Significant Species Management Plan

CRL-ENV-PLN-006-19

+61 8 6245 2050 info@calidus.com.au
Suite 12, 11 Ventor Ave West Perth WA 6005 AUSTRALIA
calidus.com.au

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Rev	Revision Details	Prepared	Reviewed	Authorised	Date
Rev 0		K. George	P. Brennan Calidus	P. Brennan Calidus	2 October 2019
Rev 1	Added bat clearance procedure and further details regarding bat monitoring and northern quoll monitoring Amended location of Kopckes Reward	K. George	P. Brennan Calidus	P. Brennan Calidus	20 November 2019
Rev 2	Added commitments made in the memo to EPA Services, Warrawoona Gold Project – Terrestrial Fauna response memo dated 24 April 2020 from Calidus Chief Operating Officer Paul Brennan Added commitments made in the email to Troy Sinclair EPA Services 24/05/2020 from Calidus Chief Operating Officer Paul Brennan	K. George	P. Brennan Calidus	P. Brennan Calidus	26 May 2020
Rev 3	Updated as per Ministerial Statement 1150.	K. George	P. Brennan Calidus	P. Brennan Calidus	25 August 2020
Rev 3.1	Amended Appendix Number error – Non substantial change	K. George	P. Brennan Calidus	P. Brennan Calidus	28 August 2020
Rev 3.2	Updated as per Feedback from Troy Sinclair EPA Services 02/02/2020	K. George	P. Brennan Calidus	P. Brennan Calidus	2 September 2020
Rev 3.3	Updated as per Feedback from Troy Sinclair EPA Services 02/02/2020	K. George	P. Brennan Calidus	P. Brennan Calidus	11 September 2020

Calidus Resources Limited
ACN 006 640 553
PO Box 1240
West Perth WA 6872
Australia 6005
+61 8 6245 2050
info@calidus.com.au
https://www.calidus.com.au/

This document has been prepared based on assumptions as reported throughout and upon information and data supplied by others.

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1 Introduction

1.1 Project Overview

The Warrawoona Gold Project is located in the Warrawoona greenstone belt (Figure 1.1) containing over 200 historic workings (mostly small shafts, stopes, and diggings). The greenfields area was historically used for small scale mining, pastoral activities and mineral exploration. A number of baseline studies conducted over the past three years by Calidus have contributed significantly to the scientific understanding of the area and allowed Calidus to design the project in a way that identifies, prevents and/or minimises adverse environmental impacts.

The Warrawoona Gold Project comprises part of the Warrawoona Syncline which accommodates several quartz lode gold deposits. The deposits are hosted within three main shear zones: the Klondyke, Copenhagen and Fielding's Find shear zones. Mineralisation generally comprises thick sub-vertical shear zones potentially amenable to low cost open-pit mining with mineralisation outcropping at surface. The Warrawoona Gold Project comprises the Klondyke and Copenhagen deposits.

Calidus wishes to progress Warrawoona Project as follows:

(a) Develop an open pit and underground to mine the Klondyke orebody.

(b) Cut back the existing Copenhagen Pit.

(c) Construct a 2.4 Million Tonnes Per Annum (Mtpa) conventional CIL processing plant.

(d) Store tailings in a 'valley fill' Tailings

(e) Construct permanent waste rock dumps (WRD).

(f) Construct additional supporting elements such as site access road, internal roads, surface water management, accommodation village.

1.2 Purpose

The Project has the potential to impact conservation significant fauna species which are protected under the Environment Protection and Biodiversity Conservation Act 1999 and Biodiversity Conservation Act 2016.

The purpose of this Significant Species Management Plan (SSMP) is to identify and mitigate potential impacts to conservation significant fauna species and ensure the Project is developed in an environmentally acceptable manner.

The objectives of this SSMP are to:

- Maintain records of conservation significant vertebrate fauna species observed within the Project area.
- Avoid or minimise impacts to conservation significant species and habitats.

- Monitor for potential impacts to conservation significant vertebrate fauna species.
- Detail the reporting requirements relating to conservation significant vertebrate fauna species.

This SSMP summarises the baseline data and the monitoring and management of conservation significant fauna vertebrate fauna species that may occur on the Warawoona Gold Project. A full description of terrestrial vertebrate fauna baseline studies for the Project and detailed impact assessment is presented in (Biologic, 2019b, 2019c).

Procedures for Significant Flora species are detailed in the Calidus Flora Management Procedure (CRL-ENV-PRO-011-19).

1.3 Revision Summary

Table 1.1 summarises the revisions made in this Management Plan.

Table 1.1: Summary of Change

Revision Number	Reason for Revision	Amended Section	Details
1	Footprint Amended	1 – Introduction	Development Envelope refers to the 1000 ha area within which Calidus intends to clear no more than 398.5 ha.
1	Error in Rev 0	6. Potential Impacts to Conservation Significant Bats	Amended location of Kopckes Reward
1	Detail became available	Added Appendix 8: Significant Bat Monitoring Methods	Added further details regarding bat monitoring
1	Detail became available	Added Appendix 7: Northern Quoll Monitoring Methods	Added further details regarding northern quoll monitoring
1	Requested by AWE in scoping meeting	Added Appendix 9 Underground Workings Clearance Procedure – Significant Bats	Added bat clearance procedure
2	Mining Exclusion Zone required further definition		Added Table 1.2 General definitions which defines what activities may and may not occur within the Mining Exclusion Zone

Revision Number	Reason for Revision	Amended Section	Details
2	Noise thresholds not addressed in previous versions	8 - Performance Criteria and Corrective Actions	Added average noise threshold to Table 9.1 Performance criteria and corrective actions for conservation significant fauna
2	Commitments made in the memo to EPA Services, Warrawoona Gold Project – Terrestrial Fauna response memo dated 24 April 2020 from Calidus Chief Operating Officer Paul Brennan	8 - Performance Criteria and Corrective Actions and Appendix 6 - Monitoring Summary	Added information to Table 9.1 Performance criteria and corrective actions for conservation significant fauna and Appendix 6 – Monitoring Summary • Further Groundwater Monitoring commitments • Additional information on which roosts will be monitored
2	Commitments made in the email to Troy Sinclair EPA Services 24/05/2020 from Calidus Chief Operating Officer Paul Brennan	8 - Performance Criteria and Corrective Actions and Appendix 6 - Monitoring Summary	Added information to Table 9.1 Performance criteria and corrective actions for conservation significant fauna and Appendix 6 Monitoring Summary Humidity monitoring commitments
2	Amended error as discussed in memo to EPA Services, Warrawoona Gold Project – Terrestrial Fauna response memo dated 24 April 2020 from Calidus Chief Operating Officer Paul Brennan	Appendix 1 - Roost classification of mine workings within the Study Area, with annual activity levels	Britannia - Biologic (2019c) contains an error in that it quotes "not sampled" for PGb in place of the correct listing of "No calls recorded". Table in appendix amended to show "No calls recorded"
3	Updated SSMP to align with Ministerial Statement Conditions 1150	Added Section 2 Legislative Context	Added Table 2.2 Ministerial Statement 1150 Conditions relating to the SSMP
3	Updated SSMP to align with Ministerial Statement Conditions 1150	Updated Section 11 – Reporting	Reporting as per Ministerial Statement
3	Updated SSMP to align with Ministerial Statement Conditions 1150	Added Section 13 Change Management	Revisions to SSMP as per Ministerial Statement 1150
3	Baseline data allowed for triggers to be estimated	Appendix 7B	Added Northern Quoll monitoring triggers
3	Baseline data allowed for draft levels to be estimated	Appendix 8B	Added Draft Significant Bat Lower Control Levels
3.1	Non-substantial Change	Errors in Appendix labelling during PDF process	

Revision Number	Reason for Revision	Amended Section	Details
3.2	Feedback from Troy Sinclair – EPA Services DWER – Noise management should align to Ministerial Statement Conditions 1150.	Table 9.1 (7, 8)	Amended noise limit to reflect MS1150 condition 7.3 (9). Maintaining a 70 decibel A noise limit and 10 millimetres per second vibration limit at Klondyke Queen roost
3.2	Feedback from Troy Sinclair – EPA Services DWER. Unclear when makeup water if required at Bow Bells South will be stopped.	Table 9.1 (8)	Clarified the limits around providing makeup water to Bow Bells South
3.2	Feedback from Troy Sinclair – EPA Services DWER. Changed text to "No abandonment of Bow Bells South roost by Pilbara Leaf-nosed Bats as a result of the project".	Table 9.1 (8), Table 2.2	Removed "permanent" as a temporary abandonment of the main roost (Bow Bells South) is not an acceptable outcome because there is no known contingency roost for a temporary abandonment by Pilbara Leaf-nosed Bat if Klondyke Queen has a reduced humidity due to dewatering. Added definition of abandonment to Table 2.2
3.2	New underground at Klondyke developed into an artificial roost at closure: discussed in Part IV supplementary documentation and during consultation but not discussed in previous versions of the SSMP	Table 9.1 (8)	Added the performance objective: manage the Klondyke Underground at closure so that the underground tunnels are conducive to Pilbara Leaf-nose Bat and Ghost Bat roosting.
3.2	Clarified what historical workings make up Bow Bells South and Klondyke Queen	Table 2.2	Bow Bells South and Klondyke Queen both have interconnecting workings and it was necessary to define both roosts to avoid confusion.
3.2	Amended Appendix error	Appendices	
3.3	Feedback from Troy Sinclair – EPA Services DWER. To align SSMP with MS1150 refer to Targets rather than KPIs.	Throughout document – predominately Table 9.1.	Changed text throughout the document from Key Performance Indicators to Targets.

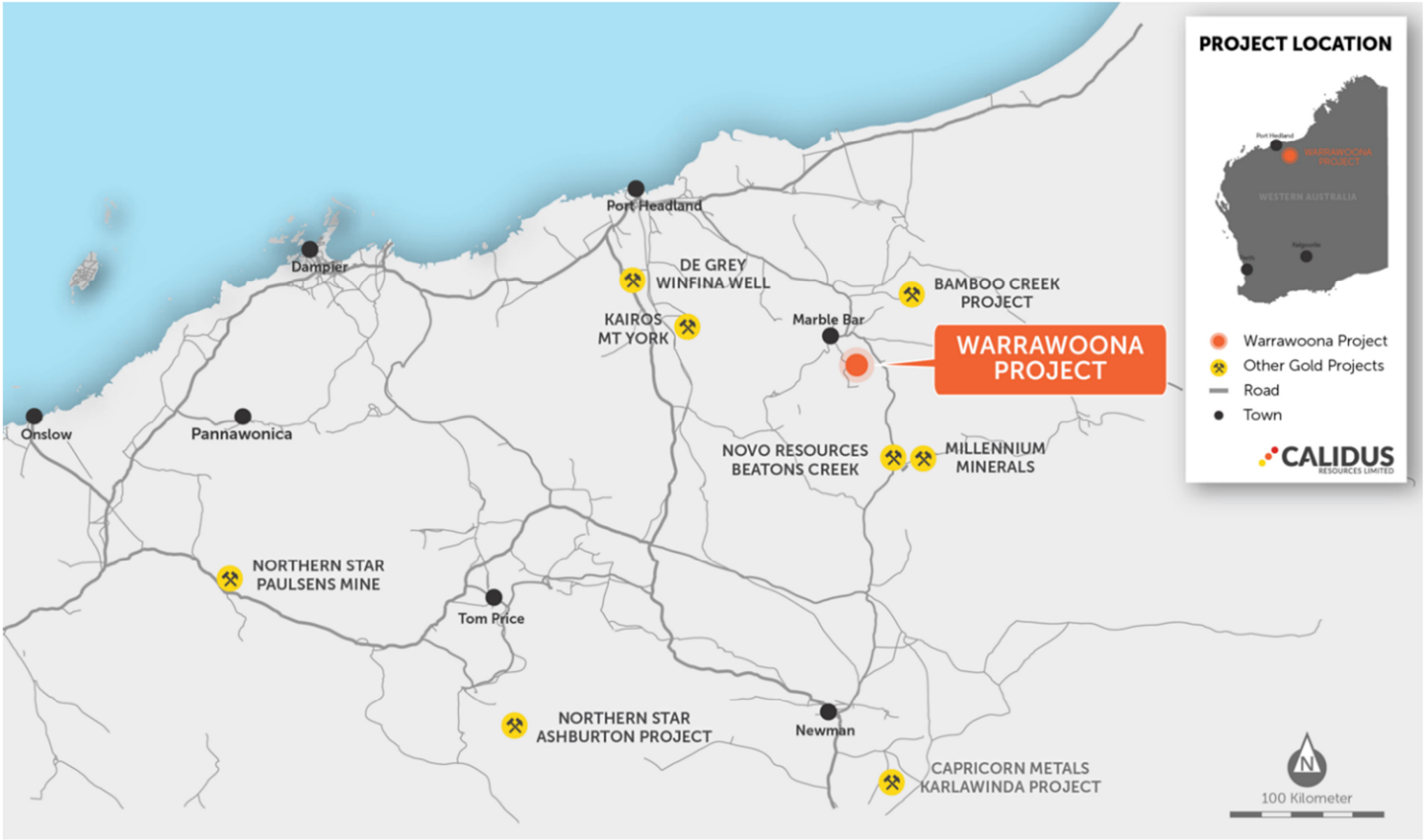


Figure 1.1 Project Location

2 Legislative Context

Environmental legislation relevant to this management plan includes the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act) and the Western Australian Environmental Protection Act 1986 (EP Act), Biodiversity Conservation Act 2016 (BC Act) and Mining Act 1978 (Mining Act).

2.1 EP Act 1986 – Ministerial Statement 1150

Table 2.1: Ministerial Statement 1150 Conditions relating to the SSMP

Condition Number	Definition	SSMP Section
7	**Significant Species Management Plan**	
7.1	Prior to **ground disturbing activities**, unless otherwise agreed by the CEO, the proponent shall finalise and submit a revision of the Significant Species Management Plan (CRL-ENV-PLN-006-19 Rev 2, May 2020_ in consultation with the agency responsible for the administration of the *Biodiversity Conservation Act 2016* (being at the time of this Statement the Department of Biodiversity, Conservation and Attractions). The Significant Species Management Plan shall, when implemented, meet the following environmental objective: (1) Avoid where possible, otherwise minimise direct and indirect impacts to significant fauna and their habitat, including, but not limited to: (a) Pilbara leaf-nosed bat; (b) Ghost bat; (c) Pilbara olive python; and (d) Northern quoll	Table 9.1 (Section 9)
7. 2	The Significant Species Management Plan required by condition 7-1 shall: (1) Specify the environmental objective to be achieved, as specified in condition 7-1; (2) Specify **management actions** to meet the environmental objective; (3) Specify **management targets**; (4) Specify monitoring to determine if **management target**s are being met; (5) Provide the format and timing for the reporting of the monitoring results against **management targets** to demonstrate that condition 7-1 has been met over the	Table 9.1 (Section 9) Appendix 8A and B: Significant Bat Monitoring Methods Appendix 7A and B: Northern Quoll Monitoring Methods

Condition Number	Definition	SSMP Section
	reporting period in the Compliance Assessment Report required by condition 4-6; (6) Specify in accordance with condition 7-5 a process for revision of **management actions** and changes to revised proposal activities, in the event that the **management targets** are not achieved. The process shall include an investigation to determine the cause of the management target(s) not being achieved.	Calidus Incident Management Procedure (CRL-ENV-PRO-024-19 HSE)
7. 3	The Significant Species Management Plan required by condition 7-1 must include provisions required by condition 7-2 to address impact to significant fauna and their habitat including, but not limited to: (1) Clearing of habitat; (2) Fragmentation of habitat; (3) Vehicle strike; (4) Collision with fencing; (5) Managing feral animals; (6) Minimising light and noise impacts; (7) Maintaining humidity at ambient levels suitable for Pilbara leaf-nosed bat at Bow Bells South roost; (8) Managing impacts on the **MEZ** by excluding surface blasting and permanent infrastructure; and (9) Maintaining a 70 decibel A noise limit and 10 millimetres per second vibration limit at Klondyke Queen roost.	Section 8 – Management Measures Table 9.1 (Section 9)
7. 4	After receiving notice in writing from the CEO that the Significant Species Management Plan satisfies the requirements of conditions 7-2 and 7-3, the proponent must: (1) Implement the Significant Species Management Plan, or any subsequent approved versions; and (2) Continue to implement the Significant Species Management Plan until the CEO has confirmed by notice in writing that the proponent has demonstrated the objectives specified in condition 7-1 have been met.	
7. 5	In the event that monitoring, tests, surveys or investigations indicate exceedance of management	Section 10, Section 11

Condition Number	Definition	SSMP Section
	targets specified in the Significant Species Management Plan, the Proponent must: (1) Report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified; (2) Implement the management target contingency actions specified in the Significant Species Management Plan within twenty-four (24) hours and continue implementation on those action until the CEO has confirmed by notice in writing that it has been demonstrated that the management target are being met and the implementation of the contingency actions is no longer required; (3) Investigate to determine the cause of the management target being exceeded; (4) Investigate to provide information for the CEO to determine potential environmental harm that occurred due to the management target being exceeded; and (5) Provide a report to the CEO within twenty-one (21) days of the exceedance being reported as required by condition 7-5(1). The report must include: (a) Details of contingency actions implemented; (b) The effectiveness of the contingency actions implemented, against the management target; (c) The finding of the investigations required by conditions 7-5(3) and 7-5(4); (d) Measures to prevent the management target being exceeded in the future; (e) Measures to prevent, control or abate the environmental harm which may have occurred; and (f) Justification of the management target remaining, or being adjusted based on better understanding, demonstrating that outcomes would continue to be met.	Calidus Incident Management Procedure (CRL-ENV-PRO-024-19 HSE) Table 9.1 (Section 9)
7. 6	The proponent: (1) May review and revise the Significant Species Management Plan; or	Section 13

Condition Number	Definition	SSMP Section
	(2) Must review and revise the Significant Species Management Plan as and when directed by the CEO.	
7. 7	The Proponent must implement the latest revision of the Significant Species Management Plan required in condition 7-1 which the CEO has confirmed by notice in writing, satisfies the requirements of conditions 7-1, 7-2 and 7-3	Section 13

2.1.1 Terminology and Definitions

2.1.2 General Definitions

Table 2.2: General Definitions

Term	Definition
Mining Exclusion Zone	32 hectare conservation zone that incorporates historical workings that are utilised by both Pilbara Leaf-nosed Bat and Ghost Bat
Activities permitted within the Mining Exclusion Zone:	Minor earth works for water dam and light vehicle access Dewatering bore within footprint of exclusion zone – generator fitted with sound proofing to be below noise limit. Monitoring activities
Activities excluded from Mining Exclusion Zone:	Surface Blasting (Underground mine sits below KQ, with 200m vertical buffer) Permanent infrastructure (dams, minor roads will be rehabilitated at closure)
Mining Exclusion Zone Water Dam	Lined dam (approx. 10m by 10m) constructed as a water source for fauna utilising the Mining Exclusion Zone.
DWER	Department of Water and Environmental Regulation
DMIRS	Department of Mines, Industry Regulation and Safety
DBCA	Department of Biodiversity, Conservation and Attractions
AWE	Commonwealth Department of Agriculture Water and Environment
Minor and Preliminary Works	Works as per application under section 41A(3) of the Environmental Protection Act 1986 • Clearing no more than 25.8 ha of vegetation within the 1000 ha mine Development Envelope for Construction and maintenance of a construction camp (and associated infrastructure) for about 75 personnel, • Construction and maintenance of a site access road 8.6 km long and 20 m wide with associated borrow pits and topsoil stockpiles,

Term	Definition
	• Construction and maintenance of Utilities corridor
Abandonment	To depart from permanently, this is outside of the natural fluctuations and variations of population estimates as is being determined through baseline monitoring to allow for the development of lower and upper control levels.
Commencement of Mining Operations	The commencement of excavation for the purpose of mineral extraction.
Klondyke Queen Roost or Klondyke Queen workings	Refers to Klondyke Queen – Adit, Klondyke Queen – Open Cut, Klondyke Queen – Hill Top. All are the same roost due to workings being interconnected - collectively known as Klondyke Queen. Roost type depends on the species (Pilbara leaf-nosed Bat or Pilbara Ghost Bat).
Bow Bells South	Bow Bells South Adit and Bow Bells South Shaft are the same roost due to workings being interconnected - collectively known as Bow Bells South. Roost type depends on the species (Pilbara leaf-nosed Bat or Pilbara Ghost Bat).

