	**AQM 06**	**AQM 07F**	**AQM 08**	**AQM 09**	**AQM 10**	**P1**	**P2**	**P3**		**Total**
HYLIDAE																										
Cyclorana maini																						**3**		**2**	**5**
Litoria rubella					0/0/1																	**1**	**1**	**82**	**84**
MYOBATRACHIDAE																									
Uperoleia russelli																						**6**			**6**
GEKKONIDAE																									
Lucasium stenodactylum					0/1/0	3/-							1/0									**5**	**1**	**1**	**7**
Lucasium wombeyi																							**2**		**2**
Crenadactylus ocellatus					0/1/0												0/1						**2**		**2**
Diplodactylus conspicillatus					0/2/0	11/-						1/2	1/0									**22**	**5**	**2**	**29**
Diplodactylus savagei		6/1				1/-		2/-	0/1						1/0			0/1				**10**	**4**		**14**
Gehyra punctata													1/0						1/-			**2**	**3**	**20**	**25**
Gehyra variegata			1/0							2/0						2/-						**11**	**3**	**2**	**16**
Heteronotia binoei		1/0	1/0		0/4/0			6/-	0/1				1/0			1/-	1/2	0/7		2/4		**18**	**25**	**1**	**44**
Heteronotia spelea																								**2**	**2**
Nephrurus wheeleri																	0/1						**1**		**1**
Oedura marmorata																						**1**		**4**	**5**
Rhynchoedura □rnate																						**1**			**1**
Strophurus elderi			1/0																			**5**	**1**		**6**
PYGOPODIDAE																									
Delma elegans		1/0																		1/0		**2**			**2**
Delma nasuta					2/0/0			1/-							0/1					1/0		**4**	**2**		**6**
Delma pax					0/1/0																	**3**	**3**		**6**
Lialis burtonis									0/1													**1**	**1**	**1**	**3**
Pygopus nigriceps																						**1**	**1**		**2**
SCINCIDAE																									
Carlia munda					0/1/0																	**4**	**4**		**8**
Cryptoblepharus ustulatus																								**1**	**1**
Ctenotus aff. Helenae					1/0/0					0/1						1/-					1/-	**5**	**3**		**8**
Ctenotus duricola	2/0		3/0							0/1			1/0			1/-						**12**	**4**		**16**
Ctenotus grandis	2/0				0/1/0							1/0				2/-	0/1					**17**	**7**		**24**
Ctenotus hanloni			1/0																			**6**	**2**		**8**
Ctenotus helenae																		0/1				**5**	**1**		**6**
Ctenotus pantherinus					0/3/0			4/-		0/2			1/0			1/-	0/1					**19**	**17**		**36**
Ctenotus rubicundus																						**2**			**2**
Ctenotus saxatilis	0/1	18/3			0/4/0			14/-							1/1		0/2	0/15		0/7		**35**	**61**			**96**
Cyclodomorphus melanops																							**1**			**1**
Eremiascincus sp. nov.																						**1**				**1**
Lerista clara												1/0										**2**				**2**
Lerista flammicauda																		0/1				**1**	**1**	**1**		**3**
Lerista muelleri																						**4**		**2**		**6**
Lerista zietzi																						**1**				**1**
Menetia greyii								1/-														**4**	**1**			**5**
Morethia ruficauda exquisita		1/0														1/-		0/1				**5**	**2**	**3**		**10**
Notoscincus ornatus												1/0										**4**				**4**
Tiliqua multifasciata			1/0																			**1**	**1**			**2**
AGAMIDAE																									
Caimanops amphiboluroides																								**1**	**1**
Ctenophorus caudicinctus		3/0			0/3/0			1/-	0/4	0/2					1/0	3/-						**20**	**28**			**48**
Ctenophorus isolepis		0/1				1/-				0/1		0/2	1/0					0/1				**33**	**12**			**45**
Ctenophorus nuchalis						6/-																**7**	**1**			**8**

Table 4.9: Herpetofauna species recorded from southern deposits in the WPIOP Mine Areas fauna study area, and overall survey totals (Phase 1/Phase 2; - denotes not sampled).

	Cardo North			Cardo East				Cane & Upper Cane				Trinity Bore						Catho Well				Total	Total	Total	Opp	Overall
FAMILY *Species Name*	**AQARL 04**	**AQM 28F**	**AQM 29**	**AQM 01F**	**AQM 02**	**AQARL 03**	**AQM 03E**	**AQM 30F**	**AQM 05**	**AQM 17**	**AQM 18**	**AQARL 02**	**AQM 27**	**AQM 27E**	**AQM 26**	**AQAR L01**	**AQM 06**	**AQM 07F**	**AQM 08**	**AQM 09**	**AQM 10**	**P1**	**P2**	**P3**		**Total**
Amphibolurus longirostris																		0/1				**6**	**3**		**2**	**11**
Pogona minor																						**2**				**2**
VARANIDAE																										
Varanus acanthurus								2/-										0/1				**3**	**6**			**9**
Varanus brevicauda					0/1/0							1/0						0/1				**5**	**4**			**9**
Varanus eremius																						**3**	**3**			**6**
Varanus giganteus																				0/1			**2**		**1**	**3**
Varanus gilleni																						**3**				**3**
TYPHLOPIDAE																										
Ramphotyphlops ammodytes	2/0		1/0			1/-				0/1							0/1					**6**	**3**			**9**
Ramphotyphlops grypus					0/2/0				0/1								1/1			0/1		**3**	**7**			**10**
Ramphotyphlops pilbarensis																						**1**				**1**
PYTHONIDAE																										
Liasis olivaceus barroni	0/1																					**2**	**1**			**3**
ELAPIDAE																										
Acanthophis wellsi								2/-														**2**	**1**			**3**
Brachyurophis approximans																		0/1					**2**			**2**
Demansia psammophis				1/-																		**2**				**2**
Furina ornata			0/1														1/0					**2**	**3**			**5**
Parasuta monachus																						**2**				**2**
Pseudechis australis																									**1**	**1**
Pseudonaja modesta																						**1**				**1**
Number of Individuals:	**6/1**	**30/5**	**9/1**	**1/-**	**3/24/1**	**23/-**	**0/-**	**33/-**	**0/8**	**2/8**	**0/-**	**5/4**	**7/0**	**0/-**	**3/2**	**12/-**	**3/10**	**0/31**	**1/-**	**4/13**	**1/-**	**323**	**239**	**1**	**129**	**692**
Number of Species:	**3/2**	**6/3**	**7/1**	**1/-**	**2/12/1**	**6/-**	**0/-**	**9/-**	**0/5**	**1/6**	**0/-**	**5/2**	**7/0**	**0/-**	**3/2**	**8/-**	**3/8**	**0/11**	**1/-**	**3/4**	**1/-**	**51**	**44**	**1**	**18**	**63**
Total Number of Species:	**5**	**7**	**8**	**1**	**15**	**6**	**0**	**9**	**5**	**7**	**0**	**6**	**7**	**0**	**4**	**8**	**9**	**11**	**1**	**6**	**1**					

4.6 Potential Short Range Endemic Invertebrates

Taxonomic groups of invertebrates with naturally small distributions are described as short-range endemics and are in part characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002, Ponder and Colgan 2002). Given the importance of short-range endemism to the conservation of biodiversity, the assessment of such invertebrate taxa is a potentially important component of impact assessment. Examples of taxonomic groups that show high levels of short-range endemism in this respect include mygalomorph spiders, millipedes, pseudoscorpions and freshwater and terrestrial molluscs.

