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Sanjiv Ridge: Ghost Bat Monitoring 2024

Report to Atlas Iron Pty Ltd

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3	Verity Steptoe	Jess Johnston	Riley Gardner, Claudia Lewis, Nick Liaros	25/03/2025

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Executive Summary

Atlas Iron Pty Ltd (Atlas) is developing the Sanjiv Ridge Project, located approximately 33 kilometres (km) south of Marble Bar, Western Australia. Stage 1 of Sanjiv Ridge was approved on 12 March 2020 (Ministerial Statement Number: 1125,) and mining commenced in 2020. As part of the Sanjiv Ridge's approvals, a *Significant Species Management Plan – Corunna Downs* (the 2017 SSMP) was developed to manage several species of significance recorded within the Stage 1 area, including ghost bat, which is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*, and under the *Biodiversity Conservation Act 2016*. Approval for the development of Stage 2 of Sanjiv Ridge was granted on the 13 September 2022 (Ministerial Statement Number: 1197). In accordance with conditions set by the Sanjiv Ridge Stage 2 approval, an updated significant species management plan was developed to cover the Stage 2 area (the 2023 SSMP) and approved on 1 August 2023. . The SSMPs prescribe a monitoring program – including surveys conducted pre-mining (baseline), during mining and post-mining – to assess the local population of the species for the life of the Sanjiv Ridge Project. A key objective of the program is to assess whether a performance objective outlined in the 2017 SSMP is being fulfilled (for roosts in the Stage 1 area), and whether trigger and threshold criteria outlined in the 2023 SSMP are being realised (for roosts in the Stage 2 Project area).

In March 2024, Atlas commissioned Biologic to undertake a survey which represents the eighth annual monitoring survey of ghost bat for the Stage 1 area (and the fourth annual survey since mining development commenced there), and the fourth annual monitoring survey of ghost bat for the Stage 2 area (where development is underway but blasting and ore extraction activities are yet to commence). The monitoring program incorporates 19 monitoring sites, comprising 15 Impact sites located within 1 km of the Sanjiv Ridge indicative disturbance envelope and four Control sites located more than 1 km from the indicative disturbance envelope. These sites include diurnal roosts and nocturnal roosts.

In accordance with the SSMPs, Atlas has established the following Performance Objectives, Key Performance Indicators, Threshold Criteria, and Trigger Criteria for ghost bat roosts ; they are as follows;

For Stage 1 roosts (CO-CA-01 and CO-CA-03), the Performance Objective is *No unauthorised access to bat cave exclusion zones*. The Key Performance Indicators for these roosts *are No ground disturbance within cave buffers (240 m for CO-CA-01 and 50 m for CO-CA-03) and no incident reports of unauthorised access to cave buffers*.

For Stage 2 roosts (CO-CA-20, CO-CA-21, CO-CA-22, CO-CA-23, CO-CA-24, CO-CA-25, CO-CA-26, CO-CA-27, CO-CA-28, and CO-CA-29), the Trigger Criterion are *Minor to moderate rockfall within a cave such that the cave remains viable as ghost bat habitat in the future once mining has ceased*, and; *Ground disturbance approaching within 10 m of exclusion areas around Stage 2 ghost bat caves*. The Threshold Criteria for the Stage 2 caves are; *Significant structural damage to a cave that would prevent ongoing use by ghost bat as a diurnal roost*, and; *Ground disturbance occurs within avoidance buffers around Stage 2 ghost bat caves*.

The field survey was conducted between 15 to 25 July 2024. Methods were consistent with monitoring completed in previous years, including ultrasonic recording and scat sheet assessment to determine the presence of ghost bat; microclimate (temperature and relative humidity) monitoring of accessible caves; and photo monitoring to identify any temporal changes in the structure and quality of habitat at each site.

At the time of the first annual monitoring survey in 2020, disturbance comprised small areas of clearing for exploration and historical mining activities, and general degradation due to pastoralism. Clearing for mine development, and construction, commenced for the Stage 1 area in 2020 and ore extraction activities commenced in 2021. Ore extraction and processing activities continued between the 2023 monitoring survey and the current annual monitoring survey, At the time of the current field survey, mining was active at three open pits associated with the Stage 1 area.

In November 2023, construction of a haul road associated with Stage 2 development commenced approximately 560 m west of CO-CA-01 and approximately 80 m east of CO-CA-21. By May 2024 the haul road had passed within approximately 40m of CO-CA-21 and approximately 360m of CO-CA-30 and reached the Stage 2 area near the Glen Herring Pit. As of August 2024, earthworks associated with the Glen Herring Pit encroached to within approximately 70 m of CO-CA-20, approximately 35m of CO-CA-24, approximately 26m of CO-CA-25 and approximately 30m of CO-CA-26. Areas burned by a wildfire on 16 December 2022) appeared to be continuing a normal state of recovery.

There was no evidence of physical changes to any the monitoring sites, either from mining activities or other factors such as rockfall events following rainfall. At the 18 accessible monitoring sites (excluding the two mine adits), recorded temperatures were suitable for roosting by ghost bat, ranging between 22.38°C at CO-CA-27 and 31.30°C at CO-CA-03.

Ultrasonic ghost bat calls were recorded at all Impact sites except CO-CA-01, CO-CA-03, CO-CA-10 and CO-CA-21. There was no other evidence (such as scats or feeding evidence) of ghost bat using CO-CA-03, CO-CA-10 or CO-CA-21 since the 2023 monitoring survey. Results of the previous monitoring surveys show that CO-CA-10 is likely only occasionally used by ghost bat, with calls only recorded during the 2017 monitoring survey.

Ghost bats were visually observed at two caves (CO-CA-01 and CO-CA-33) during the survey. At CO-CA-01 a single ghost bat was observed roosting on three occasions, with two individuals observed at CO-CA-33. Ghost bat scats deposited since the previous monitoring period were observed in four of the 15 sites monitored with scat collection sheets: 30 scats in CO-CA-01, 48 scats in CO-CA-05, one scat in CO-CA-24 and approximately 300 scats in CO-CA-33.

In accordance with the SSMPs, Atlas is committed to employing specific corrective actions when the above-mentioned key performance indicators are not met, or when the above-mentioned trigger/ threshold criteria are realised. Atlas has not reported any instance of unauthorised access or ground disturbance within the 240 m exclusion zone around cave CO-CA-01, nor within the 50 m exclusion zone around CO-CA-03, nor within the 10 m exclusion zones around the Stage 2 sites. There have been no signs of rockfall or structural damage within any of these sites. Overall, there are no signs that ghost bat activity in the Sanjiv Ridge Study Area, or the suitability of roosts as habitat for ghost bat, have been affected by mining activity. Based on these results, the key performance indicators have been met and the trigger/ threshold criteria have not been realised.

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1 Introduction

1.1 Project Background

Atlas Iron Pty Ltd (Atlas) is developing the Sanjiv Ridge Project (the Project; formerly known as the Corunna Downs Project), an iron ore mine located approximately 33 kilometres (km) south of Marble Bar in the Pilbara region of Western Australia (Figure 1.1). Stage 1 of the Project, comprising mining is via conventional open cut, crushing and screening mining methods above the groundwater table. Associated infrastructure will include open pits, waste rock dumps, mine infrastructure, a borefield and an accommodation camp which was approved on 12 March 2020 (Ministerial Statement Number: 1125) and mining commenced in 2020. As part of the Project's Stage 1 environmental approvals, to help mitigate the potential mining impacts to significant species, a *Significant Species Management Plan – Corunna Downs* (hereafter referred to as the 2017 SSMP; Atlas Iron, 2017) was developed for several species previously recorded within the Stage 1 Project area. One species of particular focus of the SSMP previously recorded within the Project area is ghost bat (*Macroderma gigas)*, which is listed as Vulnerable under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and state *Biodiversity Conservation Act 2016* (BC Act).

Stage 2 of the Project comprises above water table mining of approximately 9.45 Mt of iron ore from the Glen Herring deposit located on an adjacent range 3 km west of Stage 1. It consists of three new pits, four waste rock dumps and a 4 km haul road connecting to Stage 1, where ore will be hauled for processing. Approval for the development of was granted on the 13 September 2022 (Ministerial Statement Number: 1197). As part of the conditions of the Stage 2 approval, an updated SSMP (hereafter referred to as the 2023 SSMP (Atlas Iron, 2023) was developed to include the Stage 2 Project area. This 2023 SSMP was approved on 1 August 2023. The 2017 SSMP applies to Stage 1 operations and the 2023 SSMP applies to Stage 2 operations.

The SSMPs prescribe a monitoring program (including surveys conducted pre-mining (baseline), during mining and post-mining) – to assess the local ghost bat population for the life of the Project. A key objective of the program is to assess whether a performance objective outlined in the 2017 SSMP is being fulfilled (for roosts in the Stage 1 area), and whether trigger and threshold criteria outlined in the 2023 SSMP are being met (for roosts in the Stage 2 Project area) (Table 1.1).

Table 1.1: Relevant performance objectives under the SSMPs relating to ghost bat

Area	Performance Objective	Key Performance Indicator	Trigger criteria	Threshold criteria
		No ground disturbance within	-	-

Area	Performance Objective	Key Performance Indicator	Trigger criteria	Threshold criteria
Stage 1 roosts: CO-CA-01 CO-CA-03	*No unauthorised access to bat cave exclusion zones.*	*cave buffers (240 m for CO-CA-01 and 50 m for CO-CA-03).*		
		No incident reports of unauthorised access to cave buffers.	-	-
Stage 2 roosts: CO-CA-20 CO-CA-21 CO-CA-22 CO-CA-23 CO-CA-24	-	-	*Minor to moderate rockfall within cave such that the cave remains viable as ghost bat habitat in the future once mining has ceased.*	*Significant structural damage to cave that would prevent ongoing use by ghost bat as a diurnal roost.*
CO-CA-25 CO-CA-26 CO-CA-27 CO-CA-28 CO-CA-29	-	-	*Ground disturbance approaches within 10 m of exclusion areas around Stage 2 ghost bat caves.*	*Ground disturbance occurs within avoidance buffers around Stage 2 ghost bat caves.*

Annual monitoring has been undertaken since 2017 (Bat Call, 2021b; Biologic, 2019a, 2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2022a, 2022b, 2023a, 2024a, 2024b, in prep.-a, in prep.-b, in prep.-c; MWH, 2018a) Monitoring for the Stage 1 area primarily comprises a short-term monitoring period with data collected in the middle of the year via field survey. While monitoring for the Stage 2 area similarly involves a short-term monitoring period associated with the same field survey, selected sites within the Stage 2 area are also monitored continuously.

In April 2024, Atlas commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake the seventh annual monitoring survey of ghost bat for the Stage 1 area and the third annual monitoring survey of ghost bat for the Stage 2 area. Both areas are collectively referred to as the Study Area (Figure 1.1). For the Stage 1 area, the current survey represents the third annual survey since mining development commenced there. While development of the of the Stage 2 area is underway (with the construction of tracks and haul roads), no blasting or ore extraction activities occurred in the area prior to or during the current reporting period. This report documents the outcomes of this latest survey.

1.2 Scope and Objectives

The overarching aims of the current 2024 monitoring program were to:

- Revisit 19 previously established monitoring sites and describe the way in which ghost bats are using the sites.
- Compare ghost bat activity data from the current monitoring period to those recorded during previous monitoring years.
- Interpret changes in the ghost bat activity between monitoring surveys considering Project development, habitat disturbance from natural events (e.g. fire) and natural fluctuations in the species' distribution, abundance and activity.
- Gather temperature and humidity data to understand the microclimate of the monitoring sites and detect whether cave microclimates change.
- Interpret changes in cave microclimate considering Project development and natural fluctuation in response to climatic factors.

1.3 Compliance

The monitoring was carried out in accordance with methods prescribed by the SSMPs, following guidelines and recommendations developed by the relevant state and federal regulatory bodies, including:

- Atlas Iron (2017) Significant species management plan – Corunna Downs.
- Atlas Iron (2022) Significant species management plan – Sanjiv Ridge.
- Bat Call (2021a) A review of ghost bat ecology, threats and survey requirements.
- DEWHA (2010) EPBC Act survey guidelines for Australia's threatened bats.
- EPA (2020) Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment.