2.1.3 Conservation Significant

Vertebrate fauna species are deemed to be of conservation significance if they are afforded protection under the EPBC Act and/or BC Act. A summary of applicable legislation and status codes is provided in Table 2.3. For some species, there is insufficient information to determine their status. These species are also considered by the EPA and DBCA as being of conservation significance for all development related approvals and are listed on a 'Priority List' that is regularly reviewed and maintained by the DBCA.

Table 2.3: Definitions and terms for fauna of conservation significance

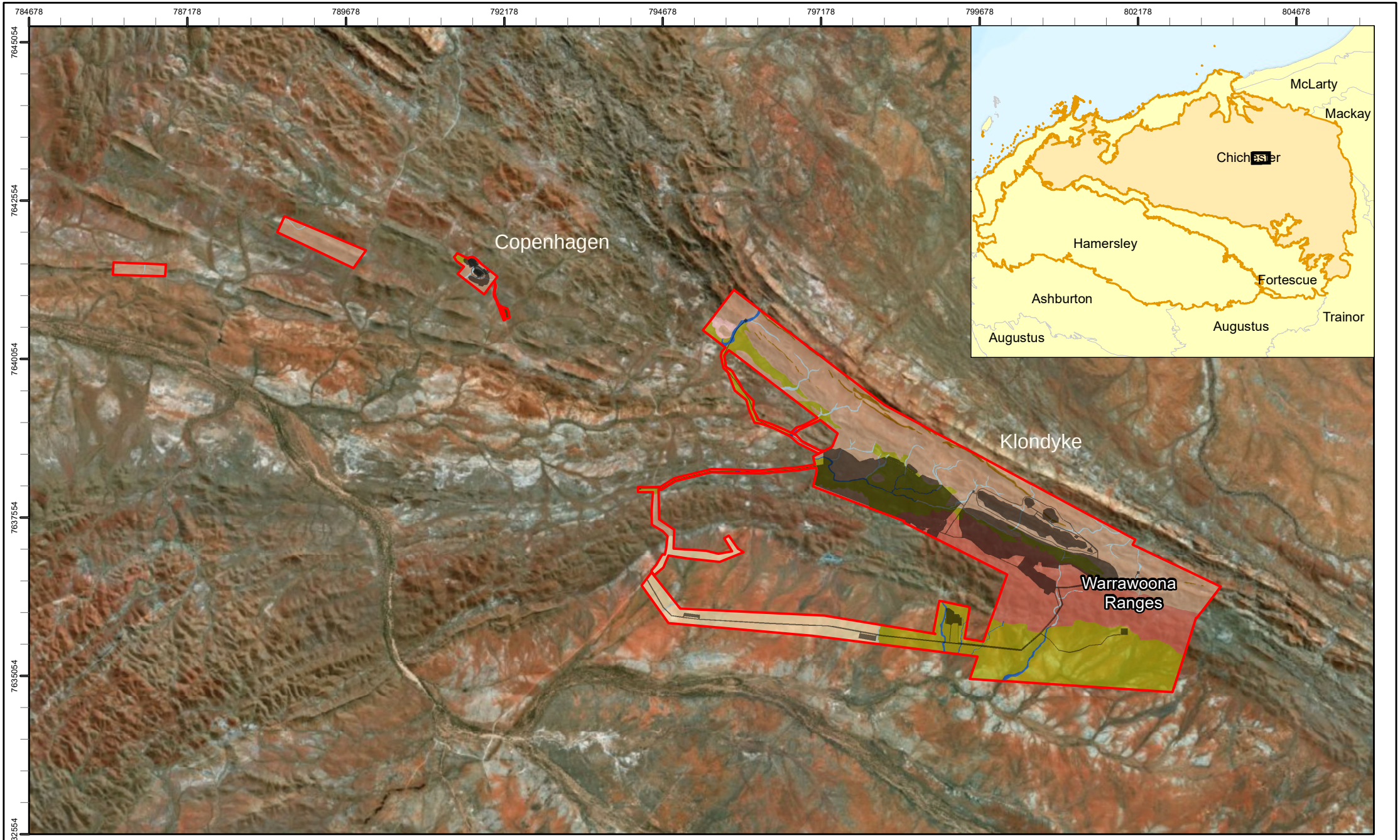
Agreement, Act or List	Status Codes
Federal	
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)** The Department of Agriculture, Water and Environment (AWE) lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) per criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Migratory (MG) • Marine (MA)
State	
***Biodiversity Conservation Act 2016* (BC Act)** At a state level, native fauna are protected under the *Biodiversity Conservation Act 2016*. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Migratory (MI) • Conservation Dependent (CD) • Other Specially Protected (OS)
DBCA Priority List DBCA produces a list of Priority species that have not been assigned statutory protection under the *Biodiversity Conservation Act 2016*. This system gives a ranking from Priority 1 to Priority 4.	• Priority 1 (Poorly known species) (P1) • Priority 2 (Poorly known species) (P2) • Priority 3 (Poorly known species) (P3) • Priority 4 (Rare, Near Threatened, and other species in need of monitoring) (P4)

For the purposes of this Plan, conservation significant fauna have been limited to terrestrial vertebrate fauna species that meet the criteria above and have been: recorded within the study area, have the potential to occur in the project area and new conservation significant species identified during project surveys or ongoing monitoring activities.

2.1.4 Project Terminology

Project terminology is as follows:

- The Project refers to the Warrawoona Gold Project which falls within the study area
- study area is defined as the area over which field surveys have been conducted (approximately 1,822 ha), as documented in (Biologic, 2019b, 2019c) (Figure 2.1).
- Development Envelope refers to the 1000 ha area within which Calidus intends to clear no more than 398.5 ha.



Legend

- Study Area
- Disturbance footprint

Habitat

- Claypan
- Disturbed
- Hillcrest/Hillslope
- Medium Drainage Line
- Minor Drainage Line
- Rocky Breakaway
- Rounded Hills
- Sandplain
- Stony Plain

biologic Environmental Survey

N

1:75,000

0 0.75 1.5 3 km

Calidus Resources - Warrawoona Gold Project
2019 Significant Species Survey
Warrawoon Impact Assessment
Figure 2.1 **Study Area and Regional Location**

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

Size A4. Created 24/09/2019

3 Roles and Responsibilities

All Calidus employees and contractors are required to comply with the requirements of this plan.

Accountability for fulfilling the requirements of this procedure is dependent on the stage of Project development (exploration, construction, operations, decommissioning).

During exploration, the Exploration Manager will be accountable for ensuring the requirements of the procedure are met.

During construction stages, whether activities are undertaken by an external service provider or internal Calidus personnel, the Project Manager / Registered Manager will be accountable for ensuring the requirements of this procedure are met.

During operational, decommissioning and closure stages, the General Manager (Registered Manager) will be accountable for ensuring the requirements of this procedure are met.

Table 3.1 – Calidus' roles and responsibilities for SSMP implementation

Role	Responsibility
Exploration Manager/ Project Manager / Registered Manager/ General Manager	Accountable for ensuring the requirements of the plan are met dependent on the stage of project development.
Senior Environmental Advisor	Implement and maintain the SSMP. Review the SSMP. Annual Audit of Compliance. Deliver monitoring/reporting data to the AWE, DBCA, DMIRS and DWER. Review and update, where applicable, the conservation status of fauna within the Warrawoona Project annually.
Site Environmental Advisor	Implement monitoring programs. Maintain monitoring records. Implement and deliver awareness training programs to personnel, contactors and visitors. Record all sightings of or incidents involving conservation significant fauna. Assess ground disturbance and access applications. Ensure all personnel involved in fauna surveys are appropriately licensed and qualified. Investigate any incidents involving conservation significant species and implement findings where relevant.
Construction and Operation Managers	Endorse implementation of the SSMP by Project personnel and contractors.

Role	Responsibility
All personnel, contractors and visitors	Participate in awareness training prior to commencing duties. Implement SSMP in daily activities, where relevant. Report all sightings and/or incidents involving conservation significant fauna.

4 Baseline Surveys

Numerous surveys have been undertaken in the Study Area since 2016, including three which were focussed on assessing the likelihood of occurrence for vertebrate species of conservation significance. Eight surveys targeting the two conservation bat species utilising methods appropriate for their detection have been undertaken. This includes studies monitoring population sizes and fluctuations, assessments on changes to roosting habitat, a genetic study, and two tracking studies investigating foraging habitat within the Study Area.

These surveys have been summarised below in Table 4.1 and Table 4.2. Baseline surveys for the Warrawoona Gold Project are summarised in detail in (Biologic, 2019b, 2019c).

Table 4.1: Summary of survey effort for terrestrial fauna surveys conducted within the Study Area

Survey Title	Year of survey	Survey Type	Survey effort	Conservation Significant Species recorded
Warrawoona Level 1 Vertebrate Fauna, and Desktop SRE and Subterranean Assessment (Biologic, 2017b)	Sept 2017	Level 1 survey	34 motion camera nights (3 sites) 12 habitat assessments	Northern Quoll (2 individuals) Western Pebble Mound Mouse
Warrawoona Gold Project: Habitat Assessment and Targeted Vertebrate Fauna Survey ((Biologic, 2018b))	July 2018	Targeted survey	40 acoustic recording nights (10 sites) 156 motion camera nights (4 sites) 12 habitat assessments	Northern Quoll (6 individuals)
Warrawoona Gold Project: 2019 Significant Species Monitoring (Biologic, 2019a)	April 2019	Targeted survey	33 acoustic recording nights (3 sites) 346 motion camera nights (5 sites) 40 habitat assessments	Northern Quoll (3-4 individuals) Pilbara Olive Python Brush-tailed Mulgara

Table 4.2: Summary of survey effort for Pilbara Leaf-nosed Bat and Ghost Bat surveys conducted within the Study Area

Study	Objective	Season	
Monitoring bats of conservation significance near Marble Bar, Western Australia: November 2016	Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Baseline data on usage and occupancy of mines in the Marble Bar area	Early Dry Season	(Specialised Zoological, 2017b)
Monitoring bats of conservation significance near Marble Bar, Western Australia: April 2017	Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Baseline data on usage and occupancy of mines in the Marble Bar area	Late Wet Season	(Specialised Zoological, 2017a)
Pilbara Ghost Bat Genetic Project 2017 (Unpublished	Ghost Bat Genetic Project	Late Wet Season	(Biologic, 2017a)

Study	Objective	Season	
report prepared for the BHP Billiton Iron Ore Pty Ltd).	Genetic and hormone analyses of ghost bat tissue and scats for increasing knowledge of cave use and movement by bats.		
Warrawoona Targeted Bat Assessment September 2017	Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Population estimates (ultrasonic recordings and video censuses) Assess underground workings within the Study Area in terms of providing roosting habitat for Pilbara Leaf-nosed Bat and Ghost Bat	Late Dry Season	(Biologic, 2018c)
Warrawoona Targeted Bat Assessment – July 2018	Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Population estimates (ultrasonic recordings and video censuses)	Dry Season	(Biologic, 2018b)
Warrawoona Targeted Bat Assessment – April 2019	Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Population estimates (ultrasonic recordings and video censuses)	Late Wet Season	(Biologic, 2019e)
Warrawoona Gold Project: VHF Bat Foraging Studies July 2018	Pilbara Leaf-nosed Bat and Ghost Bat Foraging Study (VHF) Use VHF tracking to assess foraging habitats and movement patterns	Dry Season	(Biologic, 2018a)
Warrawoona Gold Project: VHF Bat Foraging Studies April 2019	Pilbara Leaf-nosed Bat and Ghost Bat Foraging Study (VHF) Use VHF tracking to assess foraging habitats and movement patterns	Late Wet Season	(Biologic, 2019d)

5 Fauna Values

5.1 Conservation Significant Species

Of the 319 species of vertebrate fauna identified as being previously recorded and/ or having the potential to occur, 29 species are of conservation significance, comprising nine mammals, 18 birds and two reptiles. Four of these species have been recorded within the Study Area:

- Northern Quoll (*Dasyurus hallucatus*) listed as Endangered under the EPBC Act and BC Act;
- Pilbara Olive Python (*Liasis olivaceus barroni*) listed as Vulnerable under the EPBC Act and BC Act;
- Brush-tailed Mulgara (*Dasycercus blythi*) listed as a Priority 4 by DBCA; and
- Western Pebble-Mound Mouse (*Pseudomys chapmani*) listed as a Priority 4 by DBCA;
- Significant roost sites of Ghost Bat (*Macroderma gigas*) and the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*) both listed as listed as Vulnerable under the EPBC Act and BC Act; are also present in the Study Area and are discussed in Section 5.2

A further three species of conservation significance are considered “likely” to occur in the Study Area, the:

- Greater Bilby (*Macrotis lagotis*), listed as Vulnerable under the EPBC Act and BC Act;
- Peregrine Falcon (*Falco peregrinus*), listed as Specially Protected under the BC Act;
- Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardti*), listed a Priority 3 species by DBCA;

Four species are "possible" to occur, the:

Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*), listed as Vulnerable under the BC Act;

- Grey Falcon (*Falco hypoleucos*), listed as Vulnerable under the BC Act;
- Long-tailed Dunnart (*Sminthopsis longicaudata*), listed as a Priority 4 by DBCA; and
- Black-lined Ctenotus (*Ctenotus nigrilineatus*), listed as a Priority 4 by DBCA.

The remaining sixteen species are considered "rarely", "unlikely" or "high unlikely" to use the Study Area, including the Night Parrot Pezoporus occidentalis. Note that there are 'no unique fauna assemblages', no species with restricted ranges, or species required for ecological integrity recorded in the Study Area. Fourteen migratory bird species are recorded as potentially using the artificial water sources present in the Study Area (Biologic, 2017b). These are deemed as "Unlikely" or "Rarely" to occur based on the distance to previous records and a lack of habitat features (e.g. tidal mudflats, samphire, mangroves) associated with these water sources that are considered part of the species preferred habitat types. However, these migratory species are included within this SSMP due to the TSF which has the potential to attract individuals passing through the area.

5.1.1 Habitats

Habitat mapping across the study area includes a total of eight broad fauna habitat types (excluding disturbed areas). This comprises, in increasing order of extent, Claypan, Medium Drainage Line, Rocky Breakaway, Minor Drainage Line, Sandplain, Rounded Hills, Stony Plain, and Hillcrest/ Hillslope. The Rocky Breakaway is deemed to be of high significance as it provides high density denning and foraging habitat for the Northern Quoll, and foraging habitat for the Pilbara Olive Python, Ghost Bat, and Pilbara Leaf-nosed Bat. The Sandplain habitat type in the southern portion of the Study Area is also considered of high significance as it supports Brush-tailed Mulgara, and potentially Night Parrot and Greater Bilby (Biologic, 2019c). Fauna habitats of the study area are detailed in Table 5.1 (Figure 2.1). Significant Bat Habitat is discussed in Section 5.3.

Table 5.1: Fauna Habitats of the Warrawoona Gold Project Study Area.

Habitat	Habitat Value Score	Reason for significance	Area within Study Area	
			ha	%
Rocky Breakaway	High	• Northern Quoll - Provides core denning and foraging habitat • Pilbara Olive Python – provides core foraging habitat	19	1.03
Sandplain	High	• Greater Bilby and Brush-tailed Mulgara – provides core burrowing and foraging habitat • Spectacled Hare-Wallaby – core foraging habitat and shelter • Night Parrot – potential foraging and nesting habitat	137	7.51
Medium Drainage Line	Moderate	• Northern Quoll and Pilbara Olive Python - Provides dispersal and foraging habitat	19	1.02
Rounded Hills	Moderate	• Northern Quoll - Provides dispersal and foraging habitat	339	18.61
Hillcrest/ Hillslope	Moderate	• Northern Quoll - Provides dispersal and foraging habitat • Western Pebble-Mound Mouse – provides core habitat	718	39.42
Minor Drainage Line	Moderate	• Northern Quoll and Pilbara Olive Python - Provides dispersal and foraging habitat	31	1.69
Stony Plain	Moderate	• Western Pebble-Mound Mouse – provides core habitat • Spectacled Hare-Wallaby – core foraging habitat and shelter • Night Parrot – potential habitat	548	30.07
Claypan	Low	• No conservation significant species occurring or likely to occur are solely dependent on this habitat type within the Study Area or vicinity. It may be used by migratory birds when inundated.	6	0.33
		Total	**1,822**	**100**

5.1.2 Fauna Habitat Features

No semi-permanent or permanent waterbodies have been recorded within the study area during the survey. It is likely that temporary waterbodies, such as in the Claypan and Major Drainage Line habitats, will be present in the study area after significant rainfall events.

No significant caves were recorded within the study area and none are likely to occur based on the habitats present.

5.2 Conservation Significant Bats

5.2.1 Roosts

5.2.1.1 Pilbara Leaf-nosed Bat

The Threatened Species Scientific Committee, (2016b) categorises underground refuges used by the Pilbara Leaf-nosed Bat into one the following standard categories:

- Permanent diurnal roosts (Priority 1) —occupied year-round and likely the focus for some part of the 9-month breeding cycle; considered as critical habitat that is essential for the daily survival of the Pilbara Leaf-nosed Bat
- Non-permanent breeding roosts (Priority 2) —evidence of usage during some part of the 9-month breeding cycle (July–March), but not occupied year-round; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara Leaf-nosed Bat.
- Transitory diurnal roosts (Priority 3) —occupied for part of the year only, outside the breeding season (i.e. April–June), and which could facilitate long distance dispersal in the region; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara Leaf-nosed Bat.
- Nocturnal refuge (Priority 4) —occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. Excludes overhangs. Not considered critical habitat but are important for persistence in a local area.

5.2.1.2 Ghost Bat

There are no published roost for definitions for Ghost Bat.

Klondyke Queen and Comet are Priority 1 roosts (permanent with a large population)

Bow Bells South and Dawson City are Priority 2 roosts. All others within the Warawoona Study area are priority 3 or 4.

Priority 1 and 2 critical habitat covers the roost cave itself and a grouping of nearby Priority 3 and 4 refuges that work as an "apartment block" providing alternative feeding and refuge sites. i.e. Klondyke Queen, together with Dawson City and Klondyke Boulder plus the other old workings within mine exclusion zone. Bob Bullen pers com (2 October 2019).

Two sites within the Study Area, the Klondyke Queen (permanent maternity roost) and Bow Bells South (occasional diurnal roost), are considered significant Ghost Bat roosts. In addition, there are occasional diurnal Ghost Bat Roosts within Dawson City, Criterion and Klondyke Boulder workings. Nocturnal/Night Roosts occur in many of the old workings across the study area (Biologic, 2019b) (Appendix 2 and 3).

5.2.2 Ghost Bat

The highest count of the species at the Klondyke Queen adit is 475, recorded via visual counts and infra-red video in April 2019 (Biologic, 2019f) (Table 5.2).

The Ghost Bat was first confirmed at Klondyke Queen in 1957, approximately twelve years subsequent to the cessation of mining. Since this time the species has been confirmed consistently, via visual observations, from the Klondyke Queen adit. Breeding activity of the species was confirmed during the early 1990's (Hall et al., 1997), with several gravid and lactating females recorded. The consistent presence of the species indicates that the roost is likely to be permanent and represent a maternity site. The population of Ghost Bat on the Warrawoona study area is estimated to be 500 individuals. (Bob Bullen pers com 3 October 2019).

The species has also been recorded at various disused mines within the vicinity of the study area, specifically at Bow Bells, Comet (breeding records), Coronation, Marble Bar Copper and Trump mines (Armstrong and Anstee, 2000); (Hall et al., 1997)) Together with other large colonies such as Lalla Rookh, the subregion is known to support a population of approximately 1,500 individuals (Threatened Species Scientific Committee, 2016a). Table 5.2 below summarizes the population estimates of Ghost Bat at the Klondyke Queen in the study area.