4.6.1 Mygalomorph Spiders

Whilst this group is regularly collected in the Pilbara bioregion (source: Biota Internal Database), much of the taxonomy has only been resolved to the level of genus. This group is known to support a number of taxa with very limited distributions, and several species are included in Schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2008* (although none of these occur in the Pilbara bioregion).

Two species of Mygalomorph spider were recorded from the Mine Areas study area: *Synothele* sp. (family Barychelidae) and *Aname* sp. (family Nemesiidae; Plate 4.21) (Table 4.10). All specimens were collected during dedicated SRE searches via the excavation of burrows.

Table 4.10: Mygalomorph spiders recorded within the Mine Areas study area.

Taxa	Latitude	Longitude	Number
Synothele sp.	21.867°S	116.084°E	1
Synothele sp.	22.088°S	116.253°E	1
Synothele sp.	21.674°S	115.889°E	1
Synothele sp.	21.670°S	115.871°E	1
Aname sp.	21.435°S	116.032°E	1
Aname sp.	21.764°S	116.071°E	1
Aname sp.	21.992°S	116.127°E	1
Aname sp.	22.195°S	116.252°E	1
Aname sp.	22.005°S	116.138°E	1
Aname sp.	22.248°S	116.133°E	1
Aname sp.	22.409°S	116.294°E	1
Aname sp.	22.428°S	116.282°E	1
Aname sp.	22.138°S	116.237°E	1
Aname sp.	22.164°S	116.254°E	1
Aname sp.	22.026°S	116.157°E	1
Aname sp.	22.164°S	116.254°E	1
Aname sp.	21.939°S	116.134°E	1
Aname sp.	21.277°S	116.291°E	4
Aname sp.	21.154°S	116.233°E	1
Aname sp.	21.349°S	116.096°E	1
Aname sp.	21.387°S	116.051°E	5
Aname sp.	21.418°S	116.426°E	3
Aname sp.	21.435°S	116.0321°E	1
Aname sp.	20.915°S	116.2341°E	1

Plate 4.21: ***Aname* sp.**

Plate 4.22: ***Solinus* sp.**

4.6.2 Selenopid Spiders

A single Selenopid species was recorded from the Mine Areas study area. This taxon is undescribed and currently known as '*N. gen. 1 n. sp. 14*' (Crews and Harvey 2009;). Specimens were recorded at Trinity Bore Bore and Cardo Bore (Table 4.11). It should be noted that an additional 10 specimens representing the same species have been recorded outside the Mine Areas study area (Crews and Harvey 2009).

Table 4.11: Selenopid spiders recorded within the Mine Areas study area

Taxa	Latitude	Longitude	Number
N. gen. 1 n. sp. 14	22.399°S	116.326°E	1
N. gen. 1 n. sp. 14	22.199°S	116.304°E	1

Plate 4.23: Selenopid sp.

4.6.3 Pseudoscorpions

Four pseudoscorpions were recorded from the Mine Areas study area: *Solinus* sp. (family Garypinidae; Plate 4.22), Olpiidae sp. (family Olpiidae), *Afrosternophorus* sp. (family Sternorphoridae), *Synsphyronus* sp. (family Garypidae) (Table 4.12). All specimens were collected from underneath bark of *Corymbia* sp.

Table 4.12: Pseudoscorpions recorded within the Mine Areas study area.

Taxa	Latitude	Longitude	Number
Solinus sp.	22.263°S	116.258°E	2
Solinus sp.	22.154°S	116.249°E	15

Olpiidae sp.	22.208°S	116.252°E	1
Olpiidae sp.	22.276°S	116.281°E	1
Afrosternophorus sp.	22.088°S	116.252°E	2
Afrosternophorus sp.	22.208°S	116.252°E	1
Afrosternophorus sp.	22.276°S	116.281°E	5
Synsphyronus sp.	21.144°S	116.242°E	1

The specimens have been lodged with Western Australian Museum for species level identifications where this is possible. However, given the habitat they were collected from, it appears low risk that these taxa represent SREs.

4.6.4 Land Snails

In his review of the conservation status of Australia's non-marine molluscs, Ponder (1997) identified over 900 described terrestrial land snails from 23 families, with the most speciose families being the Camaenidae (408 taxa), Helicarionidae (60 taxa), Pupillidae (41 taxa), Bulimulidae (31 taxa), Punctidae (23 taxa) and Pupinidae (19 taxa). There are 230 described taxa In Western Australia, with 201 of these restricted to this State (Ponder 1997). Within the Pilbara bioregion, the most conspicuous elements of this fauna are the *Rhagada* and *Quistrachia* species (Camaenidae), though several *Bothriembryon* species (Bulimulidae) are also known.

The geographic range of the genus *Rhagada* extends from the northern Kimberley to the Carnarvon area. With 29 species currently described, the Western Australian endemic *Rhagada* is the second most diverse genus of the family Camaenidae (Solem 1997), which includes more than half the terrestrial snails of Australia (Ponder 1997). A number of *Rhagada* species inhabit the coast of the Pilbara region and the islands of the Dampier Archipelago. On the mainland, there is a series of eight coastal species between Shark Bay and Cape Leveque. These form a set of non-overlapping geographic replacements (Solem 1997).

Genetic diversification may be expected to be greater amongst land snails than for more vagile insects and vertebrates, however few genetic studies have been completed to investigate this (see Johnson et al. 2004). There is certainly extensive variation in shell morphology for *Rhagada* species from the Dampier Archipelago (including the Burrup Peninsula), with seven species described (Solem 1997) and several additional species awaiting description (Dr Peter Kendrick, DEC Karratha, pers. comm. 2004; Ms Shirley Slack-Smith, WA Museum, pers. comm. 2004). Many of these taxa have very narrow distributions, with some confined to single outcrops (Dr Peter Kendrick, pers. comm. 2004). Shell morphology of mainland *Rhagada* species within the Pilbara bioregion tends to be more conservative by comparison and species tend to have larger non-overlapping distributions (e.g. spanning a linear distance in excess of 200 km) (Solem 1997; see also Johnson et al. 2004).

The WPIOP Mine Areas study area overlays the eastern edge of the distribution of *Rhagada convicta* and the western edge of up to two undescribed banded forms, *R*. sp. "Nanutarra" and *R*. sp. "Pannawonnica" (though these forms may be conspefic).

The specimens collected from most sites during the Mine Areas survey conform with the published description of *R. convicta* (Solem 1997) (Table 4.13). Molecular analyses completed to date also agrees with the placement of these specimens with *Rhagada convicta* (Biota unpublished data). Specimens of *R. convicta* (including live individuals) were collected from eight sites where they were found aestivating under *Triodia* hummocks.

Table 4.13: Land snail taxa collected during the WPIOP Mine Areas survey and collection locations.