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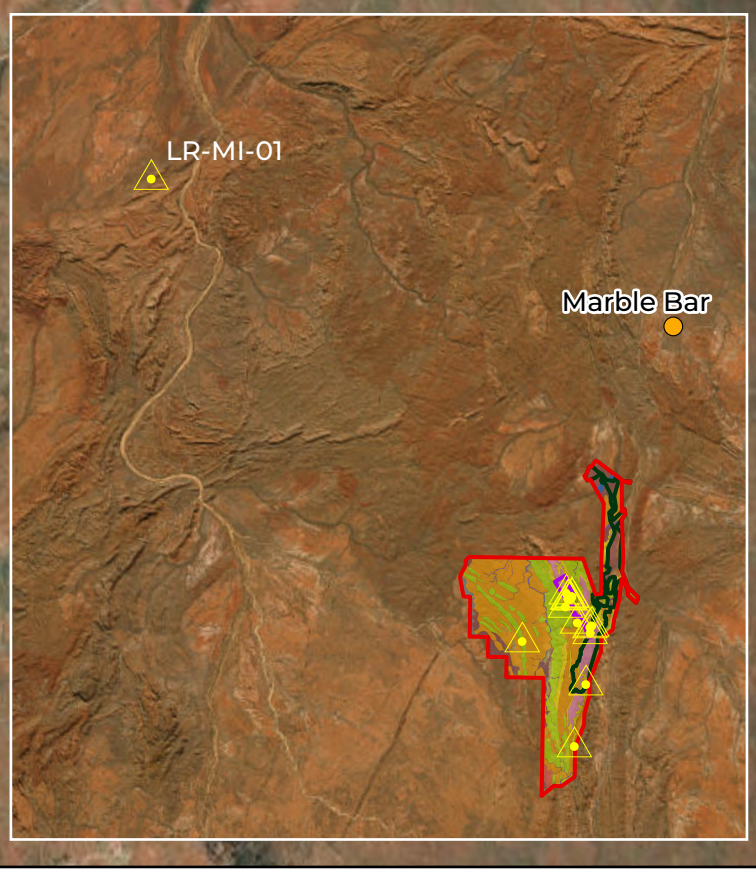


LEGEND

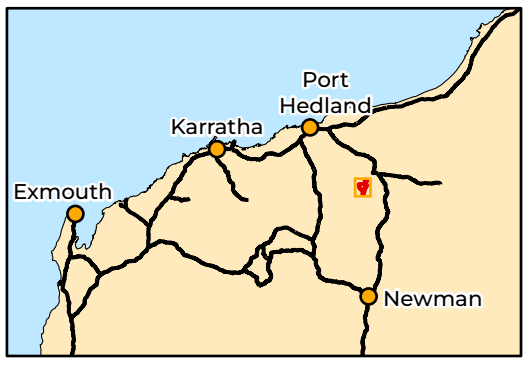
- Study Area
- Development Envelope - Stage 1
- Development Envelope - Stage 2
- Monitoring Site

Fauna Habitat

- Calcrete
- Drainage Line
- Granite Outcrop
- Granitic Upland
- Ironstone Ridgetop
- Riverine
- Rocky Foothill
- Rocky Ridge and Gorge
- Sandy Plain
- Spinifex Stony Plain
- Stony Rise

Scale 1:110,000
0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 23/01/2025



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Sanjiv Ridge Ghost Bat Monitoring 2024

Figure 1.1: Study Area and monitoring sites

1.4 Ghost Bat

1.4.1 Species Information

The ghost bat is listed as Vulnerable under the federal EPBC Act and the Western Australian BC Act The distribution of the ghost bat is restricted to geographically discontinuous populations across northern Australia; these populations are highly structured, and genetically distinct at both regional and local scales (Worthington-Wilmer *et al.*, 1994). In Western Australia, the Pilbara population is located at the southern limit of the species' range and is geographically isolated from the Kimberley population (van Dyck & Strahan, 2008) by a distance of approximately 600 km. The Pilbara population is estimated to comprise 1,850 individuals (Bat Call, 2021a).

Roost sites include caves, rock crevices and disused mine adits (Bat Call, 2021a), with stable temperatures of around 28°C (Baudinette *et al.*, 2000). While ghost bats use caves with varying levels of relative humidity (14–84%), humid caves are typically used for rearing young (Armstrong & Anstee, 2000). However, the degree to which the species requires this is relatively unknown, thus temperature is considered more important than humidity when assessing roost suitability (Armstrong & Anstee, 2000; Baudinette *et al.*, 2000; TSSC, 2016a).The largest colonies known to occur in the Pilbara are in disused mines (e.g. 500+ individuals at Lalla Rookh) while natural caves typically support up to ten individuals (Bat Call, 2021a; Cramer *et al.*, 2022; TSSC, 2016a). Natural roosts generally comprise deep, complex caves beneath bluffs or low rounded hills composed of Marra Mamba or Brockman Iron Formation (Armstrong & Anstee, 2000) and Robe Pisolite channel iron deposit geology (Bat Call, 2021a).

Ghost bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass on sand or stony ground (Bat Call, 2021a). The time spent outside the roost varies from under half of the night to the full period of darkness (Bullen *et al.*, 2023). Ghost bats have a 'sit and inspect' foraging strategy where they hang from a perch and, once their prey is detected, they drop on it or capture it in the air or glean it from the ground/ vegetation (Boles, 1999a). Preferred perches include isolated trees and trees on the edge of thin thickets on plains, or trees along the edges of watercourse woodlands (Bat Call, 2021a). Ghost bats are known to consume large insects, frogs, lizards, birds, small mammals and other bats (Boles, 1999b; Richards *et al.*, 2008a; Start *et al.*, 2019). Ghost bat diet in the Pilbara consists mainly of small mammal and bird species, and to a lesser extent, reptiles and amphibians (Claramunt *et al.*, 2018).

Ghost bats move between caves seasonally, or as dictated by weather conditions, so require a range of cave sites (Hutson *et al.*, 2001). In the Pilbara, mating typically occurs in July and August, with the females giving birth approximately three months later, in late October or early November (Cramer *et al.*, 2022; Richards *et al.*, 2008b). Outside of the breeding season,

male bats are known to disperse widely (100+ kilometres), especially during the wet season (Ottewell *et al.*, 2017; Worthington-Wilmer *et al.*, 1994). Females are more likely to stay close to, or return for breeding to, the maternity roosts from which they originated (Worthington-Wilmer *et al.*, 1994). Bullen *et al.* (2023) found that ghost bats forage up to 17.7 km from their diurnal roost in the Pilbara (compared with 12 km at Mount Etna in Queensland (Augusteyn *et al.*, 2018).

The most severe threats to the species are the destruction and disturbance of roosting (i.e. caves) and foraging habitat due to mining operations and poisoning by cane toads (Cramer *et al.*, 2022; TSSC, 2016a). Presently, there is no recovery plan for the species.

1.4.2 Classification of Roost Type

The importance of a roost site to ghost bat can be classified into four categories, as defined by Bat Call (2021a) (Table 1.2). Assessment of roost classification is informed by roost structure, timing of calls and signs of use:

- *Roost structure*: Ghost bats appear to prefer deep, complex caves with narrow entrances that open into domed chambers in which warm temperatures and moderate/ high levels of humidity are maintained (Armstrong & Anstee, 2000). Caves of this nature are more likely to be used as diurnal roosts and maternity roosts than smaller, simpler caves.
- *Timing of calls*: The timing of calls recorded at a given site may reveal whether individuals used the site as a nocturnal roost or a diurnal roost. Calls recorded immediately after sunset (i.e. when ghost bats typically depart roosts to commence foraging) are presumed to be indicative of individuals roosting diurnally, and calls recorded soon before sunrise are presumed to be by individuals entering to roost diurnally. Calls throughout the night are presumed to be individuals foraging or nocturnally roosting, however, individuals may return at any time throughout the night and not depart again.
- *Signs of use:* High levels of use of a given site, as evidenced by high volumes of scats observed on initial visits to a site, and/or high rates of scat deposition across a period of monitoring, suggest that the site is being occupied for longer periods than nocturnal visitations would allow, thereby suggesting that it is being used as a diurnal roost or possibly as a maternity roost.

Table 1.2: Roost categories for ghost bat

Category	Description	Typical features	Importance to ghost bat
Category 1	Maternity/ diurnal roost sites with year-round occupancy	Deep, dark caves with at least one roosting chamber behind a narrow entrance or in-cave constriction, a ceiling over 1.5 m in height, steady microclimate, and substantial evidence of previous occupation by ghost bat (e.g. extensive scat pile).	Critical habitat important for the ongoing presence of ghost bat in an area.
Category 2	Maternity/ diurnal roost sites with regular occupancy	These sites are similar to Category 1 sites but are usually less complex (e.g. may only contain a single chamber) and/or located in less productive areas which may only periodically attract ghost bats.	Critical habitat important for the ongoing presence of ghost bat in an area.
Category 3	Diurnal roost sites with occasional occupancy	Simple caves where one to a few ghost bats roost occasionally, or rarely. Roosting locations are not necessarily dark.	Category 3 caves which are located adjacent to Category 1 or Category 2 caves are considered critical habitat important for the ongoing presence of ghost bats in the area. While isolated Category 3 caves are not considered critical habitat essential to the long-term viability of a population, such caves may play an important role in facilitating genetic exchange between neighboring colonies by enabling the long-distance movement of individuals.
Category 4	Nocturnal roost sites with opportunistic usage	Shallow caves and deep overhangs which may be visited during the night during foraging activity, but are unlikely to support diurnal roosting (e.g. roosting locations are exposed)	Not considered critical habitat for ghost bat.

Adapted from Bat Call (2021a)

1.4.3 Previous Records

Within the Study Area, comprising Stage 1 and Stage 2 areas, there are 42 known caves, of which 18 are monitored (not including LR-MI-01) (Table 1.3). Ghost bat was recorded in the Sanjiv Ridge area during a detailed baseline survey conducted in 2014 and 2016 (MWH, 2018b) and monitoring of the species has subsequently been undertaken annually in the Stage 1 area since 2017 (Biologic, 2019a, 2021a, 2021b, 2021e, 2022a, 2023b, 2024b; MWH, 2018a). In May 2020, ghost bat was recorded in the Stage 2 area during a targeted significant species survey (Biologic, 2021c). In January 2021, the first baseline monitoring survey was undertaken of the known caves within the Stage 2 Project Area and a targeted regional survey was undertaken to gain an understanding of ghost bat occupation in the surrounding area (Biologic, 2021e).

Table 1.3: Number of ghost bat roost types within the Study Area

Stage	Habitat Value to and Use by Ghost Bat	Total
Stage 1	Potential night roost	7
	Night roost	3
	Day roost	2
Stage 2	Potential day roost	4
	Day roost	3
	Day roost	2
	Night roost	1
	Potential maternity roost	1
Outside Stage 1 and Stage 2 Development Envelope	Potential night roost	6
	Day roost	5
	Night roost	5
	Potential maternity roost	2
	Potential day roost	1

Ghost bats were previously recorded in the Sanjiv Ridge area (formerly Corunna Downs) during detailed baseline surveys conducted in 2014 and 2016. These surveys identified 19 roosts within the Study Area and were classified across four categories (MWH, 2018a). Of these, 17 roosts are actively monitored in accordance with the SSMP (Atlas Iron, 2022, 2023).

Annual monitoring of ghost bat populations in the Stage 1 area began in 2017 (MWH, 2018a) with subsequent monitoring undertaken by Biologic (Biologic, 2019a, 2021a, 2021b, 2021e, 2022a, 2022c, 2023a, 2024b). In May 2020, targeted surveys recorded ghost bats in the Stage 2 area (Biologic, 2022c). In January 2021, a baseline monitoring survey was undertaken for known caves within the Stage 2 area, alongside a targeted regional survey to better understand ghost bat occupation across the broader landscape (Biologic, 2021d). These monitoring sites are outlined in *Section 2.3*.

2 Methods

2.1 Survey

The field survey was conducted over 11 days from 15–25 July 2024. Similar to previous annual surveys since 2017. This period coincides with the start of the ghost bat mating season, when males are likely to be pursuing breeding partners and when pregnant females may be beginning to congregate in maternity roosts in advance of birthing (TSSC, 2016b).

2.2 Climate and Weather

The Bureau of Meteorology (BoM) weather station located at Marble Bar (station 004106), approximately 25 km north-northeast of the Study Area, provides comprehensive climate data relevant to the Study Area (BoM, 2024). Rainfall recorded at Marble Bar was lower than the long-term monthly average for ten of the 12 months preceding the survey (Figure 2.1). Although higher than average rainfall was recorded in March 2024 (when 171 mm was recorded versus a long-term average of 79 mm) and June 2024 (when 31 mm was recorded versus a long-term average of 22 mm), the total rainfall in the 12 months preceding the survey (288mm) was well below the long-term average (391 mm). No rainfall was recorded during the survey or for the month of July.

For ten of the 12 months preceding the survey, mean maximum temperatures recorded at Marble Bar were above the long-term average (Figure 2.1). Mean minimum temperatures during this period were more closely aligned with the long-term average (Figure 2.1). Average minimum and maximum temperatures recorded during the survey period (13.1°C and 28.2°C, respectively) were slightly warmer than long-term average minimum and maximum temperatures for July (12.2°C and 27.7°C, respectively) (Table 2.1).