Table 5.2: Baseline counts of Ghost Bat recorded at Klondyke Queen

Date	*No Recorded	Notes	Source
1957	#		Armstrong and Anstee (2000)
28/05/1959	287	May have contained repeat individuals	(Douglas, 1967)
01/05/1981	40		Hall *et al.* (1997)
08/07/1987	8		
21/09/1992	#	2 gravid and 2 with mammae present females; 5 males	
22/12/1992	#	4 lactating females; 1 with mammae present;	
03/10/1993	#	3 gravid females, 6 males with abdominal testes	
11/04/1993	#	3 females with mammae, 8 males with scrotal testes	
24/04/1994	98+	12 males, 1 female	
14/07/1994	20+	2 gravid females	
18/07/1995	40+		
20/06/1996	30+		
12/06/2001	254		Biota Environmental Sciences (2001)

Date	*No Recorded	Notes	Source
13/06/2001	338		
29/06/2001	108	On nights after drilling activity	
30/06/2001	127		
01/07/2001	107		
02/07/2001	121		
03/07/2001	128		
04/07/2001	106		
05/07/2001	366		
Feb 2006	185	Visual count of bats exiting	McKenzie and Bullen (2009)
07/11/2016	366	No refers to observed, 352 recorded via camera	Specialised Zoological (2017b)
08/11/2016	80	No refers to observed, 102 recorded via camera	
22/04/2017	24		Specialised Zoological (2017a)
28/04/2017	28		
05/05/2017	200+	Five captured, four females and one male	Biologic, (2017a)
Sept 2017	265	Visual count of bats exiting	Biologic, (2018c)
July 2018	450	Visual count of bats exiting	Biologic (2018b)
April 2019	475	Visual count of bats exiting and infra-red video	Biologic, (2019d)

Where '+' is noted, means this was the minimum number of bats present at the time
'#' indicates bats confirmed present but no count was completed
* Methods to achieve this figure may have varied

5.2.3 Pilbara Leaf-nosed Bat

Two Pilbara Leaf-nosed Bat colonies are confirmed to be present within the study area; a large colony at Bow Bells South and a small number of diurnally roosting bats at the Klondyke Queen. Both are considered Permanent Diurnal Roosts (Biologic, 2019f), with observations of pregnant bats exiting the Bow Bells South adit in January 2019 (R. Bullen pers comms in Biologic, 2019f). The numbers at Klondyke have fluctuated substantially the colony was discovered (Table 5.3). The population of the Pilbara Leaf-nose Bat on the Warrawoona study area is estimated at approximately 1500-2000 individuals. Pilbara Leaf-nosed Bat counts within Klondyke Queen complex and Bow Bells South fluctuate dependent on which roost the Pilbara Leaf -nosed Bat are utilising at the time of monitoring (Bob Bullen pers com 3 October 2019).

Table 5.3: Baseline counts of Pilbara Leaf-nosed Bat recorded at Klondyke Queen

Date	+ Estimated Population	Notes	Source
1967	-	Douglas (1967) netted the mine entrance on multiple occasions in search of Ghost Bat, no *R. Aurantia* were recorded.	Douglas (1967)
1/05/1981	~350 (between 300 and 500)	Comprising 40 non-pregnant females and 35 males. Bats commenced exodus half an hour after sunset. They appeared to time their exits with other bats (*V. Finlaysoni and Taphozous* spp.). Two and a half hours after sunset *R. Aurantia* began to return. Two hours later the ratio of *R. Aurantia* returning had exceeded those leaving	Churchill *et al.* (1988)
21/09/1992	1+	One male (no breeding evidence)	Hall *et al.* (1997)
14/07/1994	5+	One female, four males (no breeding evidence)	
18/07/1995	7+	One female, five males (no breeding evidence)	
1/06/1996	5+	Exact date within month unknown	Armstrong (2001)
1/09/1996	4	Exact date within month unknown	
1/05/1997	2	Exact date within month unknown	
1/09/1997	1	Exact date within month unknown	
1/03/1998	2	Exact date within month unknown	
1/12/1998	2	Exact date within month unknown	
12/06/2001	10+		Armstrong (2010) Biota (2001)
13/06/2001	10+		
29/06/2001	10+		
30/06/2001	10+		
1/07/2001	10+		
2/07/2001	10+		
3/07/2001	10+		
4/07/2001	10+		
5/07/2001	10+		
8/11/2016	+	152 calls, first record +8 after civil twilight	Specialised Zoological (2017b)
9/11/2016	+	96 calls, first record -12 before civil twilight	
10/11/2016	+	73 calls, first record -8 before civil twilight	
26/04/2017	+	23 calls recorded from adit, 72 recorded from roof, first call was 1.47 hours after civil twilight	Specialised Zoological (2017a)
27/04/2017	+	56 calls recorded from adit, 226 recorded from roof, first call was 0.59 minutes after civil twilight	
28/04/2017	+	77 calls recorded from adit, 307 recorded from roof, first call was 12 minutes after civil twilight	
29/04/2017	+	98 calls recorded from adit, 457 recorded from roof, first call was 13 minutes after civil twilight	
5/05/2017	+	Individuals recorded acoustically at the adit entrance near civil twilight	Biologic (2017b)
Sept 2017	+	>3000 calls recorded acoustically, and bats sighted visually at the adit entrance near civil twilight	Biologic (2017d)

Date	+ Estimated Population	Notes	Source
July 2018	+	>4,800 calls recorded acoustically, and bats sighted visually at the mine entrances near civil twilight, however a video recording within the upper adit confirmed that there were no bats roosting diurnally.	Biologic (2018)
April 2019	~1500	1,500 recorded exiting by IR-lit video on a single night	Biologic (2019f)
'+' indicates the minimum number of individuals present - or if no number indicates that bats were present * Methods to achieve this figure may have varied			

5.3 Significant Bat Habitat and Habitat Features

Utilising VHF tracking, it was determined that the proposed Klondyke Pit and TSF are not significant foraging grounds for either species, although Pilbara Leaf-nosed Bats were consistently using these development areas as a flight path. Ghost Bats tended to leave the study area upon emergence from their diurnal roost, using flight paths outside the study area along the northern edge of the Warrawoona Ranges. The preferred foraging grounds for both species are likely to be out of the study area, particularly to the plains north of the Warrawoona Ranges, and for Pilbara Leaf-nosed Bats also the region north-west of Bow Bells (Biologic, 2019d).

The existing Copenhagen open pit did not represent a crucial foraging ground or water source for either species; however, its significance may increase towards the end of the dry season. The 2019 study also recorded a single Ghost Bat individual roosting and foraging at the Comet mine for three consecutive evenings over the course of the foraging study Biologic, (2019d) showing that there is movement of Ghost Bat between Klondyke and Comet.

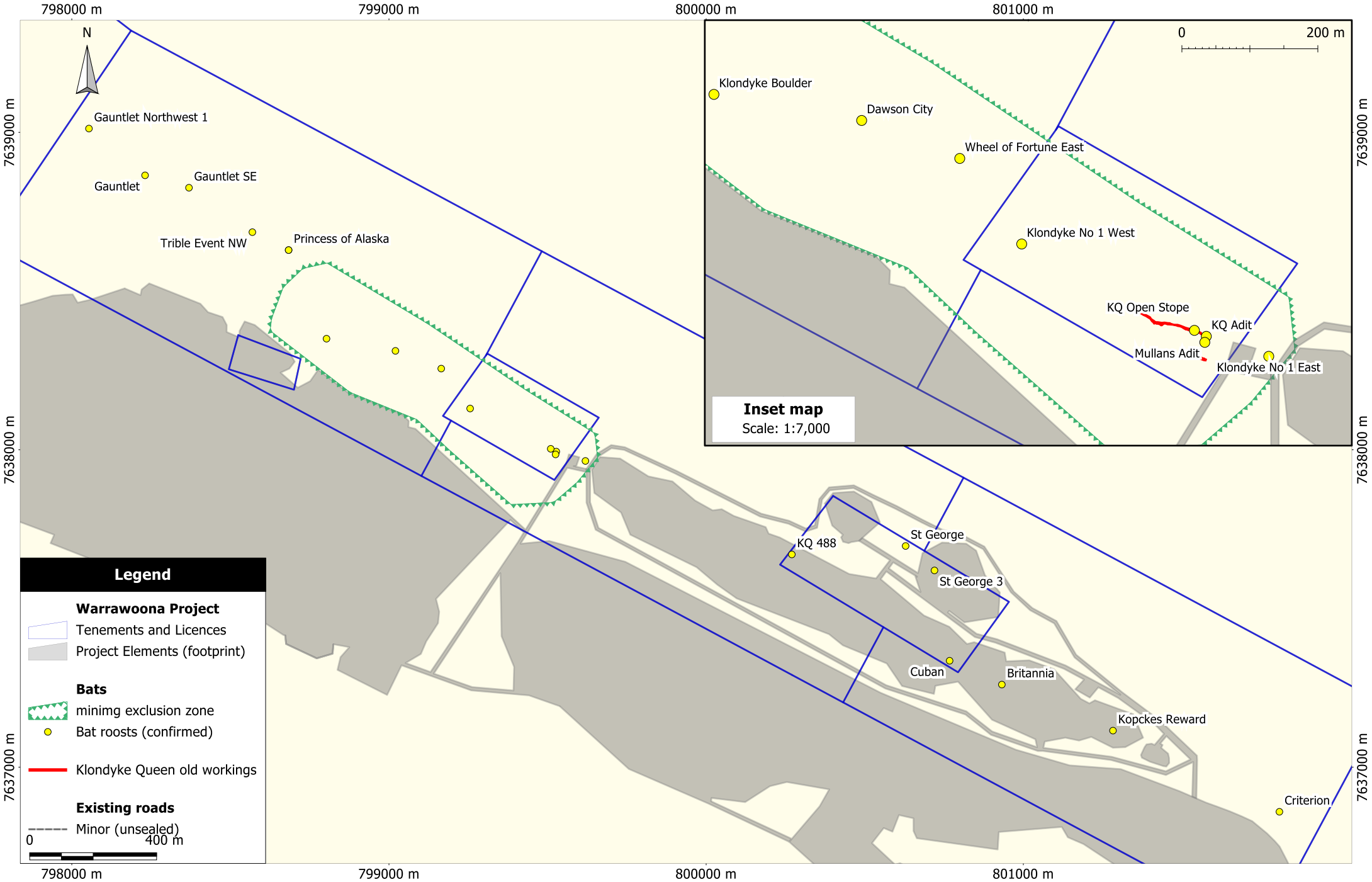
Table 5.4 classifies the habitat types within the Warrawoona Study Area with priority foraging habitats of Pilbara Leaf-nosed Bat. The habitats of the study area are made up of Priority 3 to Priority 5 habitats, Open grassland and woodland making up the majority of the study area (Priority 5 97 percent), followed by major watercourses (Priority 4 - 2 percent) and rocky outcrop (Priority 3 – 1 percent)

Figure 5.1 shows the roost locations proximal to the Warrawoona Gold Project.

Table 5.4: Classification of habitat types within the Warrawoona Study Area with priority foraging habitats of Pilbara Leaf-nosed Bat, as defined by the Threatened Species Scientific Committee, (2016b).

Foraging habitat category	Priority	Description	Availability within the Warrawoona Study Area	Area (ha) (% of Study Area)
Gorges with pools	Priority 1 (sites of relatively large biomass production, sometimes containing caves)	Watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months;	No gorges with pools are recorded in the Study Area. Temporary waterbodies are likely to present in the Claypan or Major Drainage Line after significant rainfall events.	0
Gullies	Priority 2 (less biomass production than Priority 1 gorge habitat)	Primary drainage with limited riparian development in upland rocky habitats, sometimes containing small pools that may last for weeks	Gorge/gully habitat is not a recorded habitat type within the Study Area. Minor gullies may exist in the Rounded Hills habitat.	0
Rocky outcrop	Priority 3	Areas of exposed rock at the top of rocky outcrop and mesa hills that contain caves and overhangs, and boulder piles in the granite terrains	Rocky breakaway habitat is recorded in the Study Area, running in a linear fashion along the northern edge of the Study Area. Although it represents the highest quality Priority 3 foraging habitat within the Study Area, only 18.6 ha of this habitat type has been recorded, and such represents a small proportion of the total area. The Rounded hills habitat type may potentially present some sections of rocky outcrop, as may the Hillcrest/ hillslope.	18.6 (1.0 %)

Foraging habitat category	Priority	Description	Availability within the Warrawoona Study Area	Area (ha) (% of Study Area)
Major watercourses	Priority 4 (generally supports higher productivity of biomass than the surrounding habitats)	Riparian vegetation on flat land plus the main gravelly or sandy channel of the riverbed, sometimes containing pools that persist for weeks or months	The Study Area is dissected by both Medium Drainage Line and Minor Drainage Line, associated with drainage from the Hillcrest/ hillslopes and ranges throughout the Study Area. It is likely that temporary waterbodies will be present in these habitat types after significant rainfall events. The Claypan habitat may also contain suitable Priority 4 habitat through inundation after heavy rainfall events.	55.5 (3.1 %)
Open grassland and woodland	Priority 5	Dominated by Triodia, on lowland plains, colluvial slopes and hilltops.	The Sandplain, Stony Plain, Hillcrest/ hillslope, and Rounded hills habitat types recorded in the Study Area are associated with *Triodia* hummock grassland, with scattered *Eucalyptus* trees and mallee, and *Acacia* and *Grevillea* shrubs. Combined, these habitat types make up the vast majority of the Study Area.	1,742.0 (95.9 %)



Rapallo environmental

Calidus Resources
Warrawoona Gold Project
Summary of EPA Preliminary Factors

CALIDUS RESOURCES LIMITED

Original Size: A4
Scale: 1:15,000
Datum: MGA94 Zone 50

0 400 m

Figure 5.1

Ghost Bat and Pilbara Leaf-nosed Bat roosts immediately adjacent Klondyke mine, including mining exclusion zone

6 Potential Impacts Conservation Significant Species

Each stage of the Project (construction, operation and closure/rehabilitation) has the potential to affect the abundance, distribution and condition of conservation significant fauna within the Project area and surrounds. Potential impacts of the Project on terrestrial fauna of conservation significance are summarised in Table 6.1 and Appendix 4.

Table 6.1: Potential impacts of the Project on terrestrial fauna of conservation significance.

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Removal, fragmentation or modification of habitat (including reduced or prevention of access to feeding or roosting habitats)	Total land disturbance of approximately 350 ha* (including roads, mining pits, Tailings Storage Facility, processing plant, camp etc). Total disposal of no more than 22 million loose cubic metres (LCM) adjacent surface Disposal of up to 2 million tonnes per annum of process tailings at Klondyke	Direct	Habitat loss or reduction in condition	Mortality or displacement of individuals Population fragmentation Decline in population size Local extinction Reduction in the carrying capacity of the environment (where population size levels off through time) Reduced in reproductive success Reduction in diversity
		Indirect	Habitat fragmentation and/or reduction in habitat quality of adjacent areas. Habitat modification or loss due to structural changes (*i.e.* shafts and adits). Disturbance responses or other behavioral changes in individual animals Erosion and altered drainage patterns.	
Vehicle Strike	Indicative total length of roads and pipeline/ powerline corridors of 7.6 km length (approximately 40 ha disturbance* Records of conservation significant fauna vehicle strike in the region *e.g.* Greater Bilby (Outback Ecology Services, 2012).	Direct	Collision with animals.	Mortality or injury of individuals Decline in population size

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Introduced Species	Feral cats (Biologic, 2019a) and Buffel grass (Biologic, 2017a) have been recorded within the study area Other invasive species such as red foxes, cattle, donkey have been recorded in the vicinity	Indirect	Habitat degradation and loss (from grazers and weeds) Competition for resources. Predation Increased mortality from toxic introduced species or management (e.g. poisoning) Introduction/spread of disease. Increased fuel loads from grassy weeds	Mortality of individuals. Decline in population size. Local extinction.
Increased light, noise, or vibration	Unquantified. Temporary mobile lighting will be installed in active mine pits and active operational areas. Noise and vibration from the operation of heavy machinery Noise and vibration from site works including blasting.	Direct	Disturbance responses or other behavioral changes in individual animals, especially for light sensitive species. Species using audible cues for breeding activity may also experience disruption to breeding cycles or reduced breeding success.	Displacement of individuals Reduction in reproductive success Decline in population size Reduction in diversity Reduction in carrying capacity Local extinction
		Indirect	Habitat modification or loss due to structural changes from vibration (i.e. shafts, adits). Changes in prey item aggregation for insectivorous species, resulting in changes to foraging behavior	

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Vibration	Noise and vibration from the operation of heavy machinery Noise and vibration from site works including blasting.	Indirect	Disturbance responses or other behavioral changes in individual animals Habitat modification or loss due to structural changes from vibration (i.e. shafts, adits) - the Pilbara Olive Python was recorded from a shaft.	Displacement of individuals Reduction in carrying capacity Reduction in faunal diversity.
Dust	Unspecified but increases certain to occur, particularly after blasting	Indirect	Habitat modification due to degradation of vegetation or topsoil modification	Displacement of individuals Reduction in carrying capacity Reduction in faunal diversity.
Changed Fire Regimes	Unspecified.	Indirect	Habitat modification; high frequency or intensity can reduce understory habitat cover and reduce food sources such as seeding grass for graminivorous birds. High frequency fires may impact fire sensitive species (*e.g.* Mulga) or increase dominance of early stage Triodia communities. Low frequency fires can result in dominance of senescent vegetation and high fuel loads	Reduction in carrying capacity. Reduction in faunal diversity.