Site	Species	Number Live Individuals	Location
AQASN01	*Rhagada convicta*	8	-22.405567°, 116.020572°
AQASN03	*Rhagada convicta*	1	-21.901472°, 116.102417°
AQASN04	*Rhagada convicta*	9	-22.037556°, 116.080028°
AQASN05	*Rhagada convicta*	2	-22.047056°, 116.152139°

Site	Species	Number Live Individuals	Location
AQRL06	*Rhagada convicta*	1	-22.025617°, 116.156983°
AQMSN01	*Rhagada convicta*	5	-22.405567°, 116.268178°
AQA15F	*Rhagada convicta*	1	-22.011167°, 116.136528°
AQA18	*Rhagada convicta*	17	-22.040972°, 116.162278°
AQASN01	*Rhagada* sp. "Nanutarra"	10	-22.405567°, 116.020572°

Rhagda convicta (Plate 4.24) is considered by Solem (1997) to have the largest distribution of this genus, extending from Wandagee Station in the South (Solem 1997) to Mundabullangana Station in the North (Biota unpublished data). It occupies much of the coastal habitat throughout its range, with a single break coinciding with the Chichester Range. This species therefore does not qualify as an SRE for the purpose of environmental impact assessment (EPA 2009).

Plate 4.24: ***Rhagada convicta.***

Plate 4.25: ***Rhagada* sp. "Pannawonica".**

A single collection of a smaller banded *Rhagada* specimen was made from AQASN01, the morphotype has been designated as *Rhagada* sp. "Nanutarra", as similar looking specimens have been collected from several sites along the Nanutarra Road for a distance of 60 km from AQASN01 (Table 4.13). The taxonomic affinities of this type are unresolved as is, therefore, its current conservation status.

To the north of the Mine Areas study area a third form, *Rhagada* sp. "Pannawonica" (Plate 4.25) has been collected. This form is thought to hybridise with *R. convicta* along a narrow zone of contact (Biota 2006). As noted above this form may be conspecific with *R*. sp. "Nanutarra". Strongly banded shells collected from the north-eastern boundary of the Mine Areas study area may represent intermediates between *R. convicta* and *R*. sp. "Pannawonica", as similar shells have been found at the contact point between these forms along the Pannawonica Road (Biota 2006).

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5.0 Conservation Significance

5.1 Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value are specially protected by law under the Western Australian *Wildlife Conservation Act 1950-1979*. In addition, many of these species are listed under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*).

5.1.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

Fauna species of national conservation significance are listed under the *EPBC Act 1999*, and have been classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent' (broadly consistent with International Union for Conservation of Nature (IUCN) categories: http://www.iucnredlist.org/static/categories_criteria_3_1

Migratory wader species are also protected under the *EPBC Act 1999*. The national List of Migratory Species consists of those species listed under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

5.1.1 Western Australian *Wildlife Conservation Act 1950-1979*

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2008* recognises four distinct schedules of taxa:

Schedule 1 taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;

Schedule 2 taxa are fauna which are presumed to be extinct and are declared to be fauna in need of special protection;

Schedule 3 taxa are birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, which are declared to be fauna in need of special protection; and

Schedule 4 taxa are fauna that are in need of special protection, otherwise than for the reasons mentioned in paragraphs (1), (2) and (3).

In addition to the above, fauna are also classified under five different Priority codes:

Priority One Taxa with few, poorly known populations on threatened lands. Taxa which are known from a few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna

Priority Two Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Three Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Four 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. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

Priority Five 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.

5.2 Fauna of Conservation Significance Confirmed from the Study Area

Nine species of conservation significance were recorded during the WPIOP Mine Areas fauna survey:

- Northern Quoll (*Dasyurus hallucatus*; Federal Vulnerable, State Schedule 1);
- Pilbara Orange Leaf-nosed Bat (*Rhinonicteris aurantius;* Federal Vulnerable, State Schedule 1);
- Pilbara Olive Python (*Liasis olivaceus barroni;* Federal Vulnerable, State Schedule 1);
- Long-tailed Dunnart (*Sminthopsis longicaudata;* State Priority 4);
- Grey Falcon (*Falco hypoleucos;* State Priority 4*)*;
- Australian Bustard (*Ardeotis australi;* State Priority 4);
- Ghost Bat (*Macroderma gigas;* State Priority 4*)*;
- Western Pebble-mound Mouse (*Pseudomys chapmani;* Priority 4); and
- Rainbow Bee-eater (*Merops ornatus;* Federal Migratory).

More detailed accounts of the fauna species of conservation significance recorded during the survey follow.

5.2.1 Schedule 1 Species

Northern Quoll (*Dasyurus hallucatus*)
Distribution: The Northern Quoll was originally recorded across Northern Australia from the Northwest Cape, Western Australia to south-east Queensland but has declined in recent years. Its distribution is now restricted to six main areas: the north and western top end of the Northern Territory, north of Cape York, the Atherton-Cairns area, the Carnarvon Range-Bowen area of Queensland (Menkhorst and Knight 2001), and the northwest Kimberley and Pilbara regions of Western Australia (Braithwaite and Griffiths 1994). It also occurs on numerous islands off the Australian coast (Abbott and Burbidge 1995, Burbidge and McKenzie 1978).

Ecology: The Northern Quoll, *Dasyurus hallucatus*, is classed as a medium-sized marsupial, with adult weight ranging from 300 g up to 1,200 g. It is considered a partially arboreal and aggressive carnivore, preying on a varied diet of small invertebrates and vertebrates, including lizards, birds, snakes, small mammals and frogs (Oakwood 1997).

The Northern Quoll is a short-lived mammal with both sexes maturing at 11 months. Females reproduce only once each year, and all males die shortly after reproducing (Dickman and Braithwaite 1992, Oakwood 2000). The discrete male cohorts that arise within populations make quolls vulnerable. If survivorship of juvenile males is low, then a decline in males may result in the extinction of local populations (Braithwaite and Griffiths 1994, Oakwood 2000). Therefore, any factor that results in significant increases in mortality rates of female and juvenile quolls could cause local extinction. This species is most abundant near major creek lines and rivers and in open, rocky habitat and is also commonly found in gorges, where breeding is successful (Oakwood 2008).

Likelihood of Occurrence: Captured on one occasion in an Elliot trap at site AQA19E in rocky, breakaway habitat. Scats were also noted at site AQM22 and opportunistically within the Mine Areas study area. This species is likely to occur in rocky habitats adjoining riverine vegetation in the vicinity of most of the deposit areas.

Potential Impacts: Habitat removal for the proposed Mine Areas development has the potential to impact individual and local populations of Northern Quolls in the study area, particularly if gorges and breakaways are affected.

Pilbara Orange Leaf-nosed Bat (*Rhinonicteris aurantius*)
Distribution: The Pilbara Orange Leaf-nosed Bat is a relictual monotypic genus of the family Hipposideridae. It occurs in the Pilbara region of Western Australia, through the Kimberley and across the Top End into north-western Queensland (Churchill 1991).

Ecology: Occurrence of this species is influenced by the availability of suitable roost caves (Churchill 1998). That is, deep caves offering suitable humidity and a stable temperature. In the Pilbara, they are thought to be restricted to caves where at least semi-permanent water is nearby (Dr Kyle Armstrong, Kyoto University Museum, pers. comm. 2005).

Likelihood of occurrence: *R. aurantius* was recorded via direct capture and echolocation call recordings at six sites across the study area in both cave habitats and adjacent to water. Given the small number of bats recorded (even at cave entrances), it is likely that the recorded individuals are itinerant and do not comprise part of a large roosting colony or maternity roost. However, maternity roosts might occur within the Mine Areas study area should suitable deep caves occur.