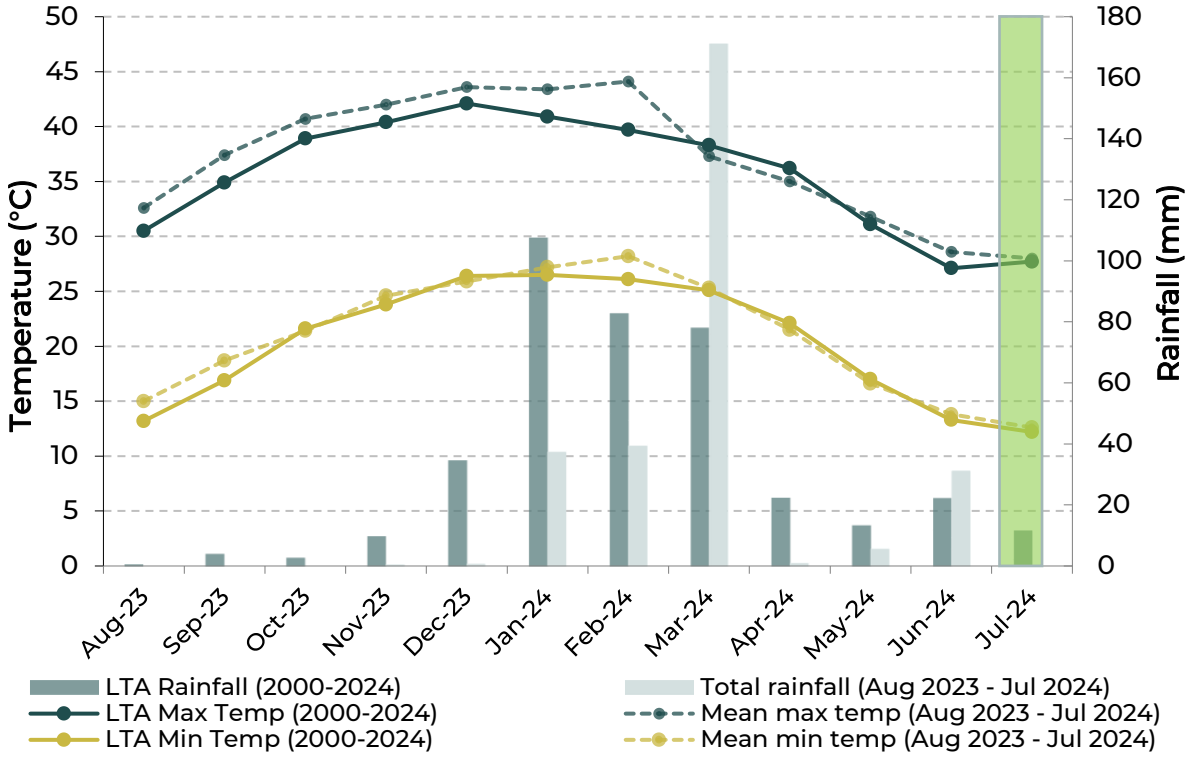

Figure 2.1: Climate data recorded at BOM Marble Bar station.

Source:. (BoM, 2024)Field survey period indicated by green shaded box.

Table 2.1: Daily weather data recorded at Marble Bar during the field survey.

Date	Temperature (°C)		Rainfall (mm)	Humidity (%)		Civil twilight	
	Min	Max		0900	1500	Dusk	Dawn
15/07/2024	11.9	30.2	0.0	32.0	21.0	1800	0615
16/07/2024	15.8	27.7	0.0	22.0	13.0	1800	0614
17/07/2024	14.0	27.5	0.0	25.0	18.0	1801	0614
18/07/2024	-	29.5	0.0	23.0	16.0	1801	0614
19/07/2024	13.4	27.9	0.0	64.0	36.0	1801	0614
20/07/2024	17.4	26.9	0.0	26.0	22.0	1802	0614
21/07/2024	11.9	26.9	0.0	23.0	15.0	1802	0613
22/07/2024	10.9	29.8	0.0	26.0	13.0	1802	0613
23/07/2024	9.7	29.9	0.0	27.0	11.0	1803	0613
24/07/2024	12.3	28.2	0.0	57.0	28.0	1803	0612
25/07/2024	13.4	25.2	0.0	33.0	24.0	1803	0612
Average	**13.1**	**28.2**	**0.0**	**32.5**	**19.7**	**1801**	**0613**

Source: (BoM, 2024)

2.3 Monitoring Sites

The monitoring program incorporates 19 monitoring sites, comprising 15 Impact sites located within 1 km of the Project's indicative disturbance footprint and four Control sites located more than 1 km from the indicative disturbance footprint (Figure 1.1). These sites include diurnal roosts and nocturnal roosts (Table 2.2).

Table 2.2: Monitoring site details

Site ID	Latitude	Longitude	Habitat type	[1]Distance from development envelope (m)	[1]Distance from indicative disturbance footprint (m)	History
Impact sites – Stage 1						
CO-CA-01	-21.4200	119.6738	Gorge/ Gully	350	350	Identified and described in March 2014 ((Outback Ecology, 2014)) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023((Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a)) monitoring surveys
CO-CA-03	-21.4678	119.6711	Gorge/ Gully	within	within	Identified and described in March 2014 ((Outback Ecology, 2014)) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023((Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a)) monitoring surveys
CO-CA-05	-21.4247	119.6742	Gorge/ Gully	within	148	Identified and described in September 2016 (MWH, 2016) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023((Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2016, 2018a)) monitoring surveys
CO-CA-10	-21.4187	119.6755	Gorge/ Gully	150	276	Identified and described in September 2016 (MWH, 2016) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2016, 2018a) monitoring surveys
Impact sites – Stage 2						
CO-CA-20	-21.3971	119.6559	Gorge/ Gully	within	50	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b,

Site ID	Latitude	Longitude	Habitat type	[1]Distance from development envelope (m)	[1]Distance from indicative disturbance footprint (m)	History
						2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-21	-21.4160	119.6620	Gorge/ Gully	within	22	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-22	-21.3921	119.6524	Rocky Hill	within	28	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-23	-21.3964	119.6540	Hillcrest/ Hillslope	within	22	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-24	-21.3966	119.6539	Gorge/ Gully	within	13	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-25	-21.3961	119.6536	Breakaway/ cliff	within	16	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023 (Biologic, 2019a, 2020, 2021a, 2021b,
CO-CA-26	-21.3957	119.6536	Hillcrest/ Hillslope	within	21	
CO-CA-27	-21.3945	119.6569	Hillcrest/ Hillslope	within	177	

Site ID	Latitude	Longitude	Habitat type	[1]Distance from development envelope (m)	[1]Distance from indicative disturbance footprint (m)	History
						2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-28	-21.3950	119.6571	Gorge/ Gully	within	169	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-29	-21.3949	119.6572	Gorge/ Gully	within	179	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-30	-21.4032	119.6518	Hillcrest/ Hillslope	280	330	Identified and described during survey work across 2019, 2020 and 2021 (Biologic, 2021e, 2022a, 2022b, 2023a, 2024b). Assessed during the 2021, 2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
Control sites						
CO-CA-18	-21.3503	119.6162	Gorge/ Gully	4.78km	4.87km	Identified and described in September 2016 (MWH, 2016) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023 (Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-33	-21.5197	119.6611	Hillcrest/ Hillslope	4.65km	4.82km	Identified and described in September 2016 (MWH, 2016) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023 (Biologic, 2019a, 2020,

Site ID	Latitude	Longitude	Habitat type	[1]Distance from development envelope (m)	[1]Distance from indicative disturbance footprint (m)	History
						2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
CO-CA-35	-21.4326	119.6135	Hillcrest/ Hillslope	5.18km	5.23km	Identified and described in September 2016 (MWH, 2016) Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023(Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a) monitoring surveys
LR-MI-01	-21.0509	119.2765	Stony Plain	48.73km	49.03km	Known ghost bat maternity roost. Assessed during the 2017, 2018, 2019, 2020, 2021,2022 and 2023((Biologic, 2019a, 2020, 2021a, 2021b, 2022a, 2022b, 2023a, 2024b; MWH, 2018a)) monitoring surveys

[1]Distance is measured from the entrance of the site. The internal space of each site may extend closer to the development envelope and indicative disturbance footprint boundaries than suggested by these measurements.

2.4 Survey Methods

2.4.1 Site Visitations

Nineteen monitoring sites were visited during the field survey, 15 of these were entered. Prior to entering the sites, a safety assessment was conducted to identify any hazards which threaten the safety of those entering. If the site was deemed safe to enter, only one person entered at any time. The other person remained outside the entrance to monitor the safety of the person inside the site, and to identify and count any bats which were flushed. If ghost bat individuals or their scats were identified scat collection sheets were inspected and ultrasonic and microclimate data to be retrieved (Table 2.3).

Table 2.3: Summary of methods employed at each site.

Site ID	Visited and assessed for signs of ghost bat presence	Scat collection sheets	Ultrasonic sound recording	Microclimate monitoring
Impact				
CO-CA-01	Yes	Yes	Short term	Short term
CO-CA-03	Yes	Yes	Short term	Short term
CO-CA-05	Yes	Yes	Short term	Short term
CO-CA-10	Yes	Yes	Short term	Short term
CO-CA-20	Yes	Yes	Short term	Short term / continuous[2]
CO-CA-21	Yes	Nil	Short term	Short term / continuous[2]
CO-CA-22	Yes	Yes	Short term / continuous	Short term / continuous[2]
CO-CA-23	Yes	Yes	Short term	Short term / continuous[2]
CO-CA-24	Yes	Yes	Short term / continuous	Short term / continuous[2]
CO-CA-25	Yes	Yes	Short term	Short term / continuous[2]
CO-CA-26	Yes	Yes	Short term	Short term / continuous[2]
CO-CA-27	Yes	Yes	Short term / continuous	Short term / continuous
CO-CA-28	Yes	Yes	N/A	Continuous
CO-CA-29	Yes	Yes	N/A	Continuous
CO-CA-30	Yes	Yes	Short term / continuous	Short term / continuous
Control				
CO-CA-18	Yes	Nil	Short term	Short term

Site ID	Visited and assessed for signs of ghost bat presence	Scat collection sheets	Ultrasonic sound recording	Microclimate monitoring
CO-CA-33	Yes	Yes	Short term / continuous	Short term / continuous
CO-CA-35	Yes	Nil	Short term / continuous	N/A
LR-MI-01	Yes	Nil	Short term	N/A

2.4.2 Habitat and Disturbance Monitoring

During previous visits to each monitoring site by Biologic, an assessment was conducted to document the site's physical characteristics and potential importance to ghost bat. Specifically, the following parameters were described:

- Entrance location and photograph.
- Entrance shape, dimensions, position in the landscape, aspect and level of exposure to daylight.
- Internal structure and dimensions including depth, floor slope, number and size of chambers.
- Presence of water either within the cave or near its entrance.

These assessments were reviewed during the current survey to identify changes in the condition of the sites which might influence ghost bat activity. To provide a pictorial record of any habitat changes, photo monitoring was conducted, whereby photos were taken from monitoring points which had been previously established at each site. The points were positioned to cover either the cave's entrance or the habitat surrounding the site. Owing to the proximity of some sites to one another, a single landscape photo was taken to encapsulate both sites within the context of the surrounding habitat. It is anticipated that similarly framed photos will be taken in subsequent years. Any documented habitat changes, which may include changes caused by natural events such as fire, or by anthropological disturbance such as mining activity, may help to explain patterns in the activity of ghost bats recorded at the sites.

2.4.3 Microclimate

Permanent ghost bat roosts generally have stable temperatures between 23–28°C (TSSC, 2016a) with ghost bats showing a preference of around 28°C (25–31°C) for the optimal maintenance of body temperature (Bat Call, 2021a; Baudinette *et al.*, 2000). Relative humidity for ghost bat roosts ranging from 50–100% is considered preferred (Armstrong & Anstee,

2000); however, the degree to which the species requires this is relatively unknown (Baudinette *et al.*, 2000; Cramer *et al.*, 2022). Although the species may also select roost sites based on humidity, the range of humidity levels recorded at sites used by the species varies widely (e.g. from 14–84%); thus, temperature is considered more important than humidity when assessing roost suitability (Armstrong & Anstee, 2000). Disturbance to roost sites (such as from mining activity) has the potential to impact the internal microclimate of the roosts, thereby affecting their suitability for ghost bats.