Impact source	Occurrence of impact within the Warrawoona Study Area	Impact pathways and potential impacts		Potential outcomes on fauna
Altered water quality	Known production of cyanide waste to occur in TSF. Cyanide level is expected to be contained to < 30mg/L	Direct	Mortality or illness due to decreased water quality, in particular in relation to cyanide levels in water sources.	Mortality/ displacement of individuals Temporal changes in carrying capacity Temporal changes in population size Temporal changes in diversity
Modification to water regimes	Minor reduction to pre-mining runoff for surface catchments present Advanced dewatering will occur in the Klondyke pit	Direct	Disturbance response from water-dependent species (e.g. migratory avian species, bat species)	Mortality/ displacement of individuals Temporal changes in carrying capacity Temporal changes in population size Temporal changes in diversity
		Indirect	Habitat modification arising from local hydrogeological changes, including change in distribution and abundance of vegetation	

7 Potential Impacts to Conservation Bat Species

Table 7.1: Potential impacts of the Project on Ghost Bat and Pilbara Leaf-nosed Bat

Impact Source	Occurrence of impact within the Warrawoona study area*	Impact Pathways		Potential impacts on fauna
Removal, fragmentation or modification of habitat (including reduced or prevention of access to feeding or roosting habitats)	Total land disturbance of 398.5 ha (including roads, mining pits, Tailings Storage Facility, processing plant, camp etc). The mining of the Klondyke Pit will result in the removal of five old workings (KQ488, Cuban, Kopckes Reward, St George 3 and Britannia). All five workings are lower value roosts for Pilbara Leaf-nosed Bat (Nocturnal Refuge) and/or Ghost Bat (Night Roost).	Direct	Habitat loss or reduction in condition	Mortality or displacement of individuals Population fragmentation Decline in population size Local extinction Reduction in carrying capacity Reduced in reproductive success Reduction in diversity
		Indirect	Habitat fragmentation and/or reduction in habitat quality of adjacent areas. Habitat modification or loss due to structural changes (i.e., loss or modification of roosts). Erosion and altered drainage patterns.	
Vibration	Drilling and blasting for the Klondyke pit Drilling and blasting associated with the Klondyke underground Vibration from nearby heavy machinery	Direct	Habitat modification or loss due to structural changes (i.e., loss or modification of roosts).	Mortality or displacement of individuals Decline in population size Reduction in carrying capacity Reduced in reproductive success Reduction in diversity
		Indirect	Disturbance responses or other behavioral changes in individual animals	
Introduced species	Feral cats (Biologic, 2019a) and Buffel grass (Biologic, 2017c) have been recorded within the study area Other invasive species such as red foxes, cattle, donkey have been recorded in the vicinity Cane toads have not been recorded in the study area.	Direct	Habitat degradation and loss, from grazers and weeds. Competition for resources. Predation Increased mortality from toxic introduced species	Mortality of individuals. Decline in population size
		Indirect	Introduction/spread of disease. Increased fuel loads from grassy weeds	
Increased light and/or noise	Light spill will occur particularly in the mine pit and around infrastructure and roads. Light placement and design will minimise light spill	Direct	Disturbance responses or other behavioral changes in individual animals, as targeted bat species are light sensitive. Species using audible cues for foraging and socialization may experience disruption.	Displacement of individuals Reduction in reproductive success Decline in population size Reduction in diversity Reduction in carrying capacity Local extinction
		Indirect	Habitat modification or loss due to structural changes from vibration (i.e. roosts in mining adits). Changes in prey item aggregation, resulting in changes to foraging behavior	

Impact Source	Occurrence of impact within the Warrawoona study area*	Impact Pathways		Potential impacts on fauna
Dust	Dust emissions will increase, particularly after blasting. Dust deposition can also be expected adjacent unsealed roads and mine pits,	Direct	Impact to vision following events causing high dust levels	Displacement of individuals Reduction in foraging success Reduction in carrying capacity Reduction in faunal diversity.
		Indirect	Habitat modification due to degradation of vegetation or topsoil modification	
Changed fire regimes	Unspecified.	Indirect	Habitat modification; high frequency or intensity can reduce understory habitat cover and reduce food sources. Low frequency fires can result in dominance of senescent vegetation and high fuel loads	Reduction in carrying capacity. Reduction in faunal diversity.
Vehicle strike	Indicative total land disturbance of roads and pipeline/ powerline corridors of 36.37 ha. approximately 29 km of roads, comprising a main road of ~7.6 km and 21.4 km worth of internal mine roads and maintenance tracks ('slower' tracks)	Direct	Collision with animals.	Mortality of individuals Decline in population size
Altered water quality	Known production of cyanide waste to occur in TSF. Cyanide level is expected to be contained to < 30mg/L Nickel arsenic levels within the Klondyke pit post closure	Direct	Mortality or illness due to decreased water quality, from cyanide and Nickel arsenic in water sources. Disturbance responses from the bat colonies (as water-dependent species)	Mortality/ displacement of individuals Temporal changes in carrying capacity Temporal changes in population size Local extinction
		Indirect	Pollution to water sources resulting in changes to prey availability and distribution	
Modification of water regimes	Some reduction to pre-mining runoff for surface catchments present Advanced dewatering will occur in the Klondyke pit	Direct	Dewatering impacting known water sources such as the Copenhagen open pit	Displacement of individuals Temporal changes in carrying capacity
		Indirect	Reduction in habitat quality due to changes in water seepage and roost humidity. Habitat modification arising from local hydrogeological changes, including change in distribution and abundance of vegetation Dewatering and discharge resulting in changes to prey availability and distribution.	Mortality/ displacement of individuals Temporal changes in carrying capacity Temporal changes in population size Local extinction
*Note areas and distances are preliminary and subject to minor changes				

Table 7.2: Summary of roosts from within the Warrawoona Gold Project to be removed during mining

Site	Easting	Northing	Site Description	Pilbara Leaf-nosed Bat Use	Ghost Bat Use
Britannia	800932	7637260	Two deep shafts if unknown depth	Nocturnal refuge	-
Cuban	800767	7637335	4 vertical shafts of unknown depth, but not very deep	Nocturnal refuge	Night roost
KQ 488	800270	7637670	Deep cut with shaft. Good potential habitat	Nocturnal refuge	Night roost
St George 3	800719	7637619	Deep shaft	Nocturnal refuge	
Kopckes Rewards	801126	7637179	Two deep shafts	Nocturnal refuge	

8 Management Measures

Management measures have been developed to control and mitigate impacts to conservation significant fauna from the Project. The management measures in this section have been classified as either Standard Management Measures; which are measures developed and implemented to manage and mitigate impacts to all conservation significant terrestrial vertebrate fauna, or Species-Specific Management Measures which are measures developed and implemented for a conservation significant fauna species that has been confirmed as present in the Project area and may potentially be impacted by the Project.

8.1 Standard Management Measures

This section details the management measures relevant to all conservation significant terrestrial vertebrate fauna. These management measures have been developed in consideration of baseline studies (Section 4), identified potential project impacts (Section 6), specialist advice and industry best practices.

The following management measures will be implemented:

- Clearing in/of sensitive habitats including caves, cliff lines, waterholes, gorges, ridges, outcrops, drainage lines, scree slopes and crevices will be kept to the minimum necessary for safe construction and operation of the Project.
- No more than 398.5ha of vegetation within the 1000ha Development Envelope will be cleared/disturbed.
- Clearing and disturbance of vegetation will be kept to the minimum necessary for safe construction and operation of the Project.
- Clearing will occur in accordance with Calidus' Ground Disturbance Permit Procedure (CRL-ENV-PRO-001-19). No clearing will occur without prior authorisation from Calidus' Ground Disturbance Permitting System.
- Night-time vehicle movements will be restricted where possible to minimise the potential for vehicle strikes.
- Signage identifying the presence of conservation significant fauna will be installed along the roads, where they intersect suitable habitat.
- Borrow pits and process water ponds will be designed and constructed to permit egress of fauna.
- Turkey's nests will be fenced to at least 1.8m (to prevent fauna entry / mortality) and constructed to ensure a point of fauna ingress/egress.
- The landfill will be operated and managed in accordance with the Environmental Protection (Rural Landfill) Regulations 2002). This will include fencing to reduce the potential for attracting fauna.
- The Warrawoona Environmental Advisor will maintain a database and maps detailing, the location of:
    - Conservation significant species and habitat.
    - Impact exclusion zones.

  - Cleared areas.
  - Rehabilitated areas.
- The Warrawoona Environmental Advisor will maintain a database detailing, the fauna monitoring schedule for the site.
- Vehicle speed limits will be imposed and enforced on Project roads.
- Off-road driving will be prohibited unless otherwise authorised by Senior Management.
- Noise, dust and light emissions will be controlled where possible to avoid excessive disturbance to native fauna, including directing lights to working areas, shielding lights to reduce glow, and using conventional dust suppression techniques (i.e. water trucks).
- Blasting will occur as per the Blast Management Plan and Procedures
- Blasting will be restricted to daytime operations.
- Cyanide will be managed as per the TSF and Cyanide Management Procedures (CRL-ENV-PRO-019-19).
- Soluble Arsenic from the NAZ waste will be managed via the Metalliferous Drainage Management Procedure (CRL-ENV-PRO-022-1919).
- All bins storing putrescible waste will have tightly secured lids to avoid fauna attraction and entry.
- Fire Breaks will be maintained, and procedures developed to manage hot works.
- Awareness training will identify conservation significant fauna and habitat and discuss relevant management measures, personnel/contractor responsibilities, and incident reporting requirements (i.e. reporting of fauna observations and/or incidents).
- All fauna mortalities and injuries will be reported to the Environmental Advisor within 24 hours and recorded within Calidus's incident reporting system (CRL-ENV-PRO-024 -19).
- All sightings of non-indigenous fauna and conservation significant fauna will be reported to the Environmental Advisor.
- The Environmental Advisor will report all conservation significant fauna injuries and mortalities to DBCA within one week (CRL-ENV-PRO-024 -19).
- Where required, fauna will be handled and transported in accordance with the procedures outlined in the DBCA's Standard Operating Procedure for Transport and Temporary Holding of Wildlife V1.1 2017.
- Interactions with fauna (e.g. feeding, harassment, capture, killing) are not permitted unless specifically authorised by the Senior Environmental Advisor.
- Domestic pets are prohibited.
- A feral fauna control program will be implemented, and a database of all feral animals captured will be maintained as a complement to the database of sightings.

- A targeted feral animal control program will be implemented where sightings are regular and/or if nuisance or dangerous individuals are seen (Introduced Fauna Control Procedure CRL-ENV-PRO-009-19)
- Vehicle weed hygiene procedures (CRL-ENV-PRO-003-19) will be implemented at all times for vehicles and equipment entering and departing the Project area.
- A weed monitoring and management programme will be developed, to ensure that any existing and new weed infestations within areas of Project disturbance (including areas of rehabilitation) are identified and controlled or eradicated.

8.2 Species-Specific Management Measures

This section details management measures specific to species which have been confirmed to be present within the study area and are likely to be impacted by the Project; namely, the Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat.

8.2.1 Northern Quoll

The estimated population size in the study area is comparable to that of Indee Station (annual population sizes between 3 -12 females and 0 – 3 males), considered to offer the area of highest suitability for northern quolls in the Pilbara (Hernandez-Santin et al., 2019).

Critical denning habitat for the Northern Quoll comprises rugged, rocky areas, often in close association with permanent water (Oakwood, 2000; Molloy et al., 2015), consistent with Rocky Breakaway habitat within the study area.

The Rocky Breakaway habitat type, provides high density denning and foraging habitat for the Northern Quoll. The Warrawoona Gold project will disturb 0.8ha of this habitat type, which represents just 4.6% of the Rocky Breakaway habitat type recorded across the project area, and only 0.2% of the total disturbance footprint. This habitat type is well represented outside the project area, across the Warrawoona Range and throughout other ranges of the Pilbara IBRA region more broadly.

The Medium/Minor Drainage Lines provide dispersal and foraging habitat for the Northern Quoll. The project will disturb 14.3ha of Medium and Minor drainage lines, which represents 28.9% of the recorded drainage line habitat types of the project area, which is just 3.6% of the total disturbance footprint. These drainage line habitat types are widespread throughout the Pilbara IBRA region

The Hillcrest/ Hillslope and Rounded Hills habitat types both contain small rocky breakaways that provide additional denning habitat for the Northern Quoll. The project will disturb 138.1ha of Hillcrest/Hillslope and 89.2ha of Rounded Hills, which represents 19.2% and 26.3% of their recorded habitat types in the project area respectively. Combined, these two widely distributed habitat types of the Pilbara make up 57% of the total disturbance footprint.

In addition to the implementation of the Standard Management Measures, Calidus is committed to implementing the following Species-Specific Management Measures for the Northern Quoll:

- A Northern Quoll monitoring program will be implemented. Monitoring will be undertaken using techniques consistent with AWE and DBCA requirements and previous survey work undertaken on the Warawoona Project Area. The Northern Quoll monitoring program will use Motion Detecting Cameras and will occur annually on a selection of control and impact area sites within the high to medium rated habitats. Further information on Northern Quoll monitoring is located in Appendix 7A and 7B.
- Inductions will provide detailed information about the Northern Quoll, including identification and employee and contractor responsibilities.
- Northern Quoll sightings, injuries and mortalities will be reported to the Environmental Advisor in accordance with Calidus' HSE Incident Management Procedure (CRL-ENV-PRO-024 -19).

8.2.2 Ghost Bat and Pilbara Leaf-nosed Bat

In addition to the implementation of the Standard Management Measures, Calidus is committed to implementing a number of species-specific management measures for the Ghost Bat and Pilbara Leaf-nosed Bat. These include:

- Avoidance of 12 Ghost Bat roosts (7-night roosts, 2 occasional diurnal roosts, 2 possible occasional diurnal roosts, 1 permanent maternity roost).
- Avoidance of 17 Pilbara Leaf-nosed Bat roosts (14 nocturnal refuges, 3 x permanent diurnal roost)
- Application of a minimum 200 metre buffer between the Klondyke Queen Adit and the proposed Klondyke Pit. Refer to Appendix 5.
- A Mining Exclusion Zone ~32 ha Mining Exclusion Zone ("bat apartment block") will be maintained. The exclusion zone includes the Pilbara Leaf-nosed Bat buffer (Appendix 5) and will incorporate the following historic workings :
    - Klondyke Queen Complex (KQ Adit, Klondyke Queen Hilltop, Klondyke Open Cut) – PLnB Permanent Diurnal Roost and Ghost Bat Permanent Maternity Roost.
    - Klondyke Boulder - Nocturnal Refuge (PLnB) and Possible occasional Diurnal Roost (GB)
    - Dawson City - Nocturnal Refuge (PLnB) and occasional Diurnal Roost (Ghost Bat)
    - Wheel of Fortune East - Nocturnal Refuge (PLnB) and Night Roost (Ghost Bat)
    - Klondyke No 1 West - Nocturnal Refuge (PLnB) and Night Roost (Ghost Bat)
    - Mullins Adit - Nocturnal Refuge (PLnB) and Possible Diurnal Roost (Ghost Bat)

  - Klondyke No 1 East- Nocturnal Refuge (PLnB) and Night Roost (Ghost Bat)
- Bat roosts, buffers and exclusion zones will be recorded in a site database and mapped on all mine plans. The database will be accessible to all Calidus departments.
- Access to workings known to be occupied by the Pilbara Leaf-nosed Bat and/or Ghost Bat will be restricted (Appendix 2).
- Bow Bells South Adit and Bow Bells South Shaft (collectively known as Bow Bells South) will be avoided (falls outside development envelope).
- Calidus will not install barbed-wire fences or other fences that could cause bat entanglements.
- Blasting techniques will be implemented to lower vibration levels in the vicinity of sensitive areas. As per the Blast Management Plan and Procedures (CRL-ENV-PRO-017-19).
- Blasting will be restricted to daytime operations.
- Sound proofing of generators associated with the production bore within 200 metres of the Klondyke Queen workings.
- Monitoring of groundwater drawdown and annual recalibration of groundwater model to map the cone of depression and it's proximity to Bow Bells South as per Groundwater Management Procedures (CRL-ENV-PRO-021-19).
- Open Pit Development will occur from east to west to allow for adaptive blast management as mining progresses closer to the Klondyke Queen Adit.
- Cyanide will be managed as per the TSF and Cyanide Management Procedure (CRL-ENV-PRO-019-19) which details cyanide destruction and tailings beach management to prevent Bat poisoning from tailings liquor.
- Standard Operating Procedures will be developed via a suitably qualified persons for preclearance of KQ488, Cuban, Kopckes Reward, St George 3 and Britannia workings to ensure that any significant bats inside the workings vacate prior to clearing Appendix 11).
- Mine site inductions will provide detailed information about Ghost Bats and Pilbara Leaf-nosed Bats and employee and contractor responsibilities.
- Research into Significant Bat responses to pit lakes will continue at Copenhagen to determine if Pilbara Leaf-nosed Bats and Ghost Bats are drinking from pits with high metal concentrations (such as Arsenic) or do Pilbara Leaf-nosed Bats and Ghost Bats avoid pit lakes (sinks).
- Research into light spill on Pilbara Leaf-nosed Bats and Ghost Bats
- Bat Monitoring (refer to Appendix 6 and Appendix 9A and 8B).

8.2.3 Other Species

Greater Bilby

There is a potential for Bilby to inhabit the sandplains in the south of the survey area. Proposed infrastructure will involve a road only and the species is known to have low site fidelity and high mobility. Preclearance surveys for Bilby will be undertaken (Appendix 6). As part of operations a significant species register will be maintained.

Pilbara Olive Python
Pilbara Olive Python will be monitored via the cameras set up for Northern Quoll and Significant Bats.

Peregrine Falcon, Spectacled Hare-Wallaby, Northern Brushtail Possum , Grey Falcon, Long-tailed Dunnart; and Black-lined Ctenotus (*Ctenotus nigrilineatus*), will be monitored opportunistically and reported via the Significant Species Register.

Water Birds (including migratory species listed under the EPBC Act) will be monitored via TSF Fauna monitoring procedures (CRL-ENV-PRO-019-19).

9 Performance Objectives, Targets and Management Actions

Performance objectives, targets and management actions for this SSMP are provided in Table 9.1. Should the targets not be met, corrective actions will be implemented.

Table 9.1 – Performance objectives, targets and management actions for conservation significant fauna

Number	Performance Objective	Targets	Management Actions
1	No unauthorised mining or clearing within the Mining Exclusion Zone	No clearing outside the Development Envelope	Check demarcation of areas to be cleared/not cleared has been undertaken and is obvious to those on the ground. Identify likely cause of incident. Implement relevant corrective actions. Report to relevant government authorities. Undertake corrective rehabilitation.
2	No unauthorised mining or clearing within the Klondyke Buffer Zone and Mining Exclusion Zone	No clearing outside the Development Envelope	Check demarcation of areas to be cleared/not cleared has been undertaken and is obvious to those on the ground. Identify likely cause of incident. Implement relevant corrective actions. Report to relevant government authorities. Undertake corrective rehabilitation.
3	No unauthorised mining or clearing near Bow Bells South	No clearing outside the Development Envelope	Check demarcation of areas to be cleared/not cleared has been undertaken and is obvious to those on the ground. Identify likely cause of incident. Implement relevant corrective actions. Report to relevant government authorities. Undertake corrective rehabilitation.

Number	Performance Objective	Targets	Management Actions
4	No road kill incidents of conservation significant fauna.	No incident reports of road kill incidents of conservation significant fauna.	Identify likely cause of incident. Review speed limits and driving procedures. Review number of and locations of fauna signposts. Consider undertaking further education and awareness training.
5	No more than 398.5 ha will be cleared within the Development Envelope.	No clearing of more than 398.5 ha. No clearing outside the Development Envelope.	Check demarcation of areas to be cleared/not cleared has been undertaken and is obvious to those on the ground. Identify likely cause of incident. Implement relevant corrective actions. Report to relevant government authorities. Undertake corrective rehabilitation.
6	Undertake Northern Quoll monitoring on an annual basis.	Monitoring conducted in accordance with methods specified in Appendix 7A and 7B.	Investigate reason for monitoring not to have been undertaken and implement corrective measures to ensure future compliance is achieved. Review Monitoring Procedure to ensure it achieves the desired outcome.
7	Minimise disturbance to Ghost Bats as a result of the project.	No permanent abandonment of Klondyke Queen roost by Ghost Bats as a result of the project	Contingency measures such as regulation of blast size, frequency or timing will be considered if roost abandonment occurs and can be attributed to blasting activities. Maintaining a 70 decibel A noise limit and 10 millimetres per second vibration limit at Klondyke Queen roost.

Number	Performance Objective	Targets	Management Actions
			Pre-clearance SOPs for old workings (Appendix 9).
8	Minimise disturbance to Pilbara Leaf-nosed Bats as a result of the project.	No abandonment of Bow Bells South roost by Pilbara Leaf-nosed Bats as a result of the project. Average humidity records are not to fall below a percentage as determined from baseline monitoring (Appendix 6).	Contingency measures such as regulation of blast size, frequency or timing will be considered if roost abandonment occurs and can be attributed to blasting activities. Maintaining a 70 decibel A noise limit and 10 millimetres per second vibration limit at Bow Bells South. Pre-clearance SOPs for old workings (Appendix 9). Monitoring of groundwater drawdown and annual recalibration of groundwater model to map the cone of depression and it's proximity to Bow Bells South as per Groundwater Management Procedures (CRL-ENV-PRO-021-19). Should the humidity and the groundwater monitoring data and the recalibrated model indicate that groundwater levels in the Bow Bells South workings or in the adjacent monitoring bore (if installed) are likely to be impacted at any time by mine dewatering, to the extent that water levels are at risk of falling below the base of the mine workings, Calidus will commission a programme of works to install a nearby groundwater supply with associated pipework infrastructure to provide a small, permanent makeup flow to the Bow Bells South workings to maintain internal humidity levels. At

Number	Performance Objective	Targets	Management Actions
			completion of operations make-up flow will be maintained until monitoring data shows that groundwater levels have returned to a level that maintains an acceptable humidity range as determined by baseline humidity monitoring and Pilbara Leaf-nosed Bat monitoring. The groundwater model will be checked 12 months prior to closure to allow makeup flow requirements through closure to be planned for. The optimum rate of flow to the workings will be determined from an eco-hydrogeological study which would be undertaken by Calidus.
9	Undertake Pilbara Leaf-nosed and Ghost Bats monitoring on a continuous basis during preconstruction, life of mine through to closure	Monitoring is undertaken as per Standard Operating Procedures developed by a suitably qualified Ecologist utilising a combination of Bat Recorder and video recording at Bow Bells South, Criterion, Dawson City, Klondyke Boulder, Klondyke Queen, Mullins adit), two reference sites (Comet and Trump), and impact sites (such as TSF) (Appendix 6) and 8A. Upper and Lower Control Limits (UCL and LCL) are in development and are currently referred to as Draft Upper and Lower Control Limits (UCL and LCL). Prior to commencement of mining operation, UCL and LCLs will be finalised and , call numbers for each site will be compared to level 1, 2 and 3 trigger values being long-term UCL/LCL, mean +/- 2sd and +/- 3sd respectively (refer to Appendix 8B)	Investigate reason for monitoring not to have been undertaken and implement corrective measures to ensure future compliance is achieved. Review Monitoring Procedure to ensure it achieves the desired outcomes. For survey events that exceed the trigger values, further interrogation of the call data will be undertaken to understand what may have caused the variation. Investigative themes will include clearing activities, blasting, TSF decant WAD cyanide concentration, dewatering activities, natural phenomenon such as rain events, dry periods, moon phase and seasonality.