Potential Impacts: Assuming that the Mine Areas study area is utilised by itinerant bats only, then it is likely that *R. aurantius* would not be impacted by the proposed development, as much of the foraging habitat will remain intact and it also occurs outside of the proposed impact area in the vicinity of Pannawonica and the Robe River Valley (Biota 2007b). However, it should be noted that although large, deep caves suitable for maternity roosting colonies were not noted within the study area, they might potentially occur (Armstrong 2001). Large, deep caves offer suitable habitat for maternity roosts, and because roosting bats are sensitive to anthropogenic disturbance (Armstrong 2001and Biota 2001), any impact on caves containing roosting colonies and maternity roosts is likely to result in a negative impact on this species in the area.

Pilbara Olive Python (*Liasis olivaceus barroni*)
Distribution: Regarded as a Pilbara endemic, this subspecies has a known distribution that coincides roughly with the Pilbara bioregion (Environment Australia 2000).

Ecology: The Pilbara Olive Python occurs in rocky areas within the Pilbara, showing a preference for rocky habitats near water, particularly rock pools.

Likelihood of Occurrence: Live animals were recorded on two occasions at sites AQM16 and AQM15E. A sloughed skin was recorded at site AQARL04.

Potential Impacts: Potential impacts include major fire events and loss of habitat from development of mining infrastructure. Mining activity may result in a decrease in prey availability and increase deaths through road impacts (Pearson 2003).

5.2.2 Priority 4 Species

Long-tailed Dunnart (*Sminthopsis longicaudata*)
Distribution: Inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region east to the central Northern Territory and South Australia (Menkhorst and Knight 2001).

Ecology: This species typically occurs on plateaus near breakaways and scree slopes, and on rugged boulder-strewn scree slopes. This species was once considered to be rare and possibly threatened, however research has now shown that it is relatively common and widespread but is restricted to its preferred rocky habitats.

Likelihood of Occurrence: Recorded on a single occasion from *Triodia* hillslope habitat at site AQM09. The Mine Areas study area contains significant rocky habitat suitable for this species. Given this, populations of *S. longicauda* may exist within the study area

Potential Impacts:. The main potential impact from the WPIOP proposal would be localised removal of rocky habitat from the mesa landforms of the deposit areas.

Grey Falcon (*Falco hypoleucos*)
Distribution: The Grey Falcon is endemic to Australia, where it is widespread but rare throughout the arid zone. This species occurs in the northern half of Western Australia, typically north of 26°S. (Johnstone and Storr 1998). The Grey Falcon is a resident or nomadic visitor to inland parts of Australia (Pizzey and Knight 1997), but its movements are poorly understood.

Ecology: This species mainly inhabits lightly wooded coastal and riverine plains (Johnstone and Storr 1998). *F. hypoleucos* may also occur near wetlands where surface water attracts prey. This falcon preys primarily on birds, especially parrots and pigeons, using high-speed chases and stoops; reptiles and mammals are also taken. It utilises old nests of other birds of prey and ravens, usually high in a living eucalypt near water or a watercourse. Peak egg-laying season is in late winter and early spring and two or three eggs are laid.

Likelihood of Occurrence: Recorded on a single occasion opportunistically within the Mine Areas study area.

Potential Impacts: Loss of nesting and foraging habitat are the main threatening process for this species, particularly through grazing and land clearing. Given the species low density in the study area, the proposed development is unlikely to affect its conservation status.

Australian Bustard (*Ardeotis australis*)
Distribution: The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the state (Johnstone and Storr 1998).

Ecology: This species prefers open or lightly wooded grassland, including *Triodia* sp. sandplains, and is considered scarce to common depending on season and habitat (Johnstone and Storr 1998). The Australian Bustard is a dispersive species, with widespread movements over long distances, probably in response to habitat and climatic conditions.

Likelihood of Occurrence: Recorded on six occasions at three systematic sites (AQARL09, AQARL07 and AQM29) and on 17 occasions opportunistically with the study area.

Potential Impacts: Due to the mobile and dispersive nature of Bustards, the potential impacts on this species are likely to be minimal. The conservation status of this species would not be altered by the proposed development.

Ghost Bat (*Macroderma gigas*)
Distribution: The Ghost Bat was previously distributed across most of inland and northern Australia, but is now restricted to the tropical north of the continent (Churchill 1998).

Ecology: The Ghost Bat occurs in a broad range of habitats, with distribution influenced by the availability of suitable caves and mines for roost sites (Churchill 1998). The distribution of this species is fragmented, with each population showing some genetic differentiation (Armstrong and Wilmer 2004; and Dr. Kyle Armstrong, pers. comm. 2004). Populations in the Pilbara bioregion appear to be isolated from those in the Kimberley and Northern Territory.

Likelihood of Occurrence:, Although not captured, evidence of *M. gigas* was noted on two occasions within the study area, and a dead Ghost Bat was recorded in the vicinity of Cardo Camp in early 2007 (Dan Kamien per. obs). The fact that the Pilbara Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) was recorded during the survey indicates that suitable Ghost Bat roosting caves are likely to occur in the study area.

Potential Impacts: Mining operations may disturb local Ghost Bat roosts, however, the WPIOP development would not be expected to affect the overall conservation status of *M. gigas*.

Western Pebble-mound Mouse (*Pseudomys chapmani*)
Distribution: The Western Pebble-mound Mouse is confined to the central and eastern Pilbara including Karijini National Park (Menkhorst and Knight 2001).

Ecology: The species is found on stony hillsides with hummock grasslands (Menkhorst and Knight 2001) and is common to very common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion. The Western Pebble-mound Mouse is well known for its behaviour of constructing extensive mounds of small stones covering areas from 0.5 to 9.0 square meters (Van Dyck and Strahan 2008). Mounds are most common on spurs and gentle slopes where suitably sized stones are present.

Likelihood of Occurrence: Although live animals were not captured, a total of nine active pebble mounds were recorded within the Mine Areas study area.

Potential Impacts: There is potential for the proposed development to impact on individual *P. chapmani*, particularly if pebble-mounds are destroyed during pit or infrastructure construction. Given the broad distribution of this species, its overall conservation status would not be altered by the proposed development.

5.2.3 Migratory Species

Rainbow Bee-eater (*Merops ornatus*)
Distribution: Occurs through the majority of the western third of Western Australia where free water is relatively readily available. May occur in many areas as either a casual or transitory species.

Ecology: This species forages aerially for insects and nests in burrows in the ground (Higgins 1999). It occurs in lightly wooded habitats that provide suitable (sandy) soil for nesting and a tall stratum of vegetation for perching.

Likelihood of occurrence: This species was recorded 109 times during the survey and is likely to be a routine visitor to the study area.

Potential Impacts: Given the mobility and habitat preferences of the species, and the relatively small extent of habitat affected, there is unlikely to be any significant impacts on the Rainbow Bee-eater's conservation status.

5.3 Other Fauna of Conservation Significance Potentially Occurring in the Study Area

Based on known fauna distributions and habitat preferences, an additional seven Schedule or Priority species may potentially occur within the study area (Appendices 1, 2 and 3). Accounts of these species are provided in Biota (2009a). With the exception of the Night Parrot, all of the species would be considered likely to occur.

Table 5.1: Other Threatened Fauna species that database searches indicate could potentially occur within the study area (Biota 2009a).