Short-term microclimate data (collected across a seven-night sampling period during the field survey) were collected from 15 sites. The microclimate of the monitoring sites was assessed via the deployment of loggers which record temperature and humidity. Devices used to collect microclimate data included:

- HOBO MX2301A devices (MX2301A). These are portable, battery-powered devices from which data can be collected via a Bluetooth connection between the device and a mobile device.
- HOBO H21-USB MicroStation devices (H21-USB). These consist of a temperature and humidity probe installed inside the given cave and attached via a cable to a MicroStation unit located outside the cave. Data can be collected via USB connection between the MicroStation and a laptop.
- EWS remote access systems (EWS). These consist of a HMP60 Vaisala Intercap Humidity and Temperature Probe installed inside the given cave and attached via a cable to an EWS Switch Data Logger (EWS Switch) located outside the cave. An EWS Switch is a solar-powered multi-communications transmitter that utilises either (and can be switched between) satellite or cellular connection for transmission of microclimate data to a web portal, allowing data to be accessed remotely via a web portal.

Microclimate loggers were set to record temperature (°C) and relative humidity (%) every three hours at fixed intervals: 12:00am, 3:00am, 6:00am, 9:00am, 12:00pm, 3:00pm, 6:00pm, and 9:00pm. Loggers were programmed to record data over seven days, although no data were recorded from the EWS system at CO-CA-01 due to technical issues. Loggers were placed in consistent locations within the caves, mirroring previous monitoring surveys.

Microclimate data were not collected from two inaccessible sites (LR-MI-01 and CO-CA-35). Additionally, microclimate data were continuously recorded at site CO-CA-44, located outside the caves, using an MX2301A device. This device documents atmospheric conditions, providing control data to compare with cave microclimates and helping to identify whether observed changes reflect natural weather fluctuations or other factors. To protect the logger

from heat generated by direct sunlight or surrounding environments, it was installed within a solar shield.

2.4.4 Ultrasonic Recording

SongMeter ultrasonic sound recorders (SMs; Wildlife Acoustics, USA) fitted with external, SMX-US ultrasonic microphones were used to quantify the level of ghost bat activity. Short-term call data (collected during the field survey with the aim of recording data across a minimum of seven consecutive nights) were collected from 18 sites. For five sites within the Stage 2 area, call data are recorded continuously via previously installed solar-powered SM systems. Microphones were placed at similar locations within the caves as they were during the previous monitoring surveys, just inside each site's entrance (or adjacent to the entrance in the case of VLRM-02) with the microphone directed across the entrance to cover the likely bat flyway. All SMs were preconfigured to activate at astronomical sunset each day and deactivate at astronomical sunrise the following morning. Audio settings permitted detection of both echolocation and social calls of the ghost bat.

Recordings were analysed by Mr Robert Bullen of Bat Call WA. using standardised techniques. The total number of calls and the time of the first and last call for each sampling night were recorded. A sampling night was from sunset to sunrise the following day. When multiple calls were recorded simultaneously, or when calling was constantly occurring during a sampling night, the number of calls were not counted, with a note of 'multiple calls' being recorded instead.

The timing of calls recorded at a given site may reveal whether individuals used the site as a nocturnal roost (i.e. visited briefly during the night during foraging or dispersal activity) or a diurnal roost. Calls recorded immediately after sunset (i.e. when ghost bats typically depart roosts to commence foraging) are presumed to be by individuals who roosted in the site during the day, while calls recorded soon before sunrise are presumed to be by individuals returning to the roost after a night of foraging. Following Bat Call W.A.'s analysis methodology, diurnal roosting is considered to be occurring when the last call during the previous recording night occurred after dawn or less than 10 minutes before dawn; or when the first call during the current monitoring night was within less than 10 minutes of dusk. Where diurnal roosts are located near sites identified as nocturnal roosts, any indications of diurnal roosting at sites identified as nocturnal roosts based on these criteria should be treated cautiously, as individuals responsible for close-to-dawn-and-dusk calls may travel to a nearby diurnal roost within a short period.

As ghost bats may emit multiple calls while using a site, recorded calls were used to indicate the presence of ghost bats rather the number of individuals which might be present. Quiet calls may be difficult to distinguish from other noise or the calls of other bat species, and a

ghost bat may use a site without calling at all (instead navigating by sight alone); thus, an absence of calls does not always indicate an absence of ghost bats.

2.4.5 Scat Deposition

Scat collection sheets previously installed in 15 of the 19 sites were assessed for the presence of ghost bat scats (Table 2.3). The sheets were installed on the floor of each site below sections of ceiling which were considered likely to support roosting by ghost bats. To assist in determining the level of visitation by ghost bat between monitoring events, the number of scats collected on these sheets were counted and the sheets cleared of scats in preparation for subsequent visits.

2.5 Personnel and Licensing

The field survey was undertaken by Biologic personnel Mark Gresser (Senior Zoologist), Aidan Williams (Senior Zoologist), Georgina Mattner (Zoologist), Stephen McGrath (Zoologist) and John Radford (Zoologist), under a WA Department of Biodiversity, Conservation and Attractions: a Regulation 27 licence for fauna taking (BA27000450-2b) and a Section 40 authorisation to take or disturb threatened fauna (TFA 2021-0065-2) issued to Chris Knuckey.

The survey was conducted under the *Animal Welfare Act 2002* Licence to Use Animals for Scientific Purposes (License No. U244/2022-2024), administered through the Department of Primary Industries and Regional Development (DPIRD). This licence is enabled through Biologic's chosen Animal Ethics Committee (AEC), Murdoch University, under permit RW3354/21.

3 Results and Discussion

3.1 Habitat and Disturbance Monitoring

In November 2023, construction of a haul road associated with Stage 2 development commenced approximately 560 m west of CO-CA-01 and approximately 80 m east of CO-CA-21. By May 2024 the haul road had passed within approximately 40 m of CO-CA-21 and approximately 360 m of CO-CA-30 and reached the Stage 2 area near the Glen Herring Pit. As of August 2024, earthworks associated with the Glen Herring Pit encroached to within approximately 70 m of CO-CA-20, approximately 35 m of CO-CA-24, approximately 26 m of CO-CA-25 and approximately 30 m of CO-CA-26 (Table 3.1; Figure 3.1; Appendix A).

Additionally, areas burned by a wildfire on 16 December 2022 in and around the Stage 2 area appear to be in a natural state of regrowth Between the 2023 and the current monitoring period mining was active at three open pits associated with the Stage 1 area (Sparrow Lake, [formerly Split Rock], Shark Gully, and Runway South). Construction of a new pit in the Stage 1 area (Razorback) commenced in December 2023, these works occurred approximately 145 m west of CO-CA-03 and continued to be developed to June 2024 encroaching to within approximately 120 m. These works did not encroach any closer to CO-CA-01 (Table 3.1; Figure 3.1; Appendix A).

Previous disturbance at the Stage 1 area (prior to 2020) comprised small areas of clearing from exploration and historical mining activities, and general degradation due to pastoralism (Biologic, 2019b, 2019c). Clearing for mine development and construction begun in 2020 with ore extraction commencing in 2021 (Biologic, 2021b, 2022a). A large wildfire occurred in December of 2022 and affected a large proportion of the Study Area (Biologic, 2023a) and further ore extraction and processing continued between the 2022 and 2023 monitoring periods.

Table 3.1: Monitoring site habitat attributes and current 2024 disturbance information

Site ID	Description	2024
Impact		
CO-CA-01	Cave located at top of rocky ridge face in rocky ridge and gorge habitat. A spring system is located ~40 m from the entrance. The cave contains two main chambers connected by a constriction.	Ore production activities associated with Runway South Pit within ~600 m to east.
CO-CA-03	Cave located at the bottom of a major gorge in rocky ridge and gorge habitat. The cave is located next to water seepage which feeds a water source at the cave entrance. The cave is characterised by two main chambers connected by a constriction.	Earthworks associated with the Razorback pit encroached to within ~120 m of CO-CA-03
CO-CA-05	Semi-exposed cavern. The entrance to the cave is 2.5 m wide and 1.5 m high. The cave comprises two chambers. The first chamber is ~4 m wide, ~1.5 m high and 10 m deep. The first chamber comes to a constriction (0.5 m high by ~0.5 m wide). The second chamber is low lying ~1.5 m high and 10 m deep. The width of the cave is difficult to determine accurately, and the low-lying roof prevents access to some section of the second chamber.	Haul road activities continued within ~191 m to east. Ore production activities associated with Runway North Pit continued within ~350 m to east. Ore production activities associated with Runway South Pit continued within ~513 m to south-east.
CO-CA-10	Semi-exposed cavern. The entrance to the cave is 1 m wide and 1 m high. Cave comprises one main chamber. The cave spans to a depth of ~8 m and the height of the highest chamber is ~2 m.	Ore production activities associated with Runway North Pit continued within ~294 m to east. Haul road activities continued within ~310 m to east. Ore production activities associated with Runway South Pit continued within ~470 m to south-east.
CO-CA-20	Sheltered vertical cavity measuring ~1 m high and 1 m wide. Cave is ~1.6 m high and extends ~10 m deep. There is a small (and thus inaccessible) cavity toward the back left of the cave that may open into a second camber. The characteristic of this potential chamber is unknown. Noticeable change in microclimate when entering cave.	Earthworks associated with the Glen Herring pit encroached to within ~70 m of CO-CA-20
CO-CA-21	Semi-exposed cavern. The entrance to the cave is 2.5 m wide and 1 m high. The cave comprises two chambers. The cave spans to a depth of ~10 m and the height of the highest chamber is 1 m. The full extent of cave not accessible for assessment.	Earthworks associated with the Glen Herring pit encroached to within ~40 m of CO-CA-21
CO-CA-22	Sheltered cavity (~0.5m wide by ~0.5 m high). Cave comprises one main chamber and two smaller chambers. The cave spans to a depth of ~12 m and the height of the highest chamber is ~2 m.	Development activities occurred to within 35 m of site (12 June 2022) [1]
CO-CA-23	Semi-exposed cavity with small entrance (~0.5 m high by ~1 m wide). Cave extends to a depth of ~10 m deep with a single ~1.5 m high chamber. A very hot and humid cave (floor is damp toward the rear. Small low pipe cavity on the middle-left hand side of the cave (too small to access).	Development activities associated with the Glen Herring pit continued but did not encroach closer to site Development activities occurred to within 40 m of site (12 June 2022) [1]

Site ID	Description	2024
CO-CA-24	Semi-exposed overhang (~4 m high by ~4 m) sheltering a round cavity (~0.5 m high by 1 m wide). Cavity extends to a depth of ~6 m with a single ~3 m high chamber.	Earthworks associated with the Glen Herring pit encroached to within ~35 m east of CO-CA-24
CO-CA-25	Sheltered vertical cavity (~1 m high and ~0.5 m wide). Cave extends to a depth of ~7 m deep with a single ~4 m high chamber.	Earthworks associated with the Glen Herring pit encroached to within ~26 m east of CO-CA-25
CO-CA-26	Exposed cavity (~1.5 m high and ~2 m wide). Cavity extended to a depth of ~5 m and comprised a single chamber ~3.5 m high. A couple of solution pipes were observed (one had a small crack through which some light was observed).	Earthworks associated with the Glen Herring pit encroached to within ~30 m east of CO-CA-26
CO-CA-27	Semi-exposed overhang (~2 m high and ~4 m wide). Overhang extends to a depth of ~8 m. A solution pipe represents the highest point within the overhang and is ~5 m high.	Development activities continued within ~120 m south-west of site (12 June 2022) [1]
CO-CA-28	Semi-exposed overhang (~2 m high and ~5 m wide). Overhang extends to a depth of ~2 m. The highest point within the overhang and is ~2 m high.	Drilling within 115 m
CO-CA-29	Semi-exposed overhang (~1 m high and ~10 m wide). Overhang extends to a depth of ~5 m. The highest point within the overhang and is ~2 m high.	Drilling within 135 m
CO-CA-30	Semi-exposed (~1.5 m wide and 0.75m high) cavity. Head backward and to the right toward a narrow step-up opening. A secondary step-up leads onto a chamber with a sloping floor ad low ceiling (~1 m) all the way to the back of the cave (~12 m deep).	Earthworks associated with the Glen Herring pit encroached to within ~360 m east of CO-CA-30
Control		
CO-CA-18	Semi-exposed overhang. Entrance spans 6 m wide by 0.5 m high. The overhang extends backward to a depth of ~5 m. The highest point within the overhang is ~2 m.	No disturbances recorded
CO-CA-33	Semi-exposed overhang entrance with horizontal opening of ~4 m with and ~0.75 m height. The overhang extends backward toward a constriction. This constriction opens into a chamber ~3 m in height. The total depth of the cave is ~20 m.	No disturbances recorded
CO-CA-35	Mine shaft (Mt Ada) with a vertical entrance (~2 m wide and ~5 m high). The depth of the mine shaft is unknown as the mine shaft cannot be safely accessed. Numerous holes extending downward in front of and within the entrance (depth unknown).	No disturbances recorded
LR-MI-01	Abandoned mine adit in undulating grassland plain at the base of a large ironstone ridge system. Old vertical mine adit in plains serves as entrance to roost.	No disturbances recorded

[1] This disturbance was not described in 2022 as it was not depicted in spatial data provided to Biologic at the time of reporting (Biologic, 2022b); consequently, this represents updated information about the disturbance between the 2021 and 2022 monitoring periods.