Number	Performance Objective	Targets	Management Actions
10	Undertake research on Pilbara Leaf-nosed and Ghost Bat utilisation of Open Pit Waters – using Copenhagen	Bats recorded at Copenhagen over different time period especially post dry season. Refer to above regarding Upper and Lower Control Limits (UCL and LCL) trigger values that are in development, to be finalised prior to the commencement of mining (Appendix 8A and 8B).	Investigate reason for monitoring not to have been undertaken and implement corrective measures to ensure research occurs. See above for survey events that exceed the trigger values.
11	Minimise likelihood of Cyanide poisoning to Significant Fauna as a result of the project.	CNWAD monitoring as per the TSF and Cyanide Management Procedure (CRL-ENV-PRO-019-19) As per TSF and cyanide management protocols, fauna monitoring at the TSF will occur twice a day to observe and record wildlife usage. One patrol will be conducted after dawn and the other in late afternoon	Identify likely cause of incident or reason for monitoring not to have been undertaken. Review TSF and cyanide management protocols. Implement corrective measures to ensure future compliance is achieved. Any exceedance of the 30mg/L CNWAD target level will be reported within 7 days to the appropriate regulatory agency.
12	Minimise likelihood of tailings entrapment to Significant Fauna as a result of the TSF	As per TSF and cyanide management procedures (CRL-ENV-PRO-019-19), fauna monitoring at the TSF will occur twice a day to observe and record wildlife usage. One patrol will be conducted after dawn and the other in late afternoon	Identify likely cause of incident. Review TSF and cyanide management protocols in particular decant and beach management. Implement corrective measures to ensure future compliance is achieved.
13	Minimise likelihood of arsenic poisoning to Significant Fauna as a result of the project.	Soluble Arsenic monitoring as per the Metalliferous Drainage Management Procedure (CRL-ENV-PRO-022-1919)	Identify likely cause of incident. Review Metalliferous Drainage management protocols.

Number	Performance Objective	Targets	Management Actions
		Research using existing Copenhagen Pit	Implement corrective measures to ensure future compliance is achieved.
14	Effective waste management procedures.	No significant increase to records of feral animals within camp and administrative facilities (due to poor waste management).	Identify likely cause of incident. Review waste management protocols. Review/increase feral animal control program. Review the feral animal management measures within this SSMP.
15	Successful implementation of the fire prevention and control management strategy.	No Project-related fires.	Identify likely cause of incident. Review fire prevention and control management strategy.
16	Effective weed control.	No new species of Declared weeds or WONS found within the Project area. No significant percentage increase in weed coverage over the Project area as compared to the surrounding pastoral station.	Identify likely cause of incident. Review weed monitoring and management program.
17	Implement Feral Fauna Control Program.	No significant increase in feral fauna numbers during annual monitoring periods.	Review likely cause of increase. Review and revise management measures to stem the increase in numbers within the Project.
18	Manage the proposed Klondyke Underground at closure so that the underground tunnels are conducive to Pilbara Leaf-nose Bat and Ghost Bat roosting.	Klondyke Underground is planned from the beginning of underground development with the endpoint of developing the workings at closure into an	Investigate reason why Klondyke Artificial Roost has not been factored into underground mine design and implement corrective measures to ensure mine design has occurred with the closure end point of Artificial Roost.

Number	Performance Objective	Targets	Management Actions
		artificial roost that can be used by Pilbara Leaf-nose Bat and Ghost Bat. Access to Klondyke Underground is restricted so that the underground tunnels are safe for Pilbara leaf-nosed Bat and Ghost Bats to inhabit. Klondyke Underground Significant Bat Closure Strategy is developed in consultation with a suitably qualified Ecologist 12 months prior to planned completion of operations. Klondyke Underground Closure Bat Strategy is implemented	Investigate reason why Klondyke Underground Significant Bat Closure Strategy has not been developed and implement corrective measures to ensure Strategy is developed.

10 Auditing and Review

10.1 Audits and Investigations

The Senior Environmental Advisor will be responsible for ensuring a compliance audit against the requirements of this SSMP is conducted every 12 months over the life of the Project.

Non-compliance of Management Actions (Table 9.1) shall be investigated as per the Calidus Incident Management Procedure (CRL-ENV-PRO-024-19 HSE) and will be investigated appropriately with additional management measures implemented where required to prevent reoccurrences.

10.2 Reviews

Calidus will undertake an initial review of the SSMP once the Project has received final environmental approvals to ensure all approval conditions, recommendations and commitments are covered. The SSMP will then be reviewed every 12 months or as required. All reviews will consider:

- Outcomes of monitoring programs.
- Changes to the conservation status of fauna species.
- Specialist advice and stakeholder consultation.
- Implementation and effectiveness of management measures and monitoring programs.
- Targets and any management/corrective actions.
- Changes to relevant legislation, policy, guidelines, management plans and industry practices.
- The identification of a conservation significant fauna species not previously confirmed within the Project area.
- Reoccurring incidents of death/injury to any conservation significant fauna.

11 Reporting

This section provides details of Calidus' reporting requirements by this SSMP. A summary of reporting requirements is provided in Table 11.1

Table 11.1 – Reporting Requirements

Department	Detail	Timing
Calidus Internal	Incident Reporting	As required
Calidus Internal	Opportunistic Reporting	As required
Calidus Internal	Preclearance Fauna Reporting	Prior to Clearing as per mine and construction schedule
Calidus Internal	Fauna Specialist Reports (Significant Bats and Northern Quoll)	Annually (NQ) and quarterly (Bats)
Calidus Internal	Groundwater model update	Annually and 12 months prior to closure
Calidus Internal	Klondyke Underground Significant Bat Closure Strategy	12 months prior to planned completion of operations
AWE	Annual Compliance Report	Annually
AWE	Non-compliance with any of the conditions of the EPBC approval must be reported to the AWE within a week of the non-compliance being detected	As Required
DMIRS	Annual Environment Report	Annually
DWER	Compliance Assessment Report	Annually
DWER	In the event that monitoring, tests, surveys or investigations indicate exceedance of management targets specified in the Significant Species Management Plan, the Proponent must: (1) Report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified; Provide a report to the CEO within twenty-one (21) days of the exceedance being reported	As Required
DBCA	Fauna injury or mortality Report Key Project Milestones relating to Blast distance from the KQ.	As Required

11.1 Internal Reporting

11.1.1 Incident Reporting

All fauna injuries and mortalities within the Project area will be reported to the Warrawoona Environmental Advisor, in accordance Calidus' HSE Incident Management Procedure (CRL-ENV-PRO-024 -19 HSE).

All incidents are reported through Calidus' Incident Reporting System and will be investigated appropriately with additional management measures implemented where required to prevent reoccurrences.

All fauna incidents are also recorded in the fauna incidence database and summaries are included in Calidus' annual compliance reports (DWER and AWE).

11.1.2 Opportunistic Reporting

All conservation significant fauna sightings are reported through Calidus' Incident Reporting System and will be investigated appropriately with additional management measures implemented where required.

A summary will be included in Calidus' annual compliance reports (DWER and AWE).

11.1.3 Fauna Specialist Reports

The fauna specialist conducting monitoring for conservation significant species for which species-specific management has been implemented will report to Calidus on each monitoring event. The specialist reports will be reviewed internally to ensure compliance with the SSMP objectives and targets.

11.2 External Reporting

11.2.1 Department of Water and Environmental Regulation

Summary of conservation significant fauna sightings, injuries and mortalities within the Project area within the Significant Species Register, as well as performance in accordance with the objectives, targets and management/corrective actions listed in Table 9.1

This includes the results of the following monitoring programs:

- Northern Quoll Monitoring Program
- Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Program
- Preclearance Surveys Significant Bats

Any significant changes to this SSMP will be also noted.

11.2.2 Department of Agriculture, Water and the Environment

Summary of conservation significant fauna sightings, injuries and mortalities within the Project area within the Significant Species Register, as well as performance in accordance with the objectives, targets and management/corrective actions listed in Table 9.1

This includes the results of the following monitoring programs:

- Northern Quoll Monitoring Program
- Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Program
- Preclearance Surveys Significant Bats

Any significant changes to this SSMP will be also noted.

11.2.3 Department of Minerals, Industry, Resources and Safety

DMIRS's AER will include a summary of the significant fauna monitoring results and compliance with approval conditions.

11.2.4 Department of Biodiversity, Conservation and Attractions

Any mortality to conservation significant fauna will be reported to the DBCA, with their standard Fauna Report Form. This combined with internal review will determine if further actions are appropriate.

Regular bat monitoring data updates to the DBCA Environmental Management Branch, corresponding to key project milestones such as

- blasting for the first time
- blasting at significantly closer locations to the Klondyke Queen Roost.
- Adaptive management resulting from monitoring data

12 Adaptive Management

Calidus will implement adaptive management practices to learn from the implementation of, monitoring, mitigation and evaluation against targets, to effectively meet the performance objectives. Adaptive management practices that will be assessed for this Significant Species Management Plan as part of this approach will include:

1. Evaluation of the monitoring program, data and comparison to baseline data and reference sites on an annual basis to verify whether responses to project activities are the same or similar to predictions.
2. Evaluation of assumptions and uncertainties of the management and monitoring program including

    - Review of data and information gathered over the review period that has increased understanding of site environment in the context of the regional ecosystem.

- Review of monitoring timings and methods as the project matures, and new methods and technologies become available that may be more effective for monitoring.
- Review of management actions as the project matures and new management measures and technologies become available that may be more effective for environmental management
- Assessment of changes which are outside the control of the project and the management measures identified (i.e. a new project within the area or region; regional change affecting management).

13 Change Management

Changes to this SSMP will be as per Ministerial Statement 1150 Condition 7.6 (Table 2.1) and EPBC 2019/8584 approval conditions).

14 Related Documentation:

CRL-ENV-STA-001-19 Environmental Management Standard

CRL-ENV-PRO-019-19 TSF and Cyanide Monitoring Procedure

CRL-ENV-PRO-022-1919 Metalliferous Drainage Management Procedure

CRL-ENV-PRO-017-19 Environmental Blast Management Procedure

CRL-ENV-PRO-002-19 Pre-stripping and Topsoil Management Procedure

CRL-ENV-PRO-024 -19 HSE Incident Management Procedure

CRL-ENV-PRO-001-19 Ground Disturbance Permit Procedure

CRL-ENV-PRO-021-19 Groundwater Management Procedures

CRL-ENV-PRO-003-19 Weed Hygiene Procedure

CRL-ENV-PRO-025-1 Feral Animal Management Procedure

CRL-ENV-PRO-011-19 Flora Management Procedure

CRL-ENV-PRO-015-19 Dust Management Procedure

DBCA's Standard Operating Procedure for Transport and Temporary Holding of Wildlife V1.1 2017.

CRL-ENV-PRO-024-19 Underground Workings Clearance Procedure – Significant Bats

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Appendix 1: Roost classification of mine workings within the Study Area, with annual activity levels

Site	Roost significance (highest recorded)		Pilbara Leaf-nosed Bat activity levels				Ghost Bat activity levels			
	Pilbara Leaf-nosed Bat	Ghost Bat	2019	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)	2019 Activity per night recorded	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)
Bow Bells Block 1	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	58 (av calls/night) (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Bow Bells South** - Adit	Permanent Diurnal Roost	Occasional Diurnal Roost	>1,750 (av calls/night)	> 2800 calls (548 individuals recorded exiting)	>4000 (Biologic, 2017d)	3-25 calls	11 recorded via video. >35 ultrasonic calls recorded per night.	Av 15 calls/night at adit	1 recorded via video-camera (Biologic, 2017d)	Present (no quantification of numbers)
Bow Bells South – Shaft**	Permanent Diurnal Roost	Occasional Diurnal Roost	Not sampled	>4,200 av calls/night (Biologic, 2018)	>1,100 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	~10 calls p.n. ultrasonic and social	~150 calls (Biologic, 2017d)	Not sampled
Britannia	Nocturnal Refuge	-	No calls recorded	Not sampled	10 (av calls/night)	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
British Exploration of Australia	Nocturnal Refuge	-	Not sampled	Not sampled	9 calls av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	1 call	Not sampled
Comet	Nocturnal Refuge	Permanent Maternity Roost	2 (av calls/night)	~25 calls/night	5 calls (Biologic, 2017d)	No calls recorded	269 recorded visually	~130 calls (67 via visual counts)	105 recorded visually (Biologic, 2017d)	Present (>43)

Site	Roost significance (highest recorded)		Pilbara Leaf-nosed Bat activity levels				Ghost Bat activity levels			
	Pilbara Leaf-nosed Bat	Ghost Bat	2019	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)	2019 Activity per night recorded	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)
Copenhagen Open Cut	Foraging site	Foraging site	23 (Range 20 - 26 calls per night)	Av 43 calls over 5 nights (range 27-68)	177 calls (Biologic, 2017d)	83 – 392 calls	No calls recorded	No calls recorded	No calls recorded	No calls recorded
Criterion	Nocturnal Refuge	Possible occasional Diurnal Roost	15 (av calls/night)	Not sampled	25 (Biologic, 2017d)	Not sampled	25 calls recorded	Not sampled	No calls recorded	Not sampled
Cuban	Nocturnal Refuge	Night roost	Not sampled	Not sampled	-	Not sampled	Not sampled	Not sampled	10 calls	Not sampled
Dawson City	Nocturnal Refuge	Occasional Diurnal Roost	126 (Range 107 - 152 calls per night)	610 calls/night	>1000 calls per night (av 727) (Biologic, 2017d)	Not sampled	~10 calls p.n.	<5 calls on two nights, 1 individual recorded exiting	10 calls (Biologic, 2017d)	Not sampled
Gauntlet	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	7 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	1 call (Biologic, 2017d)	Not sampled
Gauntlet SE	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	24 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	1 call (Biologic, 2017d)	Not sampled
Gift – Decline	Nocturnal Refuge	-	Not sampled	Not sampled	25 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	1 call (Biologic, 2017d)	Not sampled

Site	Roost significance (highest recorded)		Pilbara Leaf-nosed Bat activity levels				Ghost Bat activity levels			
	Pilbara Leaf-nosed Bat	Ghost Bat	2019	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)	2019 Activity per night recorded	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)
Gift – Shaft	Nocturnal Refuge	-	Not sampled	Not sampled	132 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	No calls recorded	Not sampled
Golden Gauntlet	Nocturnal Refuge	-	Not sampled	Not sampled	16 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	No calls recorded	Not sampled
Klondyke 1 East	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	7 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	8 calls	Not sampled
Klondyke 1 west	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	7 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	4 calls (Biologic, 2017d)	Not sampled
Klondyke Boulder	Nocturnal Refuge	Possible occasional Diurnal Roost	79 (Range 65 - 93 calls per night)	1,070 av calls/night	1070 calls/night (Biologic, 2017d)	Not sampled	~3 calls p.n.	<5 calls	5 calls (Biologic, 2017d)	Not sampled

Site	Roost significance (highest recorded)		Pilbara Leaf-nosed Bat activity levels				Ghost Bat activity levels			
	Pilbara Leaf-nosed Bat	Ghost Bat	2019	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)	2019 Activity per night recorded	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)
Klondyke Queen – Adit*	Permanent Diurnal Roost	Permanent Maternity Roost	~1,500 recorded exiting by IR-lit video	July 2018: >4800 calls and bats sighted	April 2017: Between 23 – 98 calls from the adit and 72 – 457 calls from the roof over four nights May 2017: Individuals recorded Sep 2017: >3000 calls and bats sighted	Nov 2016: 152, 96, and 73 calls over three nights (Specialised Zoological, 2017b)	~475 recorded exiting by IR-lit video	July 2018: 450 visual count of bats exiting	April 2017: 24 and 28 recorded May 2017: 200 recorded on camera, five individuals captured Sept 2017: 265 visual count of bats exiting	Nov 2016: 366 and 80 individuals observed over two nights
Klondyke Queen* – Hill Top	Permanent Diurnal Roost	Permanent Maternity Roost	Not sampled	Not sampled	255 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	~ 10 recorded visually (Biologic, 2017d)	Not sampled
Klondyke Queen* – Open Cut	Permanent Diurnal Roost	Maternity Roost	Not sampled	Not sampled	>3,000 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	~ 5 recorded visually (Biologic, 2017d)	Not sampled

Site	Roost significance (highest recorded)		Pilbara Leaf-nosed Bat activity levels				Ghost Bat activity levels			
	Pilbara Leaf-nosed Bat	Ghost Bat	2019	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)	2019 Activity per night recorded	2018 (Biologic, 2018)	2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)	2016 (Specialised Zoological, 2017b)
Klondyke Queen 488	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	58 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	4 calls (Biologic, 2017d)	Not sampled
Kopckes Reward	Nocturnal Refuge	-	Not sampled	Not sampled	5 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	No calls recorded	Not sampled
Marble Bar Copper	Nocturnal Refuge	Foraging Site	Not sampled	53 av calls/night (Biologic, 2018)	12 av calls/night (Biologic, 2017d)	Present (no quantification of numbers) (Specialised Zoological, 2017a, 2017b)	Not sampled	1 call (Biologic, 2018)	No calls recorded	Present (no quantification of numbers) (Specialised Zoological, 2017a)
Mullan's	Nocturnal Refuge	Possible Diurnal Roost	Not sampled	Not sampled	113 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	13 calls (Biologic, 2017d)	Not sampled
St George	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	6 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	2 calls (Biologic, 2017d)	Not sampled
St George 3	Nocturnal Refuge	-	Not sampled	Not sampled	2 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	No calls recorded	Not sampled

Site	Roost significance (highest recorded)		Pilbara Leaf-nosed Bat activity levels				Ghost Bat activity levels			
	Pilbara Leaf-nosed Bat	**Ghost Bat**	**2019**	**2018 (Biologic, 2018)**	**2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)**	**2016 (Specialised Zoological, 2017b)**	**2019 Activity per night recorded**	**2018 (Biologic, 2018)**	**2017 (Biologic, 2017b, 2017d; Specialised Zoological, 2017a)**	**2016 (Specialised Zoological, 2017b)**
Trible Event NW	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	25 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	1 call (Biologic, 2017d)	Not sampled
Trump	Nocturnal Refuge	Foraging site	25 (av calls/night)	270 (av calls/night)	2 (Biologic, 2017d)	Technical error	~15 calls pn	1-3 calls/night	< 5 calls p.n.	Technical error (no calls recorded)
Wheel of Fortune East	Nocturnal Refuge	Night Roost	Not sampled	Not sampled	5 av calls/night (Biologic, 2017d)	Not sampled	Not sampled	Not sampled	1 call (Biologic, 2017d)	Not sampled

* Klondyke Queen – Adit, Klondyke Queen – Open Cut, Klondyke Queen – Hill Top are the same roost due to workings being interconnected f
** Bow Bells South Adit and Bow Bells South Shaft are the same roost due to workings being interconnected
Refer to (Biologic, 2019b) for full referenced table.