Species	Common Name	Status	
		State	Federal
Pezoporus occidentalis	Night Parrot	Schedule 1	Endangered
Falco peregrinus	Peregrine Falcon	Schedule 4	–
Burhinus grallarius	Bush Stone Curlew	Priority 4	–
Neochmia ruficauda subclarescens	Star Finch	Priority 4	–
Leggadina lakedownensis	Short-tailed Mouse	Priority 4	–
Notoscincus butleri	-	Priority 4	–
Phaps histrionica	Flock Bronzewing	Priority 4	–

Detailed accounts of the above species are provided in Biota (2009d). Of the taxa listed in Table 5.1, those considered most likely to occur in the Mine Area comprise:

- Bush Stone-Curlew *Burhinus grallarius* –suitable habitat occurs in several parts of the mine area and the species is likely to be present from time to time.
- Star Finch *Neochmia ruficauda subclarescens* – suitable habitat occurs in association with larger drainages in the mine area and the species has been confirmed from the Robe River locality to the north by Biota (2006).
- Short-tailed Mouse *Leggadina lakedownensis* – suitable habitat occurs in the northern section of the mine area on clay plains north of Cochrane and Jewel.

5.3.1 Migratory Species

Database searches also indicated that 11 species listed as 'Migratory' under the *EPBC Act 1999* could occur in the area (Biota 2009d), one of which was recorded as noted in Section 5.2.3).

Many avifauna species are listed under the *EPBC Act 1999* as either migratory and/or marine species. Based on the EPBC protected matters report (Appendix 3) the following migratory species may occur within the Mine Areas study area:

- Migratory: White-bellied Sea-Eagle, Barn Swallow, Rainbow Bee-eater, Great Egret, Cattle Egret, Oriental Plover, Oriental Pratincole, Little Curlew and Fork-tailed Swift.
- Marine: Fork-tailed Swift, Great Egret, Cattle Egret, Oriental Plover, Oriental Pratincole, White-bellied Sea-Eagle, Barn Swallow, Rainbow Bee-eater and Little Curlew.

The proposed Mine Areas development is unlikely to adversely affect the conservation status of any of these species. They would not require further specific consideration as part of the assessment process.

6.0 Discussion and Conclusions

6.1 Summary of Findings

The survey of the WPIOP Mine Areas study area has documented 168 vertebrate fauna species: 79 avifauna species, 26 mammal species and 60 herpetofauna species (comprising three frogs and 72 reptiles) (Section 4.2). The habitats sampled were representative of the Land Systems and vegetation types present in the region (Section 4.1). The habitats of greatest significance within the study area occur where more major riverine drainages adjoin the rocky landforms of the deposits, making them suitable for the Schedule listed species the Northern Quoll *Dasyurus hallucatus* and the Pilbara Olive Python *Liasis olivaceus barroni.* Records of the Schedule 1 Pilbara Orange Leaf-nosed Bat *Rhinonicteris aurantius* were also made from this habitat.

Nine species of elevated conservation significance were recorded from the Mine Areas study area. There are one other Schedule species and five Priority species that were not recorded during the surveys but are considered likely to occur in the study corridor (Section 5.3).

6.2 Comparisons with other Surveys in the Locality

Although conducted under different seasonal conditions, including additional habitats, and with differential sampling effort, comparisons with other similar studies done in the locality can provide useful contextual information for the current study (Table 6.1).

Table 6.1: Comparison of the results of the WPIOP Mine Areas fauna survey with other similar fauna studies in the locality.

	No. of Species				
Survey	**Herpetofauna**	**Avifauna**	**Mammals**	**Total**	**Formally Listed Species**
WPIOP Mine Area (this study)	60	79	26	**168**	*Dasyurus hallucatus* *Rhinonicteris aurantius* *Liasis olivaceus barroni* *Sminthopsis longicaudata* *Falco hypoleucos* *Ardeotis australis* *Macroderma gigas* *Pseudomys chapmani* *Merops ornatus*
Anketell Point Rail Corridor (this study)	75	87	20	**184**	*Dasyurus hallucatus* *Falco peregrinus* *Ardeotis australis* *Phaps histrionica* *Pseudomys chapmani* *Notoscincus butleri* *Merops ornatus* *Apus pacficifus*
Mesa A Transport Corridor (Biota 2006)	67	93	21	**181**	*Dasyurus hallucatus* *Macroderma gigas* *Ardeotis australis* *Burhinus grallarius* *Pseudomys chapmani* *Notoscincus butleri* *Merops ornatus*
Bungaroo Trial Pit (Biota 2007)	51	81	16	**147**	*Dasyurus hallucatus* *Pseudomys chapmani* *Ardeotis australis* *Burhinus grallarius* *Notoscincus butleri* *Tringa glareola*

The Threatened and migratory species recorded by other surveys in the locality represent a similar listing of species to those recorded from the Mine Areas study area (Table 6.1). While somewhat lower, the study has also recorded a similar diversity of fauna species to previous studies in the locality, including the largest tally of mammals of any of the comparison surveys.

6.3 Potential Impacts

Potential impacts to terrestrial fauna arising from the development of the proposed Mine Areas ore bodies and construction of associated infrastructure would include the following:

- **Direct fauna habitat disturbance**

The primary impact that is likely to arise would be the clearing of fauna habitat necessary to mine the ore bodies and construct associated waste dumps and infrastructure. Some fauna habitats within the Mine Areas have been identified as supporting significant species, particularly where major riverine habitats adjoin rocky habitats (Section 6.1). Mine construction and any related ground-disturbing activities should aim to minimise or ideally avoid any impacts on these habitats.

- **Indirect fauna habitat modification**

A number of indirect modifications may also occur to fauna habitat within the Mine Areas. These include changes to surface hydrology, increased erosion and weed introduction or spread. The proposed development has the potential to alter surface hydrology, particularly in the minor and major drainage systems that occur in the Mine Areas. Changes to surface flows could also result in increased scour and erosion, with similar consequences for riverine fauna habitats, and engineering design of drainage treatments and crossing structures should take account of these factors.

The spread or introduction of weeds is a potential risk particularly in association with the proposed rail south of Cochrane. Changes to the floristic and structural nature of vegetation and fauna habitat can result in the habitat resource value of areas being diminished for native fauna. Mesic environments such as major creeklines are particularly susceptible to weed invasion and any consequent changes to fauna habitat. Weed and topsoil hygiene protocols will therefore be required for all earthworks.

- **Direct loss of individual fauna**

It is inevitable that there will be some localised loss of fauna due to direct mortality arising from mine construction and associated infrastructure, including that which may occur during the clearing of habitat. Ongoing impacts may also arise from more frequent vehicle movements, train movements and machinery operation along the corridor once the rail and associated access tracks are constructed. It is unlikely that the loss of individuals associated with such direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the corridor.

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Appendix 1

DEC Threatened Fauna Database Search

20.7494 °S 115.7922 °E / 22.2847 °S 116.4372 °E Aquila Mine and Rail study area

*	Date	Certainty	Seen	Location Name	Method

Schedule 1 - Fauna that is rare or is likely to become extinct

Rhinonicteris aurantius — Orange Leaf-nosed Bat — *1 records*

This species of bat occurs in a few scattered locations in the Pilbara, as well as the Kimberley. It roosts in caves and is sensitive to human disturbance.

1925	1		Red Hill	

Pezoporus occidentalis — Night Parrot — *1 records*

This nocturnal species is known to inhabit treeless or sparsely wooded spinifex (Triodia spp) near water.