760000
770000
780000
7640000
7630000
7620000

CO-CA-22
CO-CA-27
CO-CA-29
CO-CA-25
CO-CA-23
CO-CA-24
CO-CA-20

CO-CA-10
CO-CA-01
CO-CA-05

LR-MI-01
Marble Bar

CO-CA-22
CO-CA-27
CO-CA-25
CO-CA-29
CO-CA-20
CO-CA-30
CO-CA-21
CO-CA-10
CO-CA-01
CO-CA-05
CO-CA-35
CO-CA-03
CO-CA-33

LEGEND

- Study Area
- Development Envelope - Stage 1
- Development Envelope - Stage 2
- Monitoring Site
- Wildfire December 2022
- Disturbance at end of July 2023
- Disturbance at end of December 2023
- Disturbance at end of July 2024

Scale 1:110,000
0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 23/01/2025

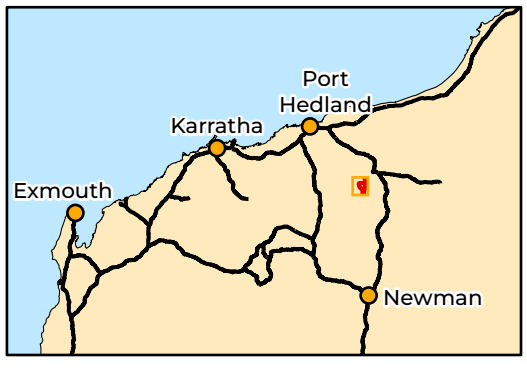

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Figure 3.1: Disturbance since the 2023 monitoring period

3.2 Microclimate

For the 15 sites where short-term (i.e. only over duration of field survey) microclimate is monitored, cave temperatures remained relatively stable, with most caves (except CO-CA-26 and CO-CA-27) recording temperatures approximating the preferred range for ghost bat (i.e. ~28°C) (Baudinette *et al.*, 2000) (Table 3.2). Average daytime temperatures ranged between 22.38°C at CO-CA-27 and 31.30°C at CO-CA-03 (Table 3.2). Diurnal roosting was recorded at sites where temperatures approximated the range preferred by ghost bats (i.e. around 28°C according to Baudinette *et al.* (2000)), roosting was also indicated at CO-CA-18, which exhibited temperatures below the preferred range for ghost bat (approximately 25°C average daytime and night-time temperature). Conversely, roosting was indicated at CO-CA-05 which recorded temperatures above the preferred range for ghost bat at around 29°C (Table 3.2). These data align with observations made by Baudinette *et al.* (2000), that while ghost bat prefer temperatures around 28°C for thermoregulation, they can demonstrate flexibility in their roost selection where necessary.

Overall, cave microclimates at both Control and Impact sites largely mirrored fluctuations in ambient conditions recorded outside CO-CA-44 (allowing for the buffering effect of the caves). As noted in section 1.4.1, ghost bats use caves with varying levels of relative humidity (14 to 84%), with humid caves are typically used for rearing young (Armstrong & Anstee, 2000). All caves monitored for microclimate were within these bounds for the duration of the survey and given the short sampling period, there was negligible variance from daytime to night-time (Table 3.2).

Table 3.2: Microclimate data summary

Site ID	Average daytime (0900–1800)		Average night-time (0900–1800)	
	Temperature (°C)	Relative Humidity (%)	Temperature (°C)	Relative Humidity (%)
[1]CO-CA-01	-	-	-	-
CO-CA-03	31.30	88.71	31.30	88.67
CO-CA-05	29.80	32.09	29.82	33.33
CO-CA-10	28.28	29.64	28.31	30.29
CO-CA-20	24.39	23.78	24.38	23.73
CO-CA-21	26.64	22.32	26.59	21.82
CO-CA-22	25.31	29.63	25.41	30.32
CO-CA-23	24.51	81.52	24.54	82.33
CO-CA-24	28.54	20.45	28.55	20.11
CO-CA-25	24.66	26.34	24.66	26.91
CO-CA-26	23.96	27.50	23.96	28.06
CO-CA-27	22.38	24.76	21.36	26.94

Site ID	Average daytime (0900–1800)		Average night-time (0900–1800)	
	Temperature (°C)	Relative Humidity (%)	Temperature (°C)	Relative Humidity (%)
CO-CA-30	27.31	67.02	27.34	66.94
CO-CA-18	25.38	28.41	25.41	28.82
CO-CA-33	29.98	66.92	29.99	66.93
CO-CA-44 (ambient)	23.51	31.37	17.84	41.92

[1]Technical issue with microclimate logger

3.3 Ultrasonic Recording

Ghost bat calls were recorded at 13 of the 18 sites during the annual survey. No calls were recorded at CO-CA-01, CO-CA-03, CO-CA-10, or CO-CA-21 (Table 3.3; Appendix D). Among the sites where calls were detected, the range of calls per night varied from zero to greater than 15. For part of the sampling call counts could not be determined due to overlapping calls (e.g. when multiple calls were recorded and it is difficult to distinguish individual calls), this suggests that actual call activity could be higher than indicated (Table 3.3; Appendix D).

Based on the timing of calls, diurnal roosting was indicated at five of the 18 sites across the seven nights of monitoring. Roosting was observed throughout the sampling period at CO-CA-05, CO-CA-33, CO-CA-35 and LR-MI-01. At CO-CA-18, roosting was indicated on most nights (five of the seven nights monitored).

When comparing similar category caves (i.e. those classified as critical roosts (Category 1 and 2)), Control caves CO-CA-33 and CO-CA-35 both Category 2 diurnal roosts (potential maternity roosts), diurnal roosting was indicated on every day sampled. Similarly, Impact cave CO-CA-05, a Category 2 diurnal roost, had diurnal roosting indicated across all sampling nights. In comparison, at Impact caves CO-CA-01 and CO-CA-03, both Category 2 diurnal roosts, there were no calls recorded and no indication of diurnal roosting during the survey. Similarly, at the Stage 2 area, Category 2 Impact caves CO-CA-22 and CO-CA-24 recorded calls on three of the seven nights sampled but again, there was no indication of diurnal roosting at these caves.

Notably, this is the first year of monitoring since 2018, where there have been no calls or diurnal roosting has been indicated at CO-CA-01. Similarly, at CO-CA-24, this is the first year since 2021 (the first year it was monitored) that there has been no indication of diurnal roosting at this cave. In addition to these two caves, this is the second year (2023 and 2024) where CO-CA-27 has not had any indication of diurnal roosting in comparison to the first two years of monitoring (2021 and 2022), where diurnal roosting was indicated on all seven nights in 2021 and five out of the eight nights monitored in 2022.

The results of the 2024 monitoring are not unexpected as ghost bats are dependent on productive foraging habitat across their range and cave usage can be sporadic. With the exception of CO-CA-01, CO-CA-24 and CO-CA-27, these data are consistent with results of previous survey work conducted in the Study Area (Table 3.3; Appendix D)(Biologic, 2019a, 2021a, 2022a, 2023a, 2024b).

Overall, any observed differences across monitoring periods and between Impact and Control sites are likely to be natural variation in cave usage, rather than directly attributable to mining activity. There have been no direct impacts to the caves affecting their structure, or suitability as roosts (see Section 3.1) and there have been similar results recorded before mining commenced in 2020. Moreover, some of the differences observed across monitoring years have only occurred across a single year in the case of CO-CA-01 and CO-CA-24, and across two years at CO-CA-27. More data in the coming years will be required to determine whether these differences represent a permanent change in the usage of these caves and therefore require a review of their current roost classifications.

Table 3.3: Ghost bat call records (short term monitoring)

Site ID	Year	Survey Dates	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Night 7	Night 8	Night 9	Night 10	Night 11	Sampling nights	Range of calls per night
Impact															
CO-CA-01	2018	9–19 July	•	R	R	•	R	R	R	-	-	-	-	7	1–18
	2019	19–30 July	R	R	R	R	R	R	R	-	-	-	-	7	9–38
	2020	18–30 June	R	R	R	R	R	R	R	R	-	-	-	8	*Multiple
	2021	5–16 July	-	R	R	R	R	R	R	R	-	-	-	7	*Multiple
	2022	29 August – 8 September	R	R	R	R	R	R	R	R	R	-	-	9	*Multiple
	2023	26 June – 6 July	R	R	R	R	R	R	R	R	R	R	R	11	*Multiple
	2024	15–25 July	-	NC	NC	NC	NC	NC	NC	NC	-	-	-	7	5
CO-CA-03	2018	9–19 July	NC	NC	NC	NC	NC	NC	NC	-	-	-	-	7	0
	2019	19–30 July	R	•	R	R	•	•	•	-	-	-	-	7	0–3
	2020	18–30 June	•	•	•	•	•	•	•	•	-	-	-	8	1–8
	2021	5–16 July	-	NC	NC	NC	NC	NC	•	NC	-	-	-	7	*Multiple
	2022	29 August – 8 September	NC	NC	NC	NC	NC	NC	NC	NC	NC	-	-	9	0
	2023	26 June – 6 July	•	R	R	R	R	R	R	•	R	R	R	11	0 - *Multiple
	2024	15–25 July	-	NC	NC	NC	NC	NC	NC	NC	-	-	-	7	0
CO-CA-05	2018	9–19 July	NC	NC	NC	NC	NC	NC	NC	-	-	-	-	7	0
	2019	19–30 July	R	R	R	R	R	R	R	-	-	-	-	7	0–11

Site ID	Year	Survey Dates	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Night 7	Night 8	Night 9	Night 10	Night 11	Sampling nights	Range of calls per night
	2020	18–30 June	R	R	R	R	R	R	R	-	-	-	-	7	*Multiple
	2021	5–16 July	-	R	R	R	R	R	R	R	-	-	-	-	*Multiple
	2022	29 August – 8 September	R	R	R	R	R	R	R	R	R	-	-	7	6–22
	2023	26 June – 6 July	-	R	R	R	R	R	R	NC	-	-	-	7	*Multiple
	2024	15–25 July	-	R	R	R	R	R	R	R	-	-	-	7	1–14
CO-CA-10	2018	9–19 July	NC	NC	NC	NC	NC	NC	NC	-	-	-	-	7	0
	2019	19–30 July	•	NC	NC	NC	NC	NC	NC	-	-	-	-	7	0–1
	2020	18–30 June	NC	NC	NC	NC	NC	NC	NC	-	-	-	-	7	0
	2021	5–16 July	-	-	-	-	-	-	-	-	-	-	-	-	-
	2022	29 August – 8 September	-	-	-	-	-	-	-	-	-	-	-	-	-
	2023	26 June – 6 July	-	NC	NC	NC	NC	NC	NC	-	-	-	-	6	0
	2024	15–25 July	-	NC	NC	NC	NC	NC	NC	NC	-	-	-	7	0
CO-CA-20	2021	5–16 July	-	-	NC	NC	NC	NC	NC	NC	•	-	-	7	0–2
	2022	29 August – 8 September	NC	•	NC	NC	NC	•	NC	-	-	-	-	7	3–18
	2023	26 June – 6 July	-	NC	NC	NC	NC	NC	NC	NC	-	-	-	7	0
	2024	15–25 July	-	-	-	•	NC	NC	NC	NC	NC	NC	-	7	0–1
CO-CA-21	2021	5–16 July	-	-	-	-	-	-	-	-	-	-	-	-	-