Appendix 2: Roost classification of mine workings within the Study Area per species and location

Site	Roost significance (highest recorded)		In Study Area	In Mining Exclusion Zone	In Warrawoona Gold Project Disturbance Envelope	Outside Study Area	Comment
	Pilbara Leaf-nosed Bat	Ghost Bat					
Bow Bells Block 1	Nocturnal Refuge	Night Roost	X				
Bow Bells South - Adit	Permanent Diurnal Roost	Occasional Diurnal Roost	X				Same Roost Workings are Connected
Bow Bells South - Shaft	Permanent Diurnal Roost	Occasional Diurnal Roost	X				Same Roost Workings are Connected
Britannia	Nocturnal Refuge	-	X		X		
British Exploration of Australia	Nocturnal Refuge	-	X				
Comet	Nocturnal Refuge	Permanent Maternity Roost				X	
Copenhagen Open Cut	Foraging site	Foraging site	X				
Criterion	Nocturnal Refuge	Possible occasional Diurnal Roost	X				
Cuban	Nocturnal Refuge	Night roost	X		X		
Dawson City	Nocturnal Refuge	Occasional Diurnal Roost	X	X			
Gauntlet	Nocturnal Refuge	Night Roost	X				
Gauntlet SE	Nocturnal Refuge	Night Roost	X				
Gift – Decline	Nocturnal Refuge	-	X				
Gift – Shaft	Nocturnal Refuge	-	X				
Golden Gauntlet	Nocturnal Refuge	-	X				
Klondyke 1 East	Nocturnal Refuge	Night Roost	X	X			
Klondyke 1 west	Nocturnal Refuge	Night Roost	X	X			
Klondyke Boulder	Nocturnal Refuge	Possible occasional Diurnal Roost	X	X			
Klondyke Queen - Adit	Permanent Diurnal Roost	Permanent Maternity Roost	X	X			Same roost, workings are connected
Klondyke Queen – Hill Top	Permanent Diurnal Roost	Permanent Maternity Roost	X	X			Same roost, workings are connected
Klondyke Queen – Open Cut	Permanent Diurnal Roost	Permanent Maternity Roost	X	X			Same roost, workings are connected
Klondyke Queen 488	Nocturnal Refuge	Night Roost	X		X		
Kopckes Reward	Nocturnal Refuge	-	X		X		
Marble Bar Copper	Nocturnal Refuge	Foraging Site				X	
Mullan's	Nocturnal Refuge	Possible Diurnal Roost	X	X			

Site	Roost significance (highest recorded)		In Study Area	In Mining Exclusion Zone	In Warrawoona Gold Project Disturbance Envelope	Outside Study Area	Comment
	Pilbara Leaf-nosed Bat	Ghost Bat					
St George	Nocturnal Refuge	Night Roost	X		X		
St George 3	Nocturnal Refuge	-	X		X		
Trible Event NW	Nocturnal Refuge	Night Roost	X				
Trump	Nocturnal Refuge	Foraging site				X	
Wheel of Fortune East	Nocturnal Refuge	Night Roost	X	X			

* Klondyke Queen – Adit, Klondyke Queen – Open Cut, Klondyke Queen – Hill Top are the same roost due to workings being interconnected f
** Bow Bells South Adit and Bow Bells South Shaft are the same roost due to workings being interconnected
Blue = Roosts to be removed, Pink Significant Roosts

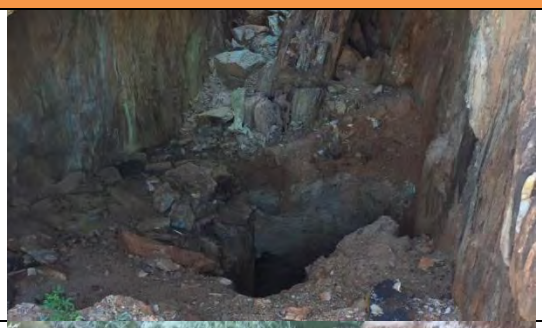
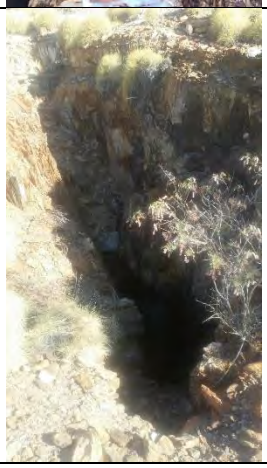
Appendix 3: Descriptions of Old Workings

Site	Easting	Northing	Entrance Photo
Bow Bells Block No 1	-21.31326	119.85700	
Bow Bells South - Adit	-21.31668	119.85944	
Bow Bells South - Shaft	-21.31668	119.85944	
Britannia	-21.34170	119.90130	
British Exploration of Australia	-21.31557	119.85940	

Site	Easting	Northing	Entrance Photo
Comet Mine	-21.23518	119.72427	
Copenhagen	-21.30555	119.81166	
Criterion	-21.34517	119.90980	
Cuban	-21.34105	119.89970	
Dawson City	-21.33253	119.88270	

Site	Easting	Northing	Entrance Photo
Dead Camel	-21.33961	119.89710	
Gauntlet	-21.32767	119.87500	
Gauntlet SE	-21.32800	119.87634	
Gift - Decline	-21.32415	119.86784	
Gift - Shaft	-21.32415	119.86784	-

Site	Easting	Northing	Entrance Photo
Golden Gauntlet	-21.32487	119.86970	
Klondyke Boulder	-21.33222	119.88060	
Klondyke No 1 East	-21.33556	119.88853	
Klondyke No 1 West	-21.33413	119.88500	

Site	Easting	Northing	Entrance Photo
Klondyke Queen - Adit	-21.33531	119.88764	
Klondyke Queen - Hill Top	-21.33531	119.88764	
Klondyke Queen - Open Cut	-21.33531	119.88764	
Klondyke Queen 488	-21.33811	119.89485	

Site	Easting	Northing	Entrance Photo
Kopckes Reward	-21.34295	119.90470	
Marble Bar Copper Mine - 1	-21.23559	119.77835	
Mullans Adit	-21.33539	119.88762	-
St George	-21.33781	119.89830	

Site	Easting	Northing	Entrance Photo
St George 3	-21.33849	119.89919	
Trible Event NW	-21.32923	119.87829	
Trump	-21.31508	119.83236	
Wheel of Fortune East	-21.33301	119.88410	

Appendix 4: Potential impacts to vertebrate species of conservation significance potentially occurring in the Study Area. Note references as per (Biologic, 2019c)

Table 5.1: Potential impacts to vertebrate species of conservation significance potentially occurring in the Study Area

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Species recorded within the Study Area								
<u>Northern Quoll</u> *Dasyurus hallucatus* **EPBC Act** Endangered **BC Act** Endangered	Confirmed (Biologic, 2017a, 2019a, 2019c)	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (Rocky Breakaway), but also in foraging/dispersal habitat in Hillcrest/ Hillslope, Rounded Hills and Medium/Minor Drainage Line Extent of barrier to movement or habitat type	Permanent / long term (life of mine) • some core habitat loss from open pits, other infrastructure will be rehabilitated	**Moderate –** The population within the Study Area is most likely permanent and considered a high-density population important for the long-term survival of the species. Although their semelparous nature (Oakwood, 2000) may make them susceptible to local extinction, the species does have good dispersal ability (Spencer, 2013; Woolley, 2015). The Warrawoona Ranges represent rocky habitat connecting north and south populations of Northern Quoll, and removal may cause some fragmentation. However, as a large portion of the rocky ridge is remaining, and full localised extinction is not expected, this is unlikely to be the case. Nineteen hectares of Rocky Breakaway habitat (core denning habitat) is present in the Study Area, and although only 0.71 ha intersects with the Disturbance Footprint, the proposal is also likely to impact on key foraging and dispersal habitat (Hillcrest/hillslope, Rounded Hills, and Medium/Minor Drainage Line).	**Low –** The preferred habitat for this species extends well outside the Study Area and the species is widespread in a regional context. In the Pilbara, the distribution of Northern Quolls is already fragmented (Hill & Ward, 2010) and there is good dispersal habitat present (drainage lines and the Warrawoona Ranges). Minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ dispersal/ denning habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	**High** – habitat fragmentation and loss by mining and infrastructure development are well recorded as potential impacts for Northern Quoll in the Pilbara (Cramer *et al.*, 2016; Woinarski *et al.*, 2014)
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Moderate –** Northern Quolls are known to cross roads (Dunlop *et al.*, 2014), and are opportunistic foragers known to scavenge roadkill (Radford, 2012). The species is regularly recorded from both vehicle strike and from being crushed in machinery (Cramer *et al.*, 2016). The widening of a single access track was found to significantly increase mortalities and led to the extirpation of a population of eastern quolls in Tasmania (Jones, 2000). Although no records of vehicle strike of Northern Quoll exist within the Study Area road infrastructure may increase within denning and foraging habitat. The threat of vehicle strike is likely to subside substantially post life of mine.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally will be low.	• Loss of individuals • Temporary reduction in population size	**Moderate** –there may be unrecorded deaths from vehicular collisions within the Study Area.
		Increased light and noise Increased noise	Extent of ground disturbance in foraging/ denning areas	Long-term (life of mine)	**Low –** Northern Quoll are known to occur around mine sites and human dwellings, and shelter amongst mine infrastructure such as vehicles, machinery and laydown areas (Oakwood, 2008) where there are enhanced levels of light and noise. There may be a higher concentrations of prey items e.g. insects around lights (Oakwood, 2008).	**Negligible –** Increased light and noise will not affect individuals outside of the Study Area.	• Possible dispersal from greatly enhanced levels of light and noise disturbance, especially in denning areas • Changes to prey distribution	**Low** - The extent to which the species may be affected by noise or light is not well understood
		Introduced Species	Extent of distribution of introduced predators and invasive weeds.	Permanent	**Moderate –** Feral predators are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). The threat posed by cats to the Northern Quoll is thought to be severe, although the impacts of cats may be reduced in rugged refuge areas (Woinarski *et al.*, 2014). Northern Quoll are susceptible to cane toad toxins (Hill & Ward, 2010), and if cane toads expand south through the Pilbara, any temporary creation of artificial water sources from discharge may attract these introduced species. Invasive weed species may disadvantage Northern Quolls through inhibiting movement or fostering inappropriate fire regimes (Hill & Ward, 2010).	**Low –** The presence of introduced predators and invasive weeds may be exacerbated by the proposed development however, it is not likely to have a significant impact on top of background levels already present.	• Loss of individuals from predation • Reduction in population size • Loss of prey items from competition • Alteration/degradation of habitat	**Low** – there are no records of Cane toads expanding into the Pilbara although they are predicted to invade the region (Cramer *et al.*, 2016). However, detailed modelling of Northern Quoll and Cane Toads does not indicate the two species distributions converging (Molloy, 2015)

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ denning areas	Long-term (life of mine)	**Low –** Northern quolls cope with fire in rocky habitats (Cook, 2010). The most detrimental local impact of fire on Northern Quolls is likely to be through consequential changes in habitat structure and floristics (Hill & Ward, 2010); however certain habitats such as deeply incised Valleys, Gorge/ Gully habitats and Rock Outcrops provide refuge from fire. Fire may also affect reproductive characteristics of Northern Quolls, or cause increased predation after removal of cover (Hill & Ward, 2010).	**Low –** The season, frequency, extent and severity of fires are all likely to be key factors influencing regional Northern Quoll populations (Hill & Ward, 2010). Fires ignited in the Study Area are likely to burn outside of the boundary and therefore impact on populations in the surrounding region; however, these are not expected to be at a significantly higher than existing levels.	• Possible loss of prey items, although Northern Quolls are less vulnerable to starvation due to an opportunistic diet • Loss of foraging/ dispersal/ denning habitat • Potential change in breeding cycles • Loss of individuals from increased predation	**Moderate** – altered fire regimes (causing habitat change and loss) is well recorded as a potential impact for Northern Quoll in the Pilbara (Cramer *et al.*, 2016; Woinarski *et al.*, 2014).
Pilbara Olive Python *Liasis olivaceus barroni* **EPBC Act** Vulnerable **BC Act** Vulnerable	Confirmed (Biologic, 2019a)	Removal, fragmentation or modification of habitat	Extent of clearing or barrier to movement in core habitat (Medium Drainage Line, Rocky Breakaway)	Permanent / long term (life of mine) • some core habitat loss from open pits, other infrastructure will be rehabilitated	**Moderate –** This species is confirmed from the Study Area, and core foraging and dispersal habitat is likely to partially removed. Destruction of habitat is an identified threat to the species (TSSC, 2008b). They may disperse across roads but drains and pits will represent barriers to movement.	**Low –** The species is known to be widespread in the surrounding region, and the preferred habitat for this species extends well outside the Study Area. Although males occupy a distinct home range, travelling up to 4 km during breeding season to locate females (Pearson, 2003), minor impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ dispersal/ denning habitat • Reduction in population size • Increase in population isolation • Increase in population isolation • Loss of genetic diversity	**Moderate** – Some level of habitat disturbance appears to be tolerated by the Pilbara Olive Python. Numerous nearby records exist, and Pilbara Olive Pythons are a larger species with higher dispersal capabilities and home ranges (Pearson, 2003; Tutt, 2004).
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Low –** there is a confirmed record of the species within the Study Area. Deliberate road kills, associated with increased road traffic from tourism and industry, are a listed threat for the species (TSSC, 2008b). The species is slow-moving, and many have died on roads due to a natural instinct to remain still in response to the vibrations of an approaching vehicle (Pearson, 2003). Road mortality is more likely to occur during breeding season when males are in search of females (Eco Logical Australia, 2015). However, most of the proposed road network is to be constructed in low quality habitat for the species.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally will be low.	• Loss of individuals • Reduction in population size	**Moderate** – Vehicle strike is a well recorded threat for the species, and there may be unrecorded deaths from vehicular collisions within the Study Area.
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ denning areas	Long-term (life of mine)	**Low –** The most detrimental local impact of fire on the species is likely to be through consequential changes in habitat structure and floristics, and loss of prey items. Individuals are mobile, and dispersal habitat will not be removed, allowing individuals movement across the Study Area.	**Low –** season, frequency and extent of fires across the Pilbara may play a key role in influencing Pilbara Olive Python habitat suitability in the Pilbara bioregion	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of foraging/ dispersal/ denning habitat • Possible loss of prey items	**Low** - the response of species to changes in regime is largely unknown and difficult to predict due to lack of data for season, frequency and extent of fires across the Pilbara, all of which may play a key role in influencing Pilbara Olive Python habitat suitability in the Pilbara bioregion (DoE, 2019).

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced species	Extent of distribution of introduced predators and invasive weeds.	Permanent	**Moderate –** Predation by introduced species (cats, foxes, dogs), particularly on juveniles, is identified as a major threat (TSSC, 2008b), as well as predation from these species on the Pilbara Olive Python's food sources (Ellis, 2013). Feral predators are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). There is likely to be a degree of overlap of preferred habitat with the Cane Toad, and the potential for opportunistic feeding of juvenile Pilbara Olive Pythons on toads at these riparian habitats (Eco Logical Australia, 2015)	**Low –** The presence of introduced predators and invasive weeds may be exacerbated by the proposed development however, the threat of such species is not expected to escalate at a regional level due to the proposed development.	• Direct loss of individuals • Reduction in population size • Loss of prey items • Alteration/degradation of habitat	**Moderate** – predation by introduced species is well recorded for the species.
		Alteration of water quality	Extent of existing and future water sources	Long term	**Moderate –** Waterholes and sources are an important feature of Pilbara Olive Python core habitat in the Pilbara (Pearson, 2003). They have been observed to use artificial water sources, such as sewage treatment ponds and recreational lakes, along with overburden heaps and railway embankment (Pearson, 2003). Changes in groundwater and surface hydrology from the proposed development activities, including in the vicinity e.g. Copenhagen, may affect the local population. The presence of TSF may attract individuals and cause direct impacts.	**Low –** Sources of permanent water are of high ecological value in the Pilbara (Carwardine *et al.*, 2014); however changes to water quality or regimes from the proposed development is unlikely to have an impact on regional populations.	• Loss of foraging/ dispersal/ denning habitat • Loss of individuals from reduction in water quality leading to mortality/displacement • Loss of prey items utilizing water sources	**Moderate** - Habitat quality is strongly influenced by the presence of water sources (Pearson, 2003), and so alteration of existing water sources in the vicinity, or creation of new sources, is likely to influence the species.
		Modification of water regimes						
<u>Brush-tailed Mulgara</u> (*Dasycercus blythi*) **DBCA Priority** Priority 4	Confirmed (Biologic, 2019a)	Removal, fragmentation or modification of habitat	Extent of clearing on core habitat (primarily Sandplain) and barrier to movement	Long-term (life of mine)	**Low –** there is only one habitat type considered highly suitable to support the species within the Study Area (Sandplain). Although disturbance or fragmentation (i.e. the proposed access track) within this habitat type may have a local impact, studies have suggested that the species can tolerate a moderate local reduction in cover (to 15 %) of its preferred habitat (Masters *et al.*, 2003).	**Low –** Mulgara have a low propensity for dispersal once a home range has been established, with high site fidelity recorded (Masters, 2003; Thompson & Thompson, 2007), and there are no other contemporary records in the vicinity. However, the preferred habitat for this species extends well outside the Study Area, and the species is widespread in a regional context. Hence low impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ burrowing habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High – It is known that Mulgara do not disperse readily and there is a confirmed record of the species within the Study Area. The preferred habitat type is likely to be impacted through planned disturbance (construction of an access track); however the species can tolerate a **Moderate** local reduction in cover of its preferred habitat (Masters *et al.*, 2003).
		Vehicle strike	Extent of expansion of existing road network	Long-term (life of mine)	**Low –** at the local scale there are confirmed records within the Study Area (eight records over multiple nights in 2019 (Biologic, 2019b)), and planned disturbance (a proposed access track) within the Sandplain habitat in which it was recorded. Therefore, there is the possibility of vehicle strike to Mulgara within the Study Area, although the probability is likely low and the ability for the population to recover is likely high.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally will be low.	• Direct loss of individuals • Reduction in population size	**Low** – there may be unrecorded deaths from vehicular collisions within the Study Area.
		Introduced Species	Extent of distribution range of introduced predators and grazers.	Permanent	**Moderate –** The species is preyed upon by feral predators (e.g. cats, foxes, dogs *etc*) (Woinarski *et al.*, 2014, 2015). These species are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). Introduced grazers such as cattle have been found to favour dune swales as "alleyways", and mammal diversity in habitat types suitable to support Mulgara is lower in areas grazed by cattle (Frank *et al.*, 2008). The combination of threat from both grazers and introduced predators poses a Moderate risk to the species.	**Low –** although predation by introduced species is recorded as one of most significant threats to Brush-tailed Mulgara, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Direct loss of individuals • Reduction in population size • Degradation of foraging/ burrowing habitat by introduced grazers	**Moderate** – predation by introduced species is well recorded for the species