1967	2		Yarraloola	

Priority One: Taxa with few, poorly known populations on threatened lands

Mormopterus loriae cobourgiana — Little North-western Mastiff Bat — *1 records*

This species occurs along the northwest coast and is known to roost in mangroves.

2000	1	20	Cape Preston	Caught or trapped

Ramphotyphlops ganei — Ramphotyphlops ganei — *1 records*

Very little is known about this species of blind snake. It grows to about 30 cm in length and has been recorded from four localities in the Pilbara including Pannawonica and Newman.

1991	1	1	Pannawonica	Dead

Priority Three: Taxa with several, poorly known populations, some on conservation lands

Lagorchestes conspicillatus leichardti — Spectacled Hare-wallaby (mainland) — *1 records*

This species has declined in many parts of its range and is vulnerable to cat and fox predation. It inhabits tropical grasslands and also suffers from the impacts of frequent fires.

1979	1	1	Mardie	Day sighting

Priority Four: Taxa in need of monitoring

Leggadina lakedownensis — Lakeland Downs Mouse (Kerakenga) — *10 records*

This secretive species is known to occur in the Pilbara and the Kimberley. Its populations rise and fall dramatically, probably in response to climatic fluctuations and availability of seeds.

2000	1	1	Mardie	Caught or trapped
2000	1	1	Mardie	Caught or trapped
2000	1	1	Mardie	Caught or trapped
2006	1	1	Fortesque/Mardie	Caught or trapped
2006	1	1	Fortesque/Mardie	Caught or trapped
2006	1	1	Fortesque/Mardie	Caught or trapped
2006	1	1	Fortesque/Mardie	Caught or trapped
2006	1	1	Fortesque/Mardie	Caught or trapped
2006	1	1	Fortesque/Mardie	Caught or trapped
2006	1	1	Fortesque	Caught or trapped

Pseudomys chapmani — Western Pebble-mound Mouse (Ngadji) — *4 records*

This species is well-known for the characteristic pebble-mounds which it constructs over underground burrow systems. These mounds are most common on spurs and lower slopes of rocky hills.

1994	2	0	Deepdale	

20.7494 °S 115.7922 °E / 22.2847 °S 116.4372 °E Aquila Mine and Rail study area

*	Date	Certainty	Seen	Location Name	Method
	1994	1		Mardie Stn	
	1996	2	0	Pannawonica	
	2000	1	0	Mardie	Definite signs

Ardeotis australis **Australian Bustard** *1 records*

This species is uncommon and may occur in open or lightly wooded grasslands.

2000	1	6	Mardie	

Burhinus grallarius **Bush Stonecurlew** *1 records*

A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.

2000	1	2	Mardie	Day sighting

Numenius madagascariensis **Eastern Curlew** *1 records*

This species is a migratory visitor and has been observed on reef flats and sandy beaches along the West Australian coast and in coastal estuaries.

2000	1	11	Cape Preston	

Neochima ruficauda subclarescens **Star Finch (western)** *1 records*

A nomadic species inhabiting grasslands and eucalypt woodlands near water.

2002	1	5	Yarraloola	Caught or trapped

***** Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Appendix 2

WA Museum NatureMap Database Search

Reptiles collected between
-20.7494, 115.7922 and -22.2847, 116.4372

Agamidae
Ctenophorus caudicinctus
Ctenophorus caudicinctus caudicinctus
Ctenophorus femoralis
Ctenophorus isolepis
Ctenophorus isolepis isolepis
Ctenophorus nuchalis
Ctenophorus reticulatus
Lophognathus gilberti gilberti
Lophognathus longirostris
Pogona minor minor
Tympanocryptis cephala

Boidae
Antaresia perthensis
Aspidites melanocephalus

Elapidae
Acanthophis wellsi
Demansia psammophis cupreiceps
Furina ornata
Parasuta monachus
Pseudechis australis
Pseudonaja modesta
Pseudonaja nuchalis
Suta fasciata
Suta punctata

Gekkonidae
Crenadactylus ocellatus horni
Diplodactylus conspicillatus
Diplodactylus savagei
Diplodactylus stenodactylus
Gehyra pilbara
Gehyra punctata
Gehyra variegata
Heteronotia binoei
Heteronotia spelea
Nephrurus wheeleri cinctus
Oedura marmorata
Rhynchoedura ornata
Strophurus elderi
Strophurus strophurus

Pygopodidae
Delma elegans
Delma nasuta
Delma pax
Lialis burtonis
Pygopus nigriceps

Scincidae
Carlia munda
Cryptoblepharus plagiocephalus
Ctenotus duricola

Ctenotus grandis
Ctenotus helenae
Ctenotus pantherinus ocellifer
Ctenotus saxatilis
Ctenotus serventyi
Cyclodomorphus melanops melanops
Egernia formosa
Glaphyromorphus isolepis
Lerista bipes
Lerista flammicauda
Lerista muelleri
Menetia greyii
Menetia surda surda
Morethia ruficauda exquisita
Notoscincus butleri
Proablepharus reginae
Tiliqua multifasciata

Typhlopidae
Ramphotyphlops ammodytes
Ramphotyphlops ganei
Ramphotyphlops grypus
Ramphotyphlops hamatus

Varanidae
Varanus acanthurus
Varanus tristis tristis

Amphibia collected between
-20.7494, 115.7922 and -22.2847, 116.4372

Hylidae
Litoria rubella

Myobatrachidae
Limnodynastes ornatus
Uperoleia russelli

Mammals collected between

-20.7494, 115.7922 and -22.2847, 116.4372

Dasyuridae
Dasykaluta rosamondae
Dasyurus hallucatus
Ningaui timealeyi
Planigale sp
Pseudantechinus woolleyae
Sminthopsis macroura

Emballonuridae
Taphozous georgianus

Hipposideridae
Rhinonicteris aurantius

Macropodidae
Macropus robustus erubescens
Macropus rufus
Petrogale rothschildi

Molossidae
Mormopterus loriae

Muridae
Leggadina lakedownensis
Mus musculus
Pseudomys delicatulus
Pseudomys hermannsburgensis
Rattus rattus
Zyzomys argurus

Phalangeridae
Trichosurus vulpecula arnhemensis

Vespertilionidae
Scotorepens greyii
Vespadelus finlaysoni

Birds collected between

-20.7494, 115.7922 and -22.2847, 116.4372

Acanthizidae
Pyrrholaemus brunneus
Smicrornis brevirostris

Accipitridae
Aquila morphnoides

Columbidae
Geopelia striata placida

Dicruridae
Grallina cyanoleuca

Falconidae
Falco berigora

Halcyonidae
Dacelo leachii
Todiramphus sanctus

Maluridae
Malurus leucopterus
Stipiturus ruficeps

Meliphagidae
Lichmera indistincta

Otididae
Ardeotis australis

Pardalotidae
Pardalotus striatus murchisoni

Passeridae
Neochmia ruficauda clarescens

Phasianidae
Coturnix ypsilophora cervina

Pomatostomidae
Pomatostomus temporalis rubeculus

Psittacidae
Cacatua sanguinea westralensis
Platycercus zonarius zonarius

Sylviidae
Cincloramphus mathewsi

Appendix 3

EPBC Protected Matters Report

Threatened Species		Status	Type of Presence
Mammals			
Dasycercus cristicauda	Mulgara	Vulnerable	Species or species habitat likely to occur within area
*Dasyurus hallucatus**	Northern Quoll	Endangered	Species or species habitat may occur within area
Petrogale lateralis lateralis	Black-flanked Rock-wallaby	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat (Pilbara form)	Vulnerable	Community likely to occur within area
Reptiles			
Morelia olivacea barroni	Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area