Site ID	Year	Survey Dates	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Night 7	Night 8	Night 9	Night 10	Night 11	Sampling nights	Range of calls per night
	2022	29 August – 8 September	NC	NC	NC	NC	NC	•	NC	-	-	-	-	7	0–1
	2023	26 June – 6 July	-	-	NC	NC	NC	NC	NC	NC	•	-	-	7	0–1
	2024	15–25 July	-	-	-	NC	NC	NC	NC	NC	NC	NC	-	7	0
CO-CA-22	2021	5–16 July	-	-	R	R	R	R	R	R	R	-	-	7	5–15
	2022	29 August – 8 September	R	R	R	R	R	R	R	R	R	-	-	9	*Multiple
	2023	26 June – 6 July	-	-	-	-	-	-	-	-	•	NC	NC	3	0–1
	2024	15–25 July	-	NC	•	NC	NC	•	NC	•	-	-	-	7	0–6
CO-CA-23	2021	5–16 July	-	-	•	NC	•	•	NC	•	R	-	-	7	1 - *Multiple
	2022	29 August – 8 September	NC	NC	NC	NC	•	•	•	-	-	-	-	7	1–3
	2023	26 June – 6 July	-	NC	NC	R	NC	NC	R	NC	-	-	-	7	0–4
	2024	15–25 July	-	-	•	NC	NC	•	NC	NC	NC	-	-	7	0–1
CO-CA-24	2021	5–16 July	-	-	R	R	R	R	R	R	R	-	-	7	*Multiple
	2022	29 August – 8 September	R	R	R	R	R	R	R	R	R	-	-	9	*Multiple
	2023	26 June – 6 July	R	R	R	R	R	R	R	R	R	R	R	11	4 - *Multiple
	2024	15–25 July	-	-	•	NC	NC	•	NC	•	NC	-	-	7	0–8
CO-CA-25	2021	5–16 July	-	-	•	•	•	R	NC	•	NC	-	-	7	1–3

Site ID	Year	Survey Dates	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Night 7	Night 8	Night 9	Night 10	Night 11	Sampling nights	Range of calls per night
	2022	29 August – 8 September	NC	•	NC	NC	•	•	•	-	-	-	-	7	0–1
	2023	26 June – 6 July	-	R	R	R	R	R	R	NC	-	-	-	7	0–8
	2024	15–25 July	-	-	•	•	NC	NC	•	NC	NC	-	-	7	0–2
CO-CA-26	2021	5–16 July	-	-	•	•	•	•	NC	NC	•	-	-	7	1–2
	2022	29 August – 8 September	NC	NC	NC	NC	NC	NC	NC	-	-	-	-	7	0
	2023	26 June – 6 July	-	R	•	•	•	NC	•	R	-	-	-	7	0–4
	2024	15–25 July	-	-	•	•	NC	•	•	•	NC	-	-	7	0–2
CO-CA-27	2021	5–16 July	-	-	R	R	R	R	R	R	R	-	-	7	*Multiple
	2022	29 August – 8 September	-	•	•	-	R	R	R	R	R	-	-	8	1–4
	2023	26 June – 6 July	NC	NC	NC	NC	•	•	•	NC	NC	NC	NC	11	0–3
	2024	15–25 July	-	NC	NC	•	NC	NC	•	NC	-	-	-	7	0–6
CO-CA-28	2021	5–16 July	-	-	NC	NC	NC	NC	•	•	NC	-	-	7	1
CO-CA-29	2021	5–16 July	-	-	NC	•	•	•	•	NC	NC	-	-	7	1–4
CO-CA-30	2021	5–16 July	-	-	•	NC	•	NC	R	NC	NC	-	-	7	1–4
	2022	29 August – 8 September	NC	NC	NC	NC	NC	NC	•	R	0	-	-	9	1–4
	2023	26 June – 6 July	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	11	0

Site ID	Year	Survey Dates	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Night 7	Night 8	Night 9	Night 10	Night 11	Sampling nights	Range of calls per night
	2024	15–25 July	-	NC	•	NC	NC	NC	NC	NC	-	-	-	7	0–8
CO-CA-34	2021	5–16 July	-	-	NC	•	NC	•	NC	•	R	-	-	7	1–2
Control															
CO-CA-18	2021	5–16 July	-	NC	NC	NC	NC	•	NC	NC	-	-	-	7	0–1
	2022	29 August – 8 September	-	NC	NC	NC	NC	NC	NC	NC	-	-	-	7	0
	2023	26 June – 6 July	-	NC	R	R	R	R	R	NC	-	-	-	7	0 - *Multiple
	2024	15–25 July	-	NC	R	R	R	R	R	NC	-	-	-	7	0–1
CO-CA-33	2021	5–16 July	-	-	-	R	R	R	R	R	R	R	-	7	5 - *Multiple
	2022	29 August – 8 September	-	R	R	R	R	R	R	R	-	-	-	7	7 - *Multiple
	2023	26 June – 6 July	R	R	R	R	R	R	R	R	R	R	R	9	*Multiple
	2024	15–25 July	R	R	R	R	R	R	R	R	R	R	-	11	0–>15
CO-CA-35	2021	5–16 July	-	-	-	R	R	R	R	R	R	R	-	7	*Multiple
	2022	29 August – 8 September	R	R	R	R	R	R	R	R	R	-	-	9	*Multiple
	2023	26 June – 6 July	R	R	R	R	R	R	R	R	R	R	R	11	*Multiple
	2024	15–25 July	R	R	R	R	R	R	R	R	R	R	-	11	0–6
CO-CA-42	2021	5–16 July	-	-	-	•	NC	NC	R	R	R	R	-	7	1–3
LR-MI-01	2018	9–19 July	R	R	R	R	R	R	R	R	R	-	-	9	*Multiple

Site ID	Year	Survey Dates	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Night 7	Night 8	Night 9	Night 10	Night 11	Sampling nights	Range of calls per night
	2019	19–30 July	R	R	R	R	R	R	R	-	-	-	-	7	*Multiple
	2020	18–30 June	R	R	R	R	R	R	R	R	-	-	-	8	*Multiple
	2021	5–16 July	-	R	R	R	R	R	R	R	R	R	-	9	*Multiple
	2022	29 August – 8 September	R	R	R	R	R	R	R	R	R	R	-	9	*Multiple
	2023	26 June – 6 July	R	R	R	R	R	R	R	R	R	R	R	11	*Multiple
	2024	15–25 July	R	R	R	R	R	R	R	R	R	R	-	11	*Multiple

Note: 'R' = calls recorded, and diurnal roosting indicated; '●' = calls recorded; 'NC'= no calls recorded; '- '= no sampling; '*' = five or more ghost bats calling at the same time.

760000 770000 780000

7640000 7630000 7620000

Average Calls 2024

Control

0 - 4

5 - 14

15 and above

Impact

0 -4

5 - 14

15 and above

CO-CA-18

CO-CA-22

CO-CA-27

CO-CA-26

CO-CA-20

CO-CA-30

CO-CA-21

CO-CA-10

CO-CA-05

CO-CA-35

CO-CA-03

CO-CA-33

LR-MI-01

Marble Bar

CO-CA-18

CO-CA-27

CO-CA-05

CO-CA-35

CO-CA-03

CO-CA-33

LEGEND

Study Area

Wildfire December 2022

Development Envelope

Stage 1

Disturbance at end of July 2024

Disturbance at end of July 2023

Stage 2

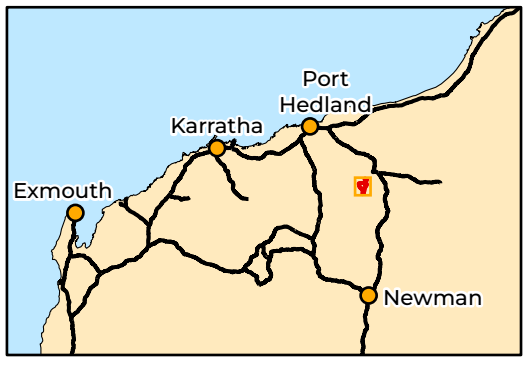
Disturbance at end of July 2024

Scale 1:110,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 09/10/2025

Biologic



ATLAS IRON PTY LTD

Sanjiv Ridge ghost bat monitoring 2024

Average nightly
Ghost bat activity

3.4 Scat Deposition

Ghost bat scats deposited since the previous monitoring period were observed in four of the 15 sites monitored with scat collection sheets, including 30 scats in CO-CA-01, 48 scats in CO-CA-05, one scat in CO-CA-24 and approximately 300 scats in CO-CA-33 (Table 3.4). When comparing the 2024 monitoring survey to previous surveys, most sites demonstrate variability between years. At CO-CA-33 a pattern of scat counts (generally exceeding ~250) has been followed by zero scats the following year. Most notably, CO-CA-24 has ranged between approximately 200-1000 scats per year, but recorded zero in 2024 (Table 3.4).

As noted by Armstrong and Anstee (2000) and Hanrahan *et al.* (2021), scat deposition rates can be affected by caves with high humidity, water ingress and foraging invertebrates. This can lead to accelerated decomposition of scats and result in underestimation of bat activity using this method alone. It is therefore expected that there would be varying levels of scat deposition between years due to cave usage rates by ghost bat, microclimatic conditions, water seepage and the presence and absence of foraging invertebrates.

Table 3.4: Scat records since annual monitoring commenced

Site ID	2019	2020	2021	2022	2023	2024
CO-CA-01	60[1]	0	140	7	23	30
CO-CA-03	-	0[1]	0	0	1	0
CO-CA-05	-	89[1]	30	1	22	48
CO-CA-20	-	0[1]	0	1	0	0
CO-CA-24	-	0[1]	400	200	1,000	1
CO-CA-25	-	2[1]	0	0	0	0

[1] Year sheet was deployed. Only caves with scat records included in table.

3.5 Ghost Bat Observations

Ghost bats were observed at two caves during the survey. At CO-CA-01 a single ghost bat was observed roosting on three occasions (16, 19 and 23 July 2024), with two individuals observed at CO-CA-33 on one occasion (17 July 2024) (Table 3.5). These observations are supportive of their current classifications as Category 2 (Diurnal roosts). While no other primary observations of ghost bat were recorded at any of the other monitoring sites during the 2024 monitoring period, sampling methodologies (i.e. ultrasonic recordings, scat sheets etc.), continue to support current cave classifications at all monitoring sites. When comparing the annual monitoring that has taken place between 2018 and 2024, observations of roosting ghost bats have been sporadic (Table 3.5). This is not surprising given that ghost bats may not use suitable roost sites for months, or even years, at a time; thus, the probability that single day-time inspections of caves coincide with ghost bat presence is generally considered low.

Table 3.5: Visual observations of ghost bat 2018–2024

Site ID	2018	2019	2020	2021	2022	2023	2024
CO-CA-01	[1]0	1	0	0	0	0	3
CO-CA-22	-	-	[1]3	0	0	0	0
CO-CA-24	-	-	[1]1	20	0	0	0
CO-CA-27	-	-	[1]14	1	0	0	0
CO-CA-28	-	-	[1]1	0	0	0	0
CO-CA-29	-	-	[1]5	0	0	0	0
CO-CA-30	-	-	-	[1]1	1	0	0
CO-CA-33	-	-	-	[1]4	2	0	2
CO-CA-35	-	-	-	[1]3	0	0	0

[1] First year of annual monitoring at cave. Only caves with visual observations included in table.

3.6 Temporal Trends

Generally, there is a demonstrated pattern of roost usage across the Stage 1 and Stage 2 areas. Most notably, this is the first year in which ultrasonic data has indicated that diurnal roosting had not occurred CO-CA-01 during the annual monitoring. However, by utilising other sampling methods and the known ecology of ghost bat, it is understood that ultrasonic data cannot be solely relied upon to determine diurnal roosting. This point is well demonstrated by the fact that a ghost bat was visually observed diurnally roosting at CO-CA-01 on three separate occasions (16, 19 and 23 July 2024) and that around 30 scats were recorded at this cave. These data combined are supportive of the current classification of CO-CA-01.

Conversely at CO-CA-24, this is the first year since 2021 (the first year it was monitored) that ultrasonic data indicated that there was no diurnal roosting at this cave. Additionally, there was a marked reduction in scats observed, from around 1,000 scats in 2023, to a single scat in the 2024 monitoring period. While the single scat observation is indicative that diurnal roosting has occurred at the site since the 2023 monitoring period, the data indicates that there has been reduction in usage of this site. It must be noted however, that this is not the first year that a low scat count has been recorded (zero in 2020), and therefore there is not sufficient evidence, over a long enough period, to justify a change in roost classification.

For these reasons, investigations into ghost bat presence and abundance must rely on multiple sources of information (ultrasonic recording, cave visitation, scat observations, foraging evidence etc.).

Table 3.6: Natural factors influencing ghost bat activity levels.