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ burrowing areas	Long term	**Moderate –** Fire will have a significant effect on Mulgara populations by loss of individuals and prey items (Masters *et al.*, 2003), and extreme fire events could lead to a severe reduction or loss in localized populations in the Study Area. Mulgara are vulnerable to changes in vegetation cover through removal or fire, preferring a habitat mosaic that includes patchiness in cover and mature Spinifex hummocks, although they will continue to use burnt areas (Körtner *et al.*, 2007). Mulgaras are also subjected to increased predation risk after removal of mature spinifex cover fol**low**ing fire (Koertner *et al.*, 2007).	**Low –** The impact of fire on regional Brush-tailed Mulgara populations is likely to be influenced by the season, frequency, extent and severity of fires.	• Direct mortality from fire events • Loss of prey items (invertebrates and rodents) • Loss of foraging/ burrowing habitat • Loss of individuals from increased post-fire predation	**Moderate** – although the impacts of fire on a local scale, such as habitat removal and loss of prey items, have been studied (Körtner *et al.*, 2007; Masters *et al.*, 2003), there is a need for more certainty on the impact of fire on Mulgara on a regional level.
Western Pebble-mound Mouse *Pseudomys chapmani* **DBCA Priority** Priority 4	Confirmed (Biologic, 2019c)	Removal, fragmentation or modification of habitat	Extent of clearing/ habitat modification, or barrier to movement, on core habitat (Hillcrest/ hillslope and Stony Plain)	Permanent / long term (life of mine) • some core habitat loss from open pits, other infrastructure will be rehabilitated	**Moderate –** core habitat types of Hillcrest/ hillslope (718 ha, 39.42 %) and Stony Plain (548 ha, 30.07 %) are the greatest in extent within the Study Area and are likely to experience loss to some extent. Given the species is a habitat specialist to these areas, the individuals within the Study Area are likely to be negatively impacted by any ground disturbances on a local level. Individuals within mounds are known to have small "core" home ranges (0.29-0.93 ha), and do not use secondary mounds, indicating that they are utilising a patchy food resource (Anstee *et al.*, 1997). Therefore, although the species occupy habitat types of greatest extent in the Study Area, they may not utilise the whole of these habitat types, occupying resource rich niches, and local disturbance may be significant. However, clearing for roads is unlikely to cause a barrier to movement between local populations, as small rodents are known to readily cross roads and use culverts (Queensland Department of Main Roads, 2000).	**Low –** The distribution of the species is strikingly fragmented by unsuitable plains and it is unlikely that the species can disperse across substantial barriers within the region (Ford & Johnson, 2007). However, the species and its core habitat are widespread in the local region and throughout the Pilbara, and despite the smaller body size (which limits long-distance dispersal) (Whitmee & Orme, 2013), only minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of core habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	High – there are multiple records within the Study Area, and the core habitat types are greatest in extent and likely to be impacted. Therefore, there is a high degree of certainty that habitat loss/modification will occur for this species.
		Vehicle strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Low –** at the local scale, the species has multiple records within the Study Area, and as a rodent has a high fecundity and "boom-bust" life-mode to recover from individual deaths (Start *et al.*, 2000).	**Negligible –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant.	• Direct loss of individuals • Reduction in population size	**Moderate** – may be unrecorded deaths from vehicular collisions within the Study Area.
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** Western Pebble-Mound Mice persist in their core spinifex habitats, and mounds are still actively tended, after fires have removed surrounding vegetation (Start *et al.*, 2000). Populations can retain density well in the initial post-fire period (Start *et al.*, 2000).	**Low –** The species have persisted in more fire-prone habitats, and it is noted as unlikely that fire has been a significant, causative factor in their decline (Start *et al.*, 2000). The season, frequency and extent of fires across the Pilbara may play a role in influencing Western Pebble-Mound Mice habitat suitability in the region, but the overall regional impact is considered low.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of prey items	**Moderate** – The species is known to persist or recover well post-fire
		Introduced Species	Extent of distribution range of introduced predators and competitors	Long term (life of mine)	**Low –** Feral predators (e.g. cats, foxes, dogs *etc*) are considered likely to occur in greater numbers near areas of human settlement and roads/tracks (Denny. E.A, 2002; Eco Logical Australia, 2015). Predation by these species is likely to be a contributing factor to the species decline; however this threat is not well researched for the species and this threat will be actively managed for the life of the development.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat	**Low** – the threats to the species have not been rigorously studied
		Increased light Increased noise	Extent of local behavioural disturbances	Long-term (life of mine)	**Low –** The species is quite adaptable and may acclimatise to certain disturbances such as noise and light as evident from active mounds been observed adjacent to exploration camps (e.g. M. O'Connell, *pers. obs.*).	**Negligible –** Increased light and noise will not affect individuals outside of the Study Area.	• Possible dispersal from greatly enhanced levels of light and noise disturbance • Changes to prey distribution	**Moderate** – species is known to tolerate a small amount of disturbance.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Species identified as likely or possibly occurring in the Study Area								
<u>Greater Bilby</u> (*Macrotis lagotis*) **EPBC Act** Vulnerable **BC Act** Vulnerable	Likely	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat (primarily Sandplain)	Long term (life of mine)	**Low –** the species is a habitat specialist in Sandplain (and potentially Stony Plain). Greater Bilbies are semi-fossorial and nocturnal, remaining in their burrows during the day and intermittently during the night for rest and refuge. They occur naturally as scattered solitary individuals or small groups (Smythe & Philpott, 1968; Southgate, 1990), and the loss or modification of core habitat may have a potential impact on the ability of the Study Area to support a population. The effects of linear land clearing for tracks, road and rail on bilby numbers is uncertain (Bradley, 2015).	**Low –** Greater Bilbies are recorded as having low site fidelity and high mobility (Southgate *et al.*, 2007); males regularly move three to five kilometres between burrows on consecutive days; and have been recorded moving up to 15 km in a few weeks (Southgate & Possingham, 1995). This high mobility, together with low population density, ensures that the area of occupancy is often far less than the extent of occurrence, and the distribution is highly fragmented within the Pilbara bio-region (Friend *et al.*, 2012). However, it is not a commonly recorded species during surveys and on a regional scale, the loss of individuals and core Sandplain habitat may have some impact.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ burrowing habitat • Reduction in population size	**Moderate** – there are local records of the species, and as a habitat specialist, the removal of core habitat would impact any individuals present in the Study Area. However, the species is known to have **Low** site fidelity and high mobility.
		Vehicle strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Moderate –** Road and rail traffic is known to cause mortality of bilbies (Bradley, 2015). There is planned disturbance (a proposed access track) within the Sandplain habitat which may support the species. Therefore, there is the probability of vehicle strike to Greater Bilby within the Study Area; however, the local impact is considered moderate due to the low population that may potential occur in the Study Area, thus a small number of vehicle strikes may have a significant impact to the species at the local scale. .	**Low –** There is a record of a Greater Bilby vehicle strike in 2012 at McPhee Creek, 32 km south east of the Study Area (Outback Ecology, 2012). Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant.	• Direct loss of individuals • Reduction in population size	**Moderate** – may be unrecorded deaths from vehicular collisions within the Study Area.
		Introduced Species	Extent of distribution range of introduced species.	Long-term (life of mine)	**Moderate –** cat predation is assumed to be a major driving factor in the decline of bilbies, and mining activities and development are expected to facilitate increased predation e.g. linear road clearings facilitating cat movement, and free water availability enabling cat persistence (Bradley, 2015). Foxes are also considered a significant threat (Bradley, 2015). However, there is a need to improve the understanding of the threat posed by introduced predators and herbivores (Dziminski & Carpenter, 2017).	**Low –** Although cats are a significant threat to the species, they do co-occur with the bilby across its extant range. Bilby distribution is associated with an absence or scarcity of grazers and rabbits, which often target areas of prime Greater Bilby habitat in the Pilbara (Bradley, 2015). Such threats are already present in the region and unlikely to be significantly exacerbated by the proposed development.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat	**Moderate** - It is hoped that numbers of feral predators such as feral cats and foxes and introduced grazers will not significantly increase with suitable monitoring and management. However, there is a need to improve the understanding of the threat posed by introduced predators and herbivores (Dziminski & Carpenter, 2017)
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** It is known that smaller and more frequent fire increase habitat and resource diversity for bilbies (Bradley, 2015). Recently burnt habitat (within the last 1-3 years) is included as a suitable habitat type for Greater Bilby (DBCA, 2017), due to promotion of a key food source (Bradley, 2015). However, there is a lack of knowledge concerning both increases in efficiency of predation on bilbies following fire (from decreased vegetation cover) and high vegetation cover becoming impenetrable to bilbies from a lack of fire (Bradley, 2015).	**Low –** the scale and frequency of fires in the region are not expected to increase. Greater Bilbies are recorded as responding well to recent fires, as well as persisting in areas of low fire frequency (e.g. Gibson Desert) (Bradley, 2015) and so the impact of changed fire regimes is not expected to be significant.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Change in food items (in the absence of plant food availability, bilbies are more reliant on invertebrate food sources).	**Moderate** - There is a need to improve the understanding of how fire regimes affect Greater Bilbies (Dziminski & Carpenter, 2017)
<u>Spectacled Hare-wallaby</u> (*Lagorchestes conspicillatus leichardti*)	Likely	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat (primarily Sandplain and Stony Plain)	Long term (life of mine)	**Low –** there are no records within the Study Area, and the species is highly unlikely to experience significant loss of core habitat. There is connectivity to similar habitat outside the boundary. It is larger species with higher dispersal capabilities, thus would be able to move away from disturbances.	**Low –** Little is known of the regional distribution of this species; however, it is unlikely that any local impacts would manifest at a regional scale.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of core habitat (Sandplain, Stony Plain)	**Moderate** – although no records within the Study Areas, the nearest record is adjacent to the boundary (1 km away). The species is highly unlikely to experience significant loss of core habitat, and as a medium sized mammal the species may be more likely to be able to overcome local barriers to movement

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
DBCA Priority Priority 3		Vehicle strike	Extent of expansion of existing road network	Long-term (life of mine)	**Moderate –** There is planned disturbance, including areas of vehicular use, within habitats likely to support the species. The species is more active at night, when it forages on shrubs, grasses, and herbs (Burbidge, 1983), which reduces the likelihood of vehicle strike. While there is the probability of vehicle strike to Hare-wallaby within the Study Area. Due to the likelihood of a low-density population, if present, the impact is considered to be moderate at the local scale as a small number of vehicle strikes is likely to impact the local population.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant.	• Direct loss of individuals • Reduction in population size	**Moderate** – there may be unrecorded deaths from vehicular collisions within the Study Area.
		Introduced species (predation and competition)	Extent of distribution range of introduced predators.	Long-term (life of mine)	**Low –** Significant threats to the species include potential predators and impacts to core habitat from grazing (Broome Bird Observatory, 2017). However, potential predators (cats, foxes etc) are unlikely to significantly increase with suitable monitoring and management.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat from grazers	**Low** – Although predation is listed as a significant threat to the species, little ecological data on the species regarding this impact is available from the region.
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Moderate –** All sites occupied by the species have potentially suitable shelters (shrubs, grass tussocks or spinifex hummocks) within 50 m of the feeding areas (Ingleby & Westoby, 1992). Although it may feed in areas regenerating after fire (Maxwell *et al.*, 1996), frequent or recent fires in the Study Area are considered to have a moderate local impact and decrease the suitability of the core habitats to provide shelter for the species.	**Low –** the scale and frequency of fires in the region are not expected to significantly increase.	• Loss of individuals from direct mortality, • Increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Change in food availability	**Moderate** – the species is known to require shelter in close proximity to feeding sites, and any increases in fire frequency or severity is likely to decrease the habitat suitability within the Study Area
<u>Northern Brushtail Possum</u> *Trichosurus vulpecula arnhemensis* **BC Act** Vulnerable	Possible	Removal, fragmentation or modification of habitat	Primary impact is the extent of clearing on core habitat (Medium/ Minor Drainage Line, and potentially rocky habitats such as Rocky Breakaway) and the extent of barrier to movement or habitat type	Permanent / long term (life of mine) • some core habitat loss from open pits other infrastructure will be rehabilitated	**Low –** Within Western Australia, the former range of the Brushtail Possum has been considerably reduced by habitat clearing and fox predation, including in large areas of arid country (DEC, 2012). Although there will be clearing and disturbance to habitat suitable to support the species, there are no records of the species occurring within the Study Area and the suitable habitat (Medium/Minor Drainage Lines) makes up a small proportion of the Study Area. However, home ranges of the species are relatively small (males 1.12 ha and 165 m; females 0.89 ha and 155 m) (Kerle, 1998), and although they overlap both inter- and intra-sexually, fragmentation may have an impact. Additionally, the habitat is only marginally suitable.	**Low –** Little ecological information is known about the Pilbara population, although it is most often recorded from gorges and major drainage lines that contain large hollow-bearing Eucalypts (DBCA, 2019a). The preferred habitat for this species therefore extends well outside the Study Area. Although the species is widespread in a regional context, it is infrequently recorded in the Pilbara region, with less than 20 records existing on NatureMap (DBCA, 2019a). The nearest record is 26 km SW of the Study Area from 2014 (DBCA, 2019a). Based on the flexibility of their habitat preferences (Kerle *et al.*, 1992), and lack of records, minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of foraging/ dispersal/ hollow habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	**Low** – Little ecological information is known about the Pilbara population of the Northern Brushtail Possum and is infrequently recorded in the Pilbara region.
		Vehicle Strike	Extent of expansion of existing road and track network	Long-term (life of mine)	**Low –** Brushtail Possums are known to cross roads (Giffney *et al.*, 2009), and this can lead to vehicle strike and mortality. However, no records of the species exist within the Study Area, although road infrastructure is going to increase within suitable habitat. With a potential reproductive rate of nearly two per year (Kerle, 1998), it is probable that populations of the Northern Brushtail Possum can readily recover from individual deaths.	**Low –** there is unlikely to be a significant increase to vehicular strike of Northern Brushtail Possums in the region.	• Loss of individuals • Reduction in population size	**Moderate** –there may be unrecorded deaths from vehicular collisions within the Study Area.
		Increased light Increased noise	Extent of ground disturbance in foraging/ denning areas	Long-term (life of mine)	**Low –** Brushtail Possums are known to occur around human habitation and activities (Roetman & Daniels, 2009) where there are enhanced levels of light and noise, although there are no specific studies on the impact of light and noise on the northern subspecies. There may be a higher concentrations of prey items e.g. insects around lights (Oakwood, 2008). There is unlikely to be a significant impact from increased light or noise to any potentially occurring local individuals.	**Low –** there is unlikely to be a significant impact from increased light or noise to Northern Brushtail Possum in the region.	• Possible dispersal from greatly enhanced levels of light and noise disturbance, especially in denning areas	**Moderate** – Although Brushtail Possums are known to co-inhabit with humans, the extent to which the northern subspecies of Brushtail Possum is affected by noise or light is not researched.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced Species	Extent of distribution of introduced predators and invasive weeds.	Long-term (life of mine)	**Low –** The Northern Brushtail Possum is regarded as a 'critical weight range' mammal, and thus more susceptible to pressure from introduced predators (Burbidge & McKenzie, 1989). Predation of the species by dingoes was observed by Kerle (1998). Although predation by foxes, cats, dingos, large pythons and large monitors is particularly significant in areas where population numbers are low (DEC, 2012), there are no records of the species within the Study Area. Invasive weed species may disadvantage Northern Brushtail Possum through inhibiting movement or fostering inappropriate fire regimes.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Loss of prey items from competition • Alteration/degradation of habitat	**Moderate** – Predators such as feral cats and foxes are unlikely to significantly increase with suitable monitoring and management.
		Changed Fire Regimes	Extent of disturbance from fire in foraging/ denning areas	Long term (life of mine)	**Low –** On a local level, inappropriate fire regimes are likely to impact any individuals present through consequential changes in habitat structure and floristics. In particular, the availability of the tree hollows and ground refuges (hollow logs, rockpiles and the burrows of other animals) utilized by the species (Kerle *et al.*, 1992) will be detrimentally impacted by frequent fire. Fire may also affect cause increased predation after removal of cover (Carwardine *et al.*, 2014). However, the high fecundity of the species means that they can readily recover from short periods of unfavourable conditions within their preferred habitat (Kerle, 1998).	**Low –** Although the season, frequency, extent and severity of fires are all likely to be a factor influencing Northern Brushtail Possum populations, the proposed development is unlikely to have an impact on a regional scale.	• Loss of foraging/ dispersal/ denning habitat, in particular refuges • Possible loss of prey items, although species is omnivorous (Cruz *et al.*, 2012) • Loss of individuals from increased predation	**Moderate** – altered fire regimes (causing habitat change and loss) is well recorded as a potential impact for Northern Quoll in the Pilbara (Cramer *et al.*, 2016; Woinarski *et al.*, 2014).
		Altered water quality Modification to water regimes	Extent of existing and future water sources	Long term (life of mine)	**Low –** Within the Pilbara the species is most often recorded from gorges and major drainage lines that contain large hollow-bearing Eucalypts (DBCA, 2019a); therefore, modification to existing water regimes and water quality from mining activities may impact suitable habitat within the Study Area. Morton (1990) emphasized the importance of drought refuges, and Kerle *et al.* (1992) believe that for Brushtail Possum, these refuges may need sufficient ground water supplies for the survival of palatable trees and shrubs. The management plan for the groundwater drawdown at Klondyke Pit and changes to surface water catchments is not expected to have a significant impact on any Northern Brushtail Possum present.	**Low –** Sources of permanent water are of high ecological value in the Pilbara (Carwardine *et al.*, 2014); however changes to water quality or regimes from the proposed development is unlikely to have an impact on regional populations.	• Changes to foraging/ dispersal/ habitat within Medium/Minor Drainage Lines • Displacement of individuals	**Low** – Little ecological information is known about the Pilbara population, and although the species may require drought refuges with sufficient groundwater, this requires further study.
Long-tailed Dunnart *Sminthopsis longicaudata* **DBCA Priority** Priority 4	Possible	Removal, fragmentation or modification of habitat	Extent of clearing on core habitat (Rocky Breakaway, and potentially Hillcrest/ hillslope and Rounded Hills) and extent of barrier to movement on habitat type	Permanent / long term (life of mine) • some core habitat loss from open pits and other infrastructure will be rehabilitated	**Low –** The species is a habitat specialist to rocky scree and plateau areas and thus clearing of such habitat may directly impact the species (Burbidge *et al.*, 2008). Clearing for roads is unlikely to cause a barrier to movement between local populations, as small rodents are known to readily cross roads and use culverts (Queensland Department of Main Roads, 2000).	**Low –** In consideration of the species smaller body size (which limits long-distance dispersal), the highly patchy nature of records and the distance between populations, the dispersal ability of this species is potentially very poor (WAM, 2019). However, the core habitat extends beyond the Study Area boundary and is considered widespread in the region and throughout the Pilbara. Hence only minor impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments • Loss of core habitat • Reduction in population size • Increase in population isolation • Loss of genetic diversity	**Moderate** – no records exist within the Study Area; however, it is likely that habitat suitable for the species will be impacted by the proposed development. Habitat fragmentation is unlikely, as small mammals are known to readily cross roads and use culverts (Queensland Department of Main Roads, 2000)
		Vehicle strike	Extent of expansion of existing road network	Long-term (life of mine)	**Low –** no records of the species exist within the Study Area, and Long-tailed Dunnarts have a relatively high fecundity to recover from individual deaths (McKenzie *et al.*, 2008).	**Negligible –** there is unlikely to be a significant increase to vehicular strike of Long-tailed Dunnarts in the region.	• Direct loss of individuals • Reduction in population size	**Moderate** – may be unrecorded deaths from vehicular collisions within the Assessment Areas. Management of vehicles within core habitat for conservation significant fauna needs to be implemented.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
		Introduced Species (predation)	Extent of distribution range of introduced predators	Long-term (life of mine)	**Low –** Although predation by introduced species is listed as a threat, these species (cats, foxes etc) are unlikely to significantly increase with suitable monitoring and management. Buffel grass is noted as threat through alteration of habitat structure and increasing fire hazard (Crowley, 2008), and the weed has been recorded within the Study Area previously and unlikely to significantly impact habitats of the species.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Low** – the cause of the species decline is not well defined, and assumed to be from a range of impact sources, including predation (Crowley, 2008).
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** the impact of changed fire regimes on this species is thought to be a contributing factor to its decline but is not well researched. Studies on other Sminthopsis species recorded that post-fire abundance was greatest at 4-9 years (mid succession habitat preference) (Wilson & Aberton, 2006).	**Low –** Although the season, frequency, extent and severity of fires are all likely to be key factors influencing Long-tailed Dunnart populations, the proposed development is unlikely to have an impact on a regional scale.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of prey items	**Low** – The species response to fire and changes to fire regimes is not well documented.
		Increased light Increased noise	Extent of local behavioural disturbances	Long-term (life of mine)	**Low –** The effects of light and noise to the species are not at all studied. However, such factor do not seem to have a major impact of other species with a similar life history and which occupy similar niches thus it is assumed the species may acclimatise to such factors.	**Negligible –** there is unlikely to be a significant impact from increased light or noise to the species in the region.	• Possible dispersal from greatly enhanced levels of light and noise disturbance • Changes to prey distribution	**Low** – The species response to fire and changes to light and noise is not well documented.
<u>Peregrine Falcon</u> *Falco peregrinus* **BC Act** Specially Protected	Likely	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat. Potential nesting habitat may be present within Rocky Breakaway habitat, and the Medium Drainage Line provides suitable foraging habitat	Permanent	**Low –** This species is a habitat generalist. It is highly mobile and can easily move away from disturbances, making it less susceptible for any impact from the proposal. Although there are no records within the Study Area, the Peregrine Falcon was recorded in 2001 approximately 10 km west of the Study Area (DBCA, 2019a).	**Negligible –** Suitable habitat for the Peregrine Falcon is widespread and common regionally outside the Study Area. The proposed development is unlikely to have an impact on this species at a regional scale due to its general habitat preference, high mobility and large distribution.	• Loss/displacement of individuals during vegetation clearing and mining developments	High – the species is highly mobile and a habitat generalist, and no breeding records or evidence of resident individuals exist.
<u>Grey Falcon</u> *Falco hypoleucos* **BC Act** Vulnerable	Possible	Removal, fragmentation or modification of habitat	Extent of clearing/ barrier to movement on core habitat. Potential nesting habitat may be present within Rocky Breakaway habitat, and the Medium Drainage Line provides suitable foraging habitat	Permanent / long term (life of mine) • some core habitat loss from open pits and other infrastructure will be rehabilitated	**Negligible –** No evidence of breeding or resident individuals within the Study Area. The species is most likely to be represented by foraging individuals within the Study Area only. This species is also highly mobile and can easily move away from disturbances, making it less susceptible for any impact from the proposal. The nearest record for this species is approximately 41 km south-east of the Study Area from 1994 (DBCA, 2019a).	**Negligible –** The proposed development is unlikely to have an impact on this species at a regional scale due to its general habitat preference, high mobility and large distribution.	• Loss/displacement of individuals during vegetation clearing and mining developments	High – the species is highly mobile and a habitat generalist, and no breeding records or evidence of resident individuals exist.
		Introduced Species	Extent of distribution range of introduced predators	Long-term (life of mine)	**Low –** Introduced predators are identified as a possible major threat to the species within roosting habitat, as individuals frequently roost of the ground exposing them to predation (cats, foxes etc). Additionally, such species may indirectly reduce the availability of prey items for the species. However, species likely to impact upon the species are already present in the Study Area.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Moderate** – the impact of introduced predators on the species is not well documented although the threat is nonetheless regarded as a major threat likely to impact the species.
		Changed Fire Regimes	Extent of disturbance from fire in core habitat areas	Long-term (life of mine)	**Low –** the impact of changed fire regimes on this species is thought to be a contributing factor to its decline but is not well researched. Frequent fire may impact the quality of nesting, roosting and foraging habitat available to the species.	**Low –** Although the season, frequency, extent and severity of fires are all likely to be key factors influencing the species, the proposed development is unlikely to have an impact on a regional scale.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of prey items	**Low** – The species response to fire and changes to fire regimes is not well documented.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Black-lined Ctenotus *Ctenotus nigrilineatus* **DBCA Priority** Priority 1	Possible	Removal, fragmentation or modification of habitat	Extent of clearing on core habitat (Rounded Hills, Hillcrest/ Hillslope, Stony Plain)	Permanent (some core habitat loss)	**Low –** Despite extensive surveys it has very rarely been recorded (Craig, 2017). The closest record of *Ctenotus nigrilineatus* is located ~57 km east of the Study Area from 2000 (DBCA, 2019a). Any diggings (trenches etc.) are likely to provide barriers for movement for this small species.	**Low –** Little ecological information is known about the distribution of the species. Based on the flexibility of their habitat preferences and lack of records, minor or no impacts at a regional scale are expected.	• Loss/displacement of individuals during vegetation clearing and mining developments	**Low** – Little ecological information is known about the species and there are very few records of the species.
		Introduced Species (weeds, predation)	Extent of distribution range of introduced weeds and predators.	Long term (life of mine)	**Low –** Buffel grass is noted as threat for other threatened Ctenotus species through alteration of habitat structure and increasing fire hazard (TSSC, 2008a), and the weed has been recorded within the Study Area previously. Individuals of the species are likely to be predated opportunistically by introduced predators such as Cats and Red Foxes.	**Low –** Although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Low** – the cause of the species decline is not well defined, and assumed to be from a range of impact sources, including predation (Crowley, 2008).
Other significant fauna								
Night Parrot *Pezoporus occidentalis* **EPBC Act** Endangered **BC Act** Critically Endangered	Unlikely	Removal, fragmentation or modification of habitat	Extent of clearing and barrier to movement on core habitat (Stony Plain, Sand Plain)	Long term (life of mine)	**Low –** the species is a habitat specialist in old age spinifex on Sand and Stony plain with Acacia (DPaW, 2017). The Study Area contains Sandplain habitat considered highly suitable to support the species, however despite targeted surveys the species has not been recorded. Night Parrots are known to fly up to 100 km per night (Burbidge, 2016), and would be able to avoid habitat fragmentation at the scale imposed by the Proposal.	**Low –** The proposed development is unlikely to have a significant impact on the species at a regional level due to the low likelihood of occurrence.	• Loss/displacement of individuals during vegetation clearing and mining developments	**Moderate** – the age of the spinifex present in the Assessment Area (based on fire records and level of disturbance) and number of habitat assessments conducted suggests that the Study Area is unlikely to support Night Parrot.
		Vehicle Strike	Extent of expansion of existing road network	Long term (life of mine)	**Low –** Published accounts of Night Parrot behaviour suggest that the Night Parrot may be prone to vehicle strikes, if it is breeding or foraging near roads or tracks in or near the Study Area. Hamilton (2017) observed a bird crouching on a road, 1-1.5m from the road edge. The bird did not fly when approached but ran under a slow-moving vehicle. A second observation recorded a bird emerging from the base of a group of Eremophila shrubs, and the bird ran across the road (Hamilton, 2017). However, the species is rare and has not been previously recorded in the Study Area.	**Low –** Although the proposed development will increase vehicle traffic generally in the region, and thus increase the likelihood of roadkill, the number of individuals affected regionally is not considered significant due to the unlikely occurrence of the species within the local vicinity and region,	• Direct loss of individuals • Reduction in population size	**High** – it is unlikely that there are unrecorded deaths from vehicular collisions within the Study Area.
		Changed fire regimes	Extent of disturbance from fire in core habitat areas	Long term (life of mine)	**Low –** The Study Area occurs within the species former distribution, thus further degradation to habitat within this area will have an ongoing effect on the species. The core habitat of the species is old age spinifex (>50 years) (DPaW, 2017) and so changes to regimes that may increase fires will detrimentally affect core habitat and likelihood of species (TSSC, 2008c).	**Low –** Although the season, frequency, extent and severity of fires are all likely to be key factors influencing the species, the proposed development is unlikely to have an impact on a regional scale due to the unlikely occurrence of the species.	• Loss of individuals from direct mortality, and increased predation from loss of habitat cover • Loss of habitat cover (i.e. mature spinifex) • Possible loss of food items	**High** – core foraging and roosting habitat is known to require spinifex of a certain age. Therefore, fire is a known impact to core habitat requirements of the species.
		Introduced Species	Extent of distribution range of introduced predators	Long-term (life of mine)	**Low –** TSSC (2008c) lists numerous threats arising from introduced species including; predation by feral cats and foxes, competition for food and degradation of habitat by livestock and feral herbivores, reduced availability of water due to consumption by camels and livestock and habitat degradation by rabbits and goats. However, the species has not been recorded in the Study Area despite targeted surveys.	**Low –** although predation by introduced species is recorded as one of most significant threats to the species, there is unlikely to be a significant increase in regional predation from proposed development in the Study Area due to the unlikely occurrence of the species.	• Loss of individuals from predation • Reduction in population size • Alteration/degradation of habitat, including increases to fuel load	**Moderate** – the impact of introduced predators on the species is not well documented although the threat is nonetheless regarded as a major threat likely to impact the species.