Migratory Species		Status	Type of Presence
Migratory Terrestrial Species			
Birds			
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundo rustica	Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus	Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species			
Birds			
Ardea alba	Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus	Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum	Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus	Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Migratory Marine Species			
Birds			
Apus pacificus	Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba	Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Migratory	Species or species habitat may occur within area
Macronectes giganteus	Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Puffinus pacificus	Wedge-tailed Shearwater	Migratory	Breeding known to occur within area

Other Matters Protected by the *EPBC Act*			
Listed Marine Species		Status	Type of Presence
Birds			
Apus pacificus	Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba	Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Listed -	Species or species habitat

		overfly marine area	may occur within area
Charadrius veredus	Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Glareola maldivarum	Oriental Pratincole	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster	White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundo rustica	Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Larus novaehollandiae	Silver Gull	Listed	Breeding known to occur within area
Macronectes giganteus	Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus	Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus	Little Curlew, Little Whimbrel	Listed - overfly marine area	Species or species habitat may occur within area
Puffinus pacificus	Wedge-tailed Shearwater	Listed	Breeding known to occur within area

Appendix 4

Regulation 17 "Licence to take fauna for scientific purposes"

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: **Locked Bag 30**
Bentley Delivery Centre WA 6983

DATE OF ISSUE 23/04/2007
VALID FROM 01/05/2007
DATE OF EXPIRY 30/04/2008

LICENSING OFFICER

LICENSEE: DR G HUMPHREYS (GARTH)
ADDRESS BIOTA ENVIRONMENTAL SCIENCES
P.O. BOX 155
LEEDERVILLE
W.A. 6903

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DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: **Locked Bag 30**
Bentley Delivery Centre WA 6983

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WILDLIFE CONSERVATION ACT 1950
REGULATION 17

LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.

2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.

3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.

4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.

5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTORGENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.

6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.

7 **********ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE COMMONWEALTH DEPT OF THE ENVIRONMENT AND WATER RESOURCES, PHONE 02 6274 1900. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.**********

8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.

9 FURTHER CONDITIONS (NUMBERED TO) ARE ATTACHED.

PURPOSE CAPTURE AND RELEASE FAUNA SURVEY OF WEST PILBARA IRON ORE PROJECT MINE AND RAIL FROM CAPE PRESTON TO APPROX 30KM SOUTH OF REDHILL STATION.

AUTHORISED PERSONS MR ROY TEALE, MR GREG HAROLD, MR PHIL RUNHAM, MS ZOE HAMILTON, MR M GREENHAM, MR A JOHNSON, MR D KAMIEN, MS E HARRIS, MS J ADCOFT, MR L LOVELL, MR P SAWERS. JASON ALEXANDER

Appendix 5

Bat Call Analysis

Specialised Zoological

Bat call identification

from Cardo, Pilbara, WA

Type:	Bat Call Analysis
Prepared for:	Biota Environmental Sciences
Date:	20 January 2009
Job No.:	SZ089
Prepared by:	Specialised Zoological Kyle Armstrong and Yuki Konishi ABN 92 265 437 422 0404 423 264 kyle.armstrong@graduate.uwa.edu.au kyle.n.armstrong@gmail.com

SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from Cardo, near Red Hill in the Pilbara region of Western Australia. Six species were identified (Table 1). The calls of the yellow-bellied sheath-tailed bat *Saccolaimus flaviventris* can sometimes be confused with those of the northern free-tailed bat *Chaerephon jobensis*. In this case, the calls appeared to be from *S. flaviventris*.

Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 2, and representative call sequences are illustrated in Figure 1. Further data is available should verification be required.

METHODS

Signals as recorded with an Anabat SD1 unit were supplied as downloaded sequences, which were examined in AnalookW 3.5f software. Three call variables were measured on good quality search phase pulses in representative call sequences: pulse duration (milliseconds), maximum frequency (kHz) and characteristic frequency (equivalent to minimum frequency; kHz). Species were identified based on information in McKenzie and Muir (2000) and Armstrong and Coles (2007). Nomenclature follows Armstrong and Reardon (2006).

SPECIES OF CONSERVATION SIGNIFICANCE

One species of conservation significance was detected on two nights – the Pilbara leaf-nosed bat *Rhinonicteris aurantia*. The identification was unambiguous and based on both characteristic frequency and pulse structure (Armstrong and Coles 2007). The calls were also distinct from the high frequency calls made by Finlayson's cave bat *Vespadelus finlaysoni* when inside or near cave entrances (see example in Figure 2). The first record of *R. aurantia* in the Pilbara region was at an old disused mine, now collapsed, on Red Hill Station in 1925 (Armstrong 2001). It is likely that daytime roosts will exist in the area. However, whether the species roosts during the day where echolocation calls were recorded would need to be determined with further work. The number of sequences recorded was relatively low, and at times of the night (i.e. well after dusk or well before dawn – 22:01, 01:53, 02:04, 03:40) when an individual might be expected to visit caves to rest while out foraging away from the daytime roost. Night visitation of caves that are not used during the day has been observed on many occasions in this species (K.N. Armstrong pers. obs.).

Further detailed information on this species can be found on the Commonwealth Government's SPRAT database, and citations therein (Department of the Environment, Water, Heritage and the Arts 2008). If there was a requirement to demonstrate that *R. aurantia* did not roost within the areas planned for development, further work should be undertaken as described in the SPRAT profile for this species.

REFERENCES

ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6–9. [ISSN 1448-5877]

Armstrong, K.N. (2001). The roost habitat and distribution of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research* 28: 95–104.

Armstrong, K. and Reardon, T. (2006). Standardising common names of bats in Australia. *The Australasian Bat Society Newsletter* 26: 37–42.

Armstrong, K.N. and Coles, R.B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonicteris aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* 88: 94–104.

Department of the Environment, Water, Heritage and the Arts (2008). *Rhinonicteris aurantia* (Pilbara form). In: Species Profile and Threats Database, Department of the Environment, Water, Heritage and the Arts, Canberra. URL: http://www.environment.gov.au/sprat

McKenzie, N.L. and Muir, W.P. (2000). Bats of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* Supplement 61: 465–477.

TABLE 1. Species identifications, with the degree of confidence indicated by a code. Date correlates with site; see Table 2 for full species names.

Date	*C. gouldii*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Serial 3709						
11/11/2008	—	—	M	H	H	H
14/11/2008	H	H	—	—	H	H
15/11/2008	—	H	—	—	H	H

Definition of confidence level codes:

R Reference. Capture of the species was made at the site, and the identification is supported by measurements, a *Reference* call recording, and/or submission of a specimen/tissue to a museum.

H High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material.

M Medium. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the Summary section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

TABLE 2. Summary of variables from representative call sequences.