Factor	Relevance	Potential impact on results
Breeding cycle	Female ghost bats are thought to congregate in maternity roosts during the breeding season, with males and non-breeding females dispersing more widely in search of productive foraging grounds (Armstrong & Anstee, 2000; Worthington-Wilmer *et al.*, 1994).	**Low**. The current survey was conducted at the same or similar time of year as the previous nine surveys, and therefore, the likely overall impact is very low.
Weather conditions	Ghost bats move between a number of caves seasonally, or as dictated by weather conditions (Hutson *et al.*, 2001). For example, outside of the breeding season, male bats are known to disperse widely, especially during the wet season when conditions generally allow bats to use caves that would otherwise not be suitable (Worthington-Wilmer *et al.*, 1994).	**Low**. The current survey was conducted at the same or similar time of year to the previous nine monitoring periods, and no atypical weather conditions (such as heat waves or storms) were observed. Although relative humidity measured within the monitoring sites varied between the surveys, such variation is expected and, overall, conditions remained well within tolerance levels for ghost bat.
Moonlight	The level of moonlight has the potential to impact ghost bat behaviour by influencing the time they leave a roost to forage (e.g. individuals may avoid leaving a roost when moonlight is bright), as well as the availability and behaviour of prey species (e.g. some prey may avoid being active when bright moonlight makes them more vulnerable to predators which hunt by sight, such as ghost bats) (Armstrong, 2010; Milne *et al.*, 2005).	**Low**. The species has been regularly recorded during previous monitoring periods across various phases of the moon cycle. It is possible that ghost bats prefer to be active earlier and for shorter periods during brighter nights and this could affect levels of activity recorded at the monitoring sites; however, this idea is untested.
Previous rainfall	The amount of rainfall in preceding wet seasons can impact the productivity of prey species and the availability of water for drinking, which can in turn influence the distribution and abundance of predators like ghost bat.	**Low**. Rainfall preceding the survey was similar to previous wet seasons preceding the previous monitoring periods and were generally consistent with rainfall patterns in the area.
Fire	Fire can affect the quality of foraging habitat by reducing the abundance of prey species via the removal of vegetation cover, and competition with foxes and cats can reduce the availability of prey items (TSSC, 2016a). Studies have also shown that ghost bats leave fire-affected areas and return as the undergrowth regenerates (Bullen & McKenzie, 2011).	**Low**. Despite a fire in December 2022, the impact to ghost bat foraging habitat within the vicinity of monitoring sites was minimal. These areas are recovering, and it follows that these fires did not have had a lasting impact on the carrying capacity of the Study Area and surrounding region.

3.7 Limitations and Constraints

The EPA outlines a number of factors that can affect the adequacy of fauna surveys (EPA, 2020). These were assessed in relation to both the short-term and continuous sampling periods and no significant limitations were identified (Table 3.7).

Table 3.7: Survey limitations

Potential limitation or constraint	Applicability to the current monitoring period	Limitation
Availability of data and information	All contextual resources required to complete the survey were available (previous surveys, database searches, environmental information, climate data etc.). Contextual information on the habitats and landforms present within the Study Area, as well as previous records of, ghost bat is also well documented (MWH, 2018b).	No
Competency/ experience of the survey team	The Biologic field personnel involved in the survey have a combined total of 30 years' experience undertaking fauna surveys in the Pilbara. Biologic have conducted surveys at Sanjiv Ridge for six years and have experience with similar scopes throughout the Pilbara.	No
Scope of the survey	The scope was a monitoring survey and was conducted within that framework. All chosen methods were able to be executed as expected.	No
Timing, weather and season	Weather conditions were appropriate for detecting ghost bat activity. The annual monitoring survey was undertaken eight days following a new moon.	No
Disturbance that may have affected results	The monitoring program is designed to track the occurrence of disturbances within the Study Area. Signs of historical and recent disturbances observed in the Study Area were described.	No
Adequacy of the survey intensity	Monitoring was undertaken in accordance with the SSMPs, using standardised and established techniques which are considered suitable for an ongoing monitoring program targeting significant species. The survey employed the same methods as were applied in previous years.	No
Proportion of survey achieved/ access problems	All monitoring sites were accessible during the survey. Assessments were consistent across sites and comparable to previous surveys.	No
Problems with data and analysis	Microclimate data at CO-CA-01 were not available for the entirety of the monitoring period due to technical issues with the equipment and the inability to collect data from the backup system due to the presence of ghost bats.	Partial

4 Conclusion

This survey was successful in assessing patterns of ghost bat activity at the 18 monitoring sites identified by the SSMP, along with one additional site known be used by ghost bat as an important regional roost. Replicable sampling methods were successfully applied to obtain data about the way these sites are being used by the species.

Notably, this is the first year of monitoring where there have been no calls or diurnal roosting indicated (by way of ultrasonic recording) at CO-CA-01 since 2018. Similarly, at CO-CA-24, this is the first year that there has been no indication of diurnal roosting at this cave (since 2021) and the second year in a row where CO-CA-27 has not had any indication of diurnal roosting (since 2021). However, by utilising other sampling methods and the known ecology of ghost bat, it is understood that ultrasonic data cannot be solely relied upon to determine roosting status within a cave. This is supported by data (scats/ cave visitation) where there is evidence to suggest that the usage of these caves may be variable but remain largely unchanged.

For these reasons, investigations into ghost bat presence and abundance must rely on multiple sources of information (ultrasonic recording, cave visitation, scat observations, foraging evidence etc.).

By continuing to use multimodal sampling methods and analysing results of subsequent monitoring surveys, these data will assist Atlas to identify whether mining activities associated with the Project are having a significant impact on the suitability of the sites as ghost bat roosts and/or on the way the sites (and more generally the Study Area) are used by ghost bat.

In accordance with the SSMPs, Atlas is committed to employing specific corrective actions when the following key performance indicators are not met, or when the following trigger criteria are realised.

- Key performance indicators for Stage 1 sites CO-CA-01 and CO-CA-03:
    - *No ground disturbance within cave buffers (240 m for CO-CA-01 and 50 m for CO-CA-03).*
    - *No incident reports of unauthorised access to cave buffers.*
- Trigger criteria for Stage 2 sites CO-CA-20, CO-CA-21, CO-CA-22, CO-CA-23, CO-CA-24, CO-CA-25, CO-CA-26, CO-CA-27, CO-CA-28 and CO-CA-29:
    - *Minor to moderate rockfall within cave such that the cave remains viable as ghost bat habitat in the future once mining has ceased.*
    - *Ground disturbance approaches within 10 m of exclusion areas around Stage 2 ghost bat caves.*

There have been no instances of unauthorised access or ground disturbance within the 240 m exclusion zone around cave CO-CA-01, nor within the 50 m exclusion zone around CO-CA-03, nor within the 10 m exclusion zones around the Stage 2 sites. There have been no signs of rockfall or structural damage within any of these sites. Overall, there are no signs that ghost bat activity in the Sanjiv Ridge Study Area, or the suitability of roosts as habitat for the species, have been affected by current mining activity. Based on these results, the key performance indicators have been met, and the trigger criteria have not been realised.

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Appendix A: Habitat and Disturbance

Site ID	Description	Records of disturbance			
		2021	2022	2023	2024
Impact					
CO-CA-01	Cave located at top of rocky ridge face in rocky ridge and gorge habitat. A spring system is located ~40 m from the entrance. The cave contains two main chambers connected by a constriction.	Haul road developed within ~390 m to east. Pit (Runway North) developed within ~485 m to east. Pit (Runway South) developed within ~600 m to east.	Wildfire on 16 December 2022 burned ridgetop above cave. Entrance to cave unburnt. Haul road activities continued within ~390 m to east. Ore production activities associated with Runway North continued within ~485 m to east. Ore production activities associated with Runway South Pit continued within ~600 m to east.	Haul road developed (associated with Stage 2, commenced November 2023) within ~560 m to west. Haul road activities within ~390 m to east. Ore production activities associated with Runway North within ~485 m to east. Ore production activities associated with Runway South Pit within ~600 m to east.	Development activities continued but did not encroach closer to site
CO-CA-03	Cave located at the bottom of a major gorge in rocky ridge and gorge habitat. The cave is located next to water seepage which feeds a water source at the cave entrance. The cave is characterised by two main chambers connected by a constriction.	Wildfire following the 2020 monitoring survey. Exploration activities undertaken within ~121 m to east. Haul road developed within ~480 m to west. Weeds around pool CO-WS-14.	Pit (Split Rock) developed within ~450m to west. Haul road activities continued within ~480 m to west.	No additional disturbances recorded during annual survey. Exploration activities associated with Razorback Pit (commenced December 2023) within ~145 m to south-west. Ore production activities associated with Sparrow Lake (formerly Split Rock) Pit continued within ~450 m to west. Haul road activities continued within ~480 m to west.	Earthworks associated with the Razorback pit encroached to within ~120 m of CO-CA-03

Site ID	Description	Records of disturbance			
		2021	2022	2023	2024
CO-CA-05	Semi-exposed cavern. The entrance to the cave is 2.5 m wide and 1.5 m high. The cave comprises two chambers. The first chamber is ~4 m wide, ~1.5 m high and 10 m deep. The first chamber comes to a constriction (0.5 m high by ~0.5 m wide). The second chamber is low lying ~1.5 m high and 10 m deep. The width of the cave is difficult to determine accurately, and the low-lying roof prevents access to some section of the second chamber.	Haul road developed within ~191 m to south-east. Pit (Runway North) developed within ~350 m to east. Pit (Runway South) developed within ~513 m to south-east.	Wildfire on 16 December 2022 burned ridgetop above cave. Entrance to cave unburnt. Haul road activities continued within ~191 m to east. Ore production activities associated with Runway North Pit continued within ~350 m to east. Ore production activities associated with Runway South Pit continued within ~513 m to south-east.	Haul road activities continued within ~191 m to east. Ore production activities associated with Runway North Pit continued within ~350 m to east. Ore production activities associated with Runway South Pit continued within ~513 m to south-east.	Development activities continued but did not encroach closer to site
CO-CA-10	Semi-exposed cavern. The entrance to the cave is 1 m wide and 1 m high. Cave comprises one main chamber. The cave spans to a depth of ~8 m and the height of the highest chamber is ~2 m.	Pit (Runway North) developed within ~294 m to east. Haul road developed within ~310 m to east. Pit (Runway South) developed within ~470 m to south-east.	Wildfire on 16 December burned ridgetop above cave, with patchy burnt areas close to the cave entrance. Ore production activities associated with Runway North Pit continued within ~294 m to east. Haul road activities continued within ~310 m to east. Ore production activities associated with Runway South Pit continued within ~470 m to south-east.	Ore production activities associated with Runway North Pit continued within ~294 m to east. Haul road activities continued within ~310 m to east. Ore production activities associated with Runway South Pit continued within ~470 m to south-east.	Development activities continued but did not encroach closer to site

Site ID	Description	Records of disturbance			
		2021	2022	2023	2024
CO-CA-20	Sheltered vertical cavity measuring ~1 m high and 1 m wide. Cave is ~1.6 m high and extends ~10 m deep. There is a small (and thus inaccessible) cavity toward the back left of the cave that may open into a second camber. The characteristic of this potential chamber is unknown. Noticeable change in microclimate when entering cave.	No additional disturbances recorded	Wildfire on 16 December burned around the cave and surrounding landscape.	Development activities recorded within ~115 m of site (29 September 2023)	Earthworks associated with the Glen Herring pit encroached to within ~70 m of CO-CA-20
CO-CA-21	Semi-exposed cavern. The entrance to the cave is 2.5 m wide and 1 m high. The cave comprises two chambers. The cave spans to a depth of ~10 m and the height of the highest chamber is 1 m. The full extent of cave not accessible for assessment.	No additional disturbances recorded	Wildfire on 16 December burned around the cave and surrounding landscape	Haul road associated with Stage 2 (commenced November 2023) approached to within ~80 m east of site	Earthworks associated with the Glen Herring pit encroached to within ~40 m of CO-CA-21
CO-CA-22	Sheltered cavity (~0.5m wide by ~0.5 m high). Cave comprises one main chamber and two smaller chambers. The cave spans to a depth of ~12 m and the height of the highest chamber is ~2 m.	Drilling within 230 m	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities occurred to within 35 m of site (12 June 2022) [1]	Development activities continued, but did not encroach closer to site	

Site ID	Description	Records of disturbance			
		2021	2022	2023	2024
CO-CA-23	Semi-exposed cavity with small entrance (~0.5 m high by ~1 m wide). Cave extends to a depth of ~10 m deep with a single ~1.5 m high chamber. A very hot and humid cave (floor is damp toward the rear. Small low pipe cavity on the middle left hand side of the cave (too small to access).	Drilling within 400 m	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities occurred to within 40 m of site (12 June 2022) [1]	Development activities continued, but did not encroach closer to site	Development activities associated with the Glen Herring pit continued but did not encroach closer to site
CO-CA-24	Semi-exposed overhang (~4 m high by ~4 m) sheltering a round cavity (~0.5 m high by 1 m wide). Cavity extends to a depth of ~6 m with a single ~3 m high chamber.	Drilling within 415 m	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities continued to within ~60 m east of site (12 June 2022) [1]	Development activities continued, but did not encroach closer to site	Earthworks associated with the Glen Herring pit encroached to within ~35 m east of CO-CA-24
CO-CA-25	Sheltered vertical cavity (~1 m high and ~0.5 m wide). Cave extends to a depth of ~7 m deep with a single ~4 m high chamber.	Drilling within 355 m	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities continued to within ~45 m east of site (12 June 2022) [1]	Development activities continued, but did not encroach closer to site	Earthworks associated with the Glen Herring pit encroached to within ~26 m east of CO-CA-25
CO-CA-26	Exposed cavity (~1.5 m high and ~2 m wide). Cavity extended to a depth of ~5 m and comprised a single chamber ~3.5 m high. A couple of solution pipes were observed (one had a small crack through which some light was observed).	Drilling within 325 m	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities continued within ~50 m east of site (12 June 2022)[1]	Development activities continued, most recently (12 June 2023) to within ~35m north of site	Earthworks associated with the Glen Herring pit encroached to within ~30 m east of CO-CA-26