Species	Likelihood of occurrence	Impact source	Impact					
			Extent	Duration	Magnitude (Local)	Magnitude (Regional)	Potential consequence of impact	Certainty (Level of Confidence)
Migratory Birds • Barn Swallow (MI) • Fork-tailed Swift (MI) • Sharp-tailed Sandpiper (MI) • Common Greenshank (MI) • Wood Sandpiper (MI) • Curlew Sandpiper (CR/MI) • Common Sandpiper (MI) • Grey Wagtail (MI) • Oriental Pranticole (MI) • Oriental Plover (MI) • Pectoral Sandpiper (MI) • Yellow Wagtail (MI) • Osprey (MI) • Glossy Ibis (MI)	Unlikely/ Rare	Altered water quality	Extent of existing and future water sources	Long term (life of mine)	**Low –** Cyanide will be produced in the leaching of gold from ore, which will be added to the ore slurry. Cyanide is known to cause significant mortality events when present above a critical toxicity threshold (Griffiths *et al.*, 2014), particularly for migratory birds and bats (Eisler & Wiemeyer, 2004). to significantly impact upon the local population. Moderately high levels of Nickel arsenic may be present in the Klondyke pit lake post closure and may directly impact upon the health of individuals. However, over time this will become increasing saline and thus become too saline for wildlife to drink (B. Bullen *pers. comms.*). Open waterbodies (e.g. the TSF) are an attractant to these species; however, their occurrence is deemed Unlikely or Rare based on a lack of previous records and other habitat requirements.	**Low –** Sources of permanent water are of high ecological value in the Pilbara (Carwardine *et al.*, 2014); however changes to water quality from the proposed development is unlikely to have an impact on regional populations due to their unlikely or rare occurrence.	• Loss of individuals from reduction in water quality (e.g. cyanide) leading to mortality/ displacement • Loss of foraging habitat during mining • Loss of prey items utilizing water sources	**Moderate -** cyanide is known known to cause significant mortality events to avian species when present above a critical toxicity threshold (Griffiths *et al.*, 2014).

Note: coloured cells indicate a scale of magnitude significance, where yellow = Low, Orange = Moderate, and red = High.

Appendix 5: Details of Mining Exclusion Zone and Klondyke Queen Buffer

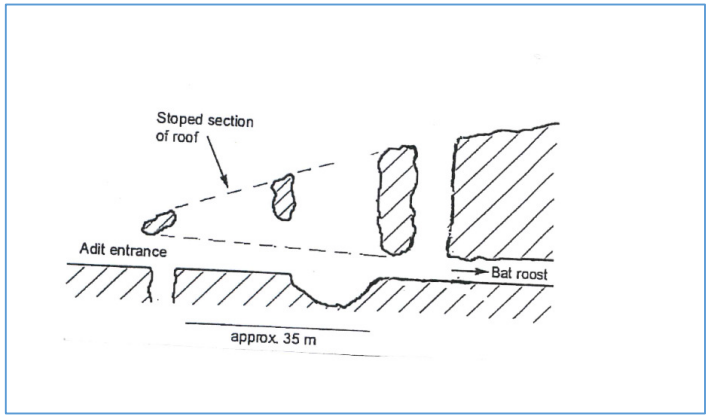


Figure 1: Klondyke Queen Workings Adapted from (Biota Environmental Sciences, (2001)

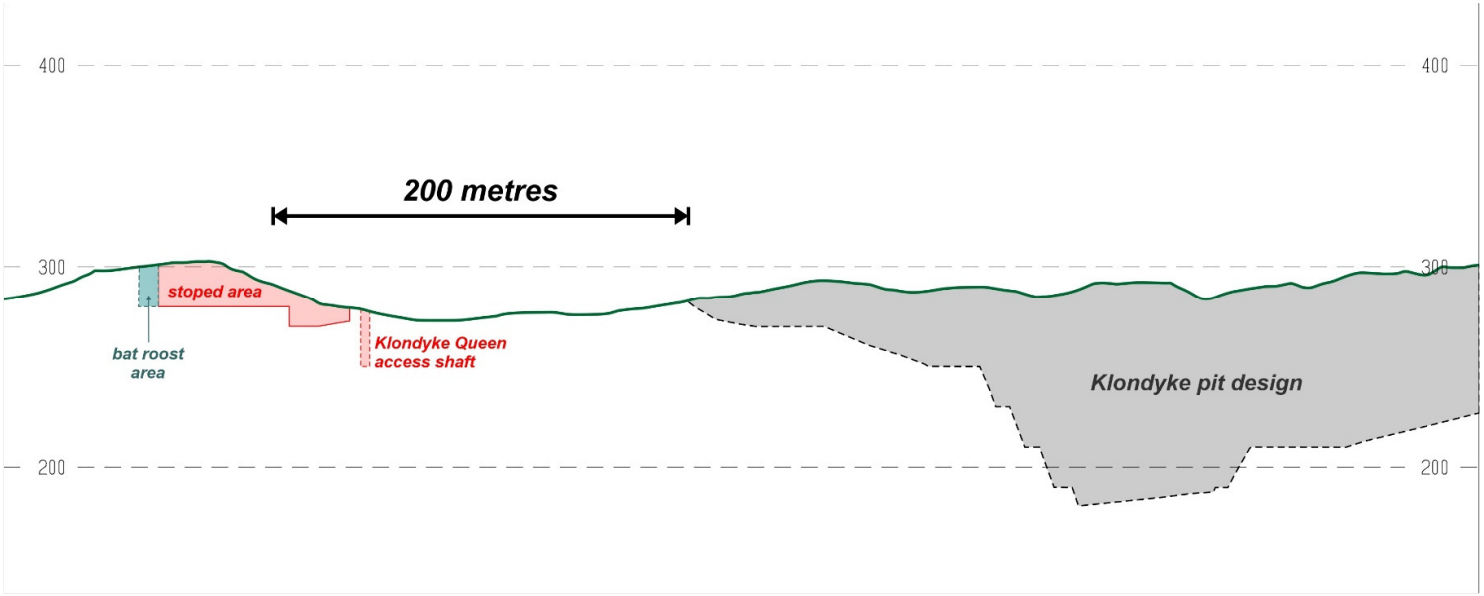
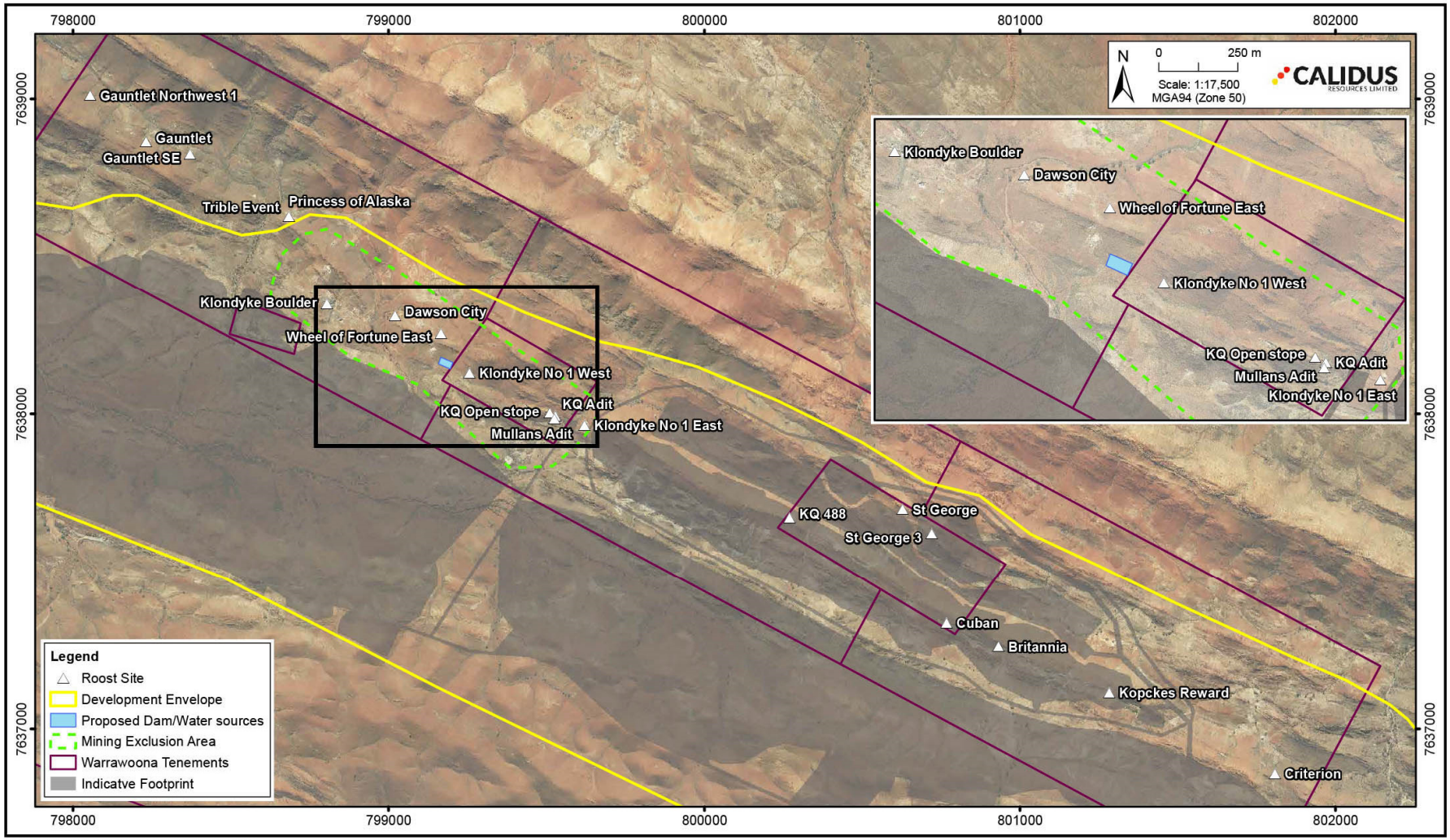


Figure 2:Cross section of Klondyke Queen Workings in proximity to the western edge of the proposed Klondyke Pit. Note that the roosts are likely to be at the eastern end of the adit in separate chambers (Bob Bullen Pers com 9/5/2019). This cannot be verified further due to safety reasons.

Figure 3: The Klondyke Queen Complex containing the Ghost Bat Permanent Maternity Roost and the Pilbara Leaf-nosed Bat Permanent Diurnal Roost.



Source: DMIRS - Tenements, Biologic - Habitats
Drawn: CAD Resources (08 9246 3242), Date: Nov 2019, CAD Ref: a2738_F001_32, Rev: A

Figure 4: Location of the Mine Exclusion Zone incorporating: Klondyke Queen Complex (KQ Adit, Klondyke Queen Hilltop, Klondyke Open Cut) – PLnB Permanent Diurnal Roost and Ghost Bat Permanent Maternity Roost. Klondyke Boulder - Nocturnal Refuge (PLnB) and Possible occasional Diurnal Roost (GB), Dawson City - Nocturnal Refuge (PLnB) and occasional Diurnal Roost (Ghost Bat), Wheel of Fortune East - Nocturnal Refuge (PLnB) and Night Roost (Ghost Ba), Klondyke No 1 West - Nocturnal Refuge (PLnB) and Night Roost (Ghost Bat), Mullins Adit - Nocturnal Refuge (PLnB) and Possible Diurnal Roost (Ghost Bat), Klondyke No 1 East- Nocturnal Refuge (PLnB) and Night Roost (Ghost Bat).

Appendix 6: Monitoring Summary

Fauna Species	Recorded on Study Area	Method	Monitoring Parameters	Timing	Monitoring Locations
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Yes	Echolocation call recorders and where possible video recording at diurnal and maternity roosts (Appendix 8A and 8B), Pre-clearance Survey on nocturnal/night roosts requiring removal (Appendix 9)	Presence/Absence, Call Counts, Humidity recording (Bow Bells South and Klondyke Queen Roosts)	Continuous collection of echolocation call data (summarised on a monthly basis) and pre clearance prior to clearing Bow Bells South: Humidity monitoring prior to commencement of dewatering