Species	s,p[1]	Duration (msec)[2]	Max Frequency (kHz)[2]	Char frequency (kHz)[2]
Gould's wattled bat *Chalinolobus gouldii*	1,28	10.8 ± 3.3 4.6 – 15.3	29.0 ± 5.8 25.6 – 43.7	25.9 ± 2.5 24.3 – 32.8
Pilbara leaf-nosed bat *Rhinonicteris aurantia*	5,9	— —	— —	119.1 ± 0.6 117.7 – 119.3
Yellow-bellied sheath-tailed bat *Saccolaimus flaviventris*	1,1	14.7 —	17.9 —	15.8 —
Little broad-nosed bat *Scotorepens greyii*	2,14	4.2 ± 0.9 3.1 – 6.2	63.4 ± 4.8 52.7 – 69	41.7 ± 1.7 38.1 – 43.7
Common sheath-tailed bat *Taphozous georgianus*	3,14	9.1 ± 1.6 5.9 – 11.8	29.7 ± 0.6 29.0 – 30.7	25.3 ± 0.3 24.9 – 26.1
Finlayson's cave bat *Vespadelus finlaysoni*	3,36	5.1 ± 0.9 3.7 – 6.8	63.1 ± 4.5 56.7 – 72.1	55.8 ± 0.6 54.1 – 56.7

[1] s,p: number of sequences measured, combined total number of pulses measured;

[2] Mean ± SD; range.

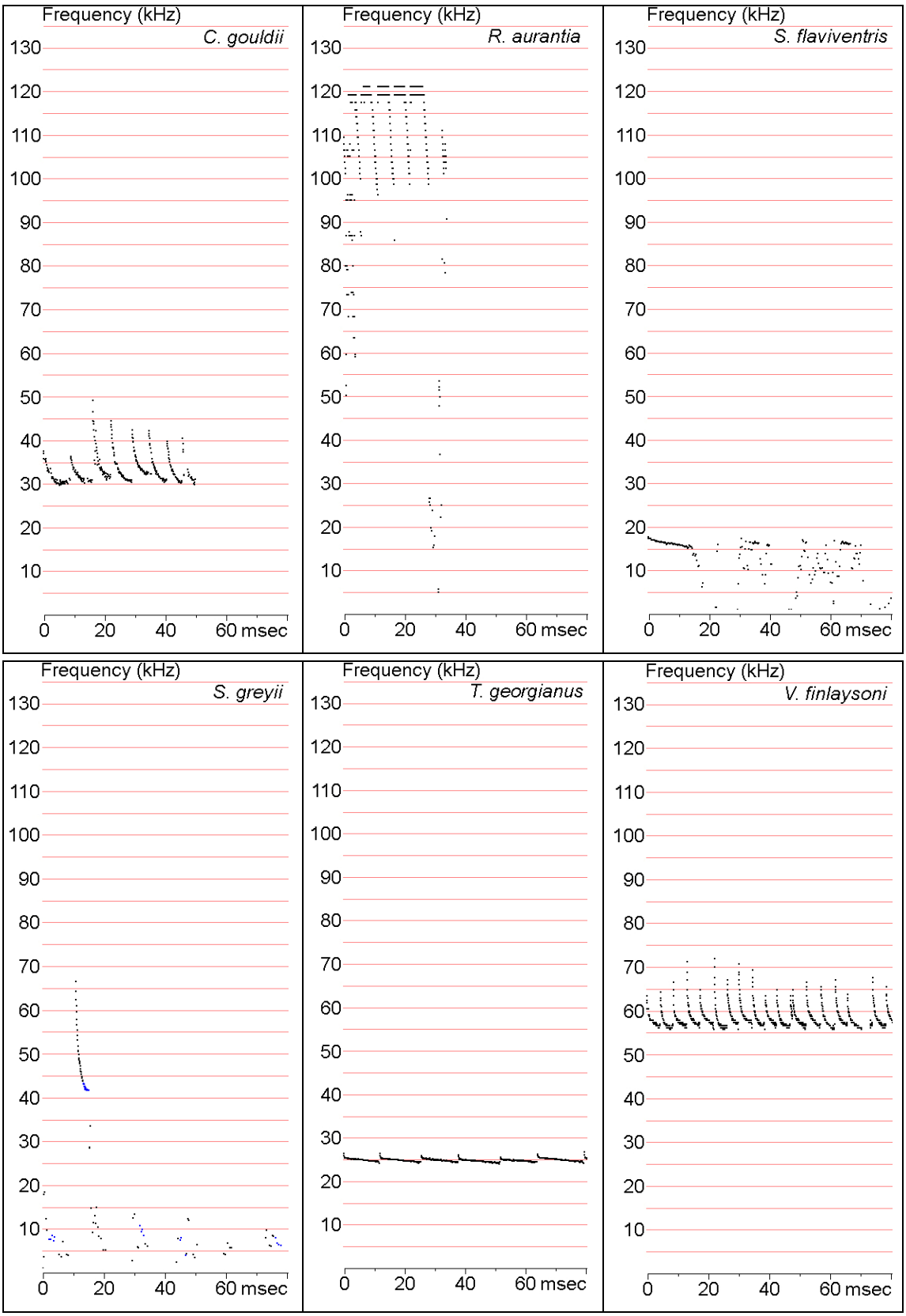

FIGURE 1. Representative call sequences of the six species identified (time is compressed between pulses).

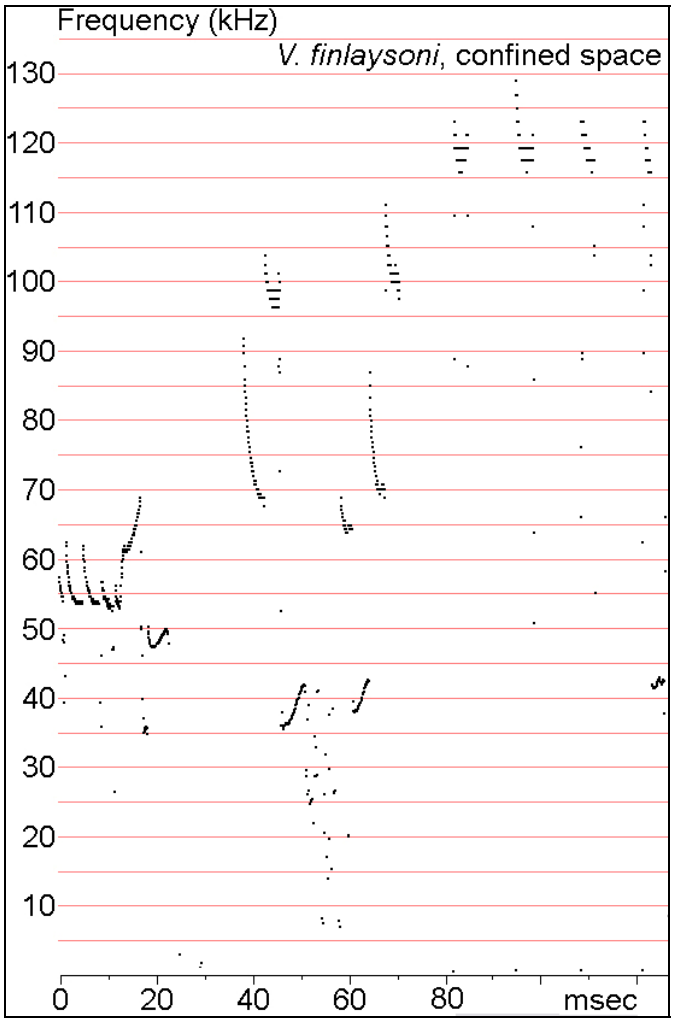

FIGURE 2. Representative call sequence of *Vespadelus finlaysoni* in a confined space such as a cave entrance (time is compressed between pulses).