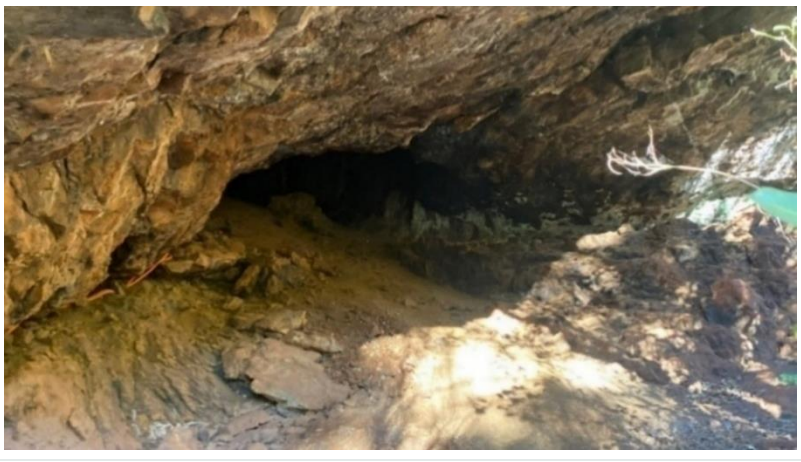
Site ID	Description	Records of disturbance			
		2021	2022	2023	2024
CO-CA-27	Semi-exposed overhang (~2 m high and ~4 m wide). Overhang extends to a depth of ~8 m. A solution pipe represents the highest point within the overhang and is ~5 m high.	No additional disturbances recorded	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities continued within ~120 m south-west of site (12 June 2022) [1]	Development activities continued but did not encroach closer to site	Development activities continued but did not encroach closer to site
CO-CA-28	Semi-exposed overhang (~2 m high and ~5 m wide). Overhang extends to a depth of ~2 m. The highest point within the overhang and is ~2 m high.	Drilling within 115 m	Wildfire on 16 December burned around the cave and surrounding landscape.	Development activities continued but did not encroach closer to site	Development activities continued but did not encroach closer to site
CO-CA-29	Semi-exposed overhang (~1 m high and ~10 m wide). Overhang extends to a depth of ~5 m. The highest point within the overhang and is ~2 m high.	Drilling within 135 m	Wildfire on 16 December burned around the cave and surrounding landscape.	Development activities continued but did not encroach closer to site	Development activities continued but did not encroach closer to site
CO-CA-30	Semi-exposed (~1.5 m wide and 0.75m high) cavity. Head backward and to the right toward a narrow step-up opening. A secondary step-up leads onto a chamber with a sloping floor ad low ceiling (~1 m) all the way to the back of the cave (~12 m deep).	No additional disturbances recorded	Wildfire on 16 December burned around the cave and surrounding landscape. Development activities continued within ~710 m north of site (12 June 2022) [1]	Development activities continued, but did not encroach closer to site	Earthworks associated with the Glen Herring pit encroached to within ~360 m east of CO-CA-30
Control					
CO-CA-18	Semi-exposed overhang. Entrance spans 6 m wide by 0.5 m high. The overhang extends backward to a depth of ~5 m. The highest point within the overhang is ~2 m.	No additional disturbances recorded	Wildfire on 16 December 2022 burned ridgetop above cave. Entrance to cave unburnt.	No additional disturbances recorded	No additional disturbances recorded

Site ID	Description	Records of disturbance			
		2021	2022	2023	2024
CO-CA-33	Semi-exposed overhang entrance with horizontal opening of ~4 m with and ~0.75 m height. The overhang extends backward toward a constriction. This constriction opens into a chamber ~3 m in height. The total depth of the cave is ~20 m.	No additional disturbances recorded	No additional disturbances recorded	No additional disturbances recorded	No additional disturbances recorded
CO-CA-35	Mine shaft (Mt Ada) with a vertical entrance (~2 m wide and ~5 m high). The depth of the mine shaft is unknown as the mine shaft cannot be safely accessed. Numerous holes extending downward in front of and within the entrance (depth unknown).	No additional disturbances recorded	No additional disturbances recorded	No additional disturbances recorded	No additional disturbances recorded
LR-MI-01	Abandoned mine adit in undulating grassland plain at the base of a large ironstone ridge system. Old vertical mine adit in plains serves as entrance to roost.	No additional disturbances recorded	No additional disturbances recorded	No additional disturbances recorded	No additional disturbances recorded

Appendix B: Photo Monitoring - Impact Sites

CO-CA-01					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4678°**	**119.6711°**	**PPB**	**-21.4681°**	**119.6717°**
2021			2021		
2022			2022	No photo available	
2023			2023		
2024			2024		

CO-CA-05					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4248**	**119.6742**	**PPB**	**-21.4243**	**119.6737**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

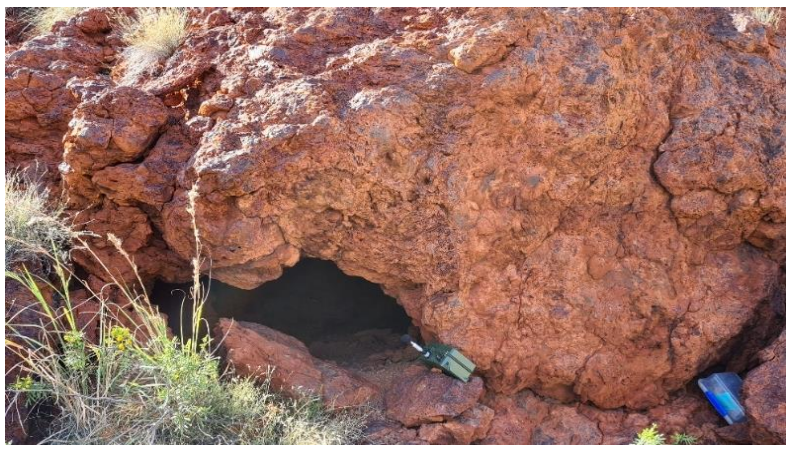
CO-CA-03					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4678°**	**119.6711°**	**PPB**	**-21.4681°**	**119.6717°**
2021			2021		
2022			2022		
2023			2023		
2024	No photo available		2024	No photo available	

CO-CA-10					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4187**	**119.6754**	**PPB**	**-21.4187**	**119.6754**
2021			2021	No photo available	
2022			2022	No photo available	
2023			2023		
2024			2024		

CO-CA-20					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3971**	**119.6559**	**PPB**	**-21.3974**	**119.6561**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-21					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3964**	**119.6541**	**PPB**	**-21.3970**	**119.6535**
2022			2022		
2023			2023		
2024			2024		

CO-CA-22					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3921**	**119.6524**	**PPB**	**-21.3923**	**119.6523**
2021			2021		
2022			2022		
2023			2023		
2024	No photo available		2024	No photo available	

CO-CA-23					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3964**	**119.6541**	**PPB**	**-21.3970**	**119.6535**
2021			2021		
2022			2022		
2023			2023		
2024	No photo available		2024	No photo available	

CO-CA-24					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3966**	**119.6539**	**PPB**	**-21.3966**	**119.6539**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-25					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3961**	**119.6537**	**PPB**	**-21.3966**	**119.6531**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-26					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3958**	**119.6536**	**PPB**	**-21.3966**	**119.6531**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-27					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3943**	**119.6571**	**PPB**	**-21.3943**	**119.6571**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-28					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3950**	**119.6570**	**PPB**	**-21.3945**	**119.6573**
2021			2021		
2022	No photo available		2022	No photo available	
2023			2023		
2024			2024		

CO-CA-29					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3949**	**119.6573**	**PPB**	**-21.3945**	**119.6573**
2021			2021		
2022	No photo available		2022	No photo available	
2023			2023		
2024			2024		

CO-CA-30					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4032**	**119.6518**	**PPB**	**-21.4032**	**119.6518**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

Appendix C: Photo Monitoring – Control Sites

CO-CA-18					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.3503**	**119.6162**	**PPB**	**-21.3503**	**119.6162**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-33					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.5196**	**119.6611**	**PPB**	**-21.5200**	**119.6614**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

CO-CA-35					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4326**	**119.6136**	**PPB**	**-21.4326**	**119.6136**
2021			2021		
2022			2022		
2023			2023		
2024			2024		

LR-MI-01					
Photo Point ID	**Location**		**Photo Point ID**	**Location**	
	Latitude	**Longitude**		**Latitude**	**Longitude**
PPA	**-21.4326**	**119.6136**	**PPB**	**-21.4326**	**119.6136**
2021			2021		
2022			2022	No photo available	
2023			2023		
2024	No photo available		2024	No photo available	

Appendix D: Ghost Bat Call Activity – Annual Monitoring

Site ID	Date	Number of calls	Roosting indicated
CO-CA-01	16/07/2024	0	N
	17/07/2024	0	N
	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N
	22/07/2024	0	N
CO-CA-03	16/07/2024	0	N
	17/07/2024	0	N
	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N
	22/07/2024	0	N
CO-CA-05	16/07/2024	5	R
	17/07/2024	5	R
	18/07/2024	2	R
	19/07/2024	8	R
	20/07/2024	14	R
	21/07/2024	1	R
	22/07/2024	3	R
CO-CA-10	16/07/2024	0	N
	17/07/2024	0	N
	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N
	22/07/2024	0	N
CO-CA-18	16/07/2024	1	N
	17/07/2024	0	N
	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N

Site ID	Date	Number of calls	Roosting indicated
	22/07/2024	0	N
CO-CA-20	18/07/2024	1	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N
	22/07/2024	0	N
	23/07/2024	0	N
	24/07/2024	0	N
CO-CA-21	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N
	22/07/2024	0	N
	23/07/2024	0	N
	24/07/2024	0	N
CO-CA-22	16/07/2024	0	R
	17/07/2024	3	R
	18/07/2024	0	R
	19/07/2024	0	R
	20/07/2024	2	R
	21/07/2024	0	R
	22/07/2024	6	R
CO-CA-23	17/07/2024	1	N
	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	1	N
	21/07/2024	0	N
	22/07/2024	0	N
	23/07/2024	0	N
CO-CA-24	16/07/2024	0	R
	17/07/2024	4	R
	18/07/2024	0	R
	19/07/2024	0	R
	20/07/2024	8	R

Site ID	Date	Number of calls	Roosting indicated
	21/07/2024	0	R
	22/07/2024	4	R
CO-CA-25	17/07/2024	1	N
	18/07/2024	2	R
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	1	R
	22/07/2024	0	N
	23/07/2024	0	N
CO-CA-26	17/07/2024	2	R
	18/07/2024	1	R
	19/07/2024	0	N
	20/07/2024	1	R
	21/07/2024	1	R
	22/07/2024	2	R
	23/07/2024	0	N
CO-CA-27	16/07/2024	0	R
	17/07/2024	0	R
	18/07/2024	2	R
	19/07/2024	0	R
	20/07/2024	0	R
	21/07/2024	6	R
	22/07/2024	0	R
CO-CA-30	16/07/2024	0	N
	17/07/2024	8	N
	18/07/2024	0	N
	19/07/2024	0	N
	20/07/2024	0	N
	21/07/2024	0	N
	22/07/2024	0	N
CO-CA-33	16/07/2024	7	R
	17/07/2024	0	R
	18/07/2024	0	R
	19/07/2024	>15	R

Site ID	Date	Number of calls	Roosting indicated
	20/07/2024	0	R
	21/07/2024	0	R
	22/07/2024	7	R
CO-CA-35	16/07/2024	6	R
	17/07/2024	0	R
	18/07/2024	0	R
	19/07/2024	2	R
	20/07/2024	0	R
	21/07/2024	0	R
	22/07/2024	1	R
LR-MI-01	15/07/2024	Multiple	R
	16/07/2024	Multiple	R
	17/07/2024	Multiple	R
	18/07/2024	Multiple	R
	19/07/2024	Multiple	R
	20/07/2024	Multiple	R
	21/07/2024	Multiple	R
	22/07/2024	Multiple	R
	23/07/2024	Multiple	R
	24/07/2024	Multiple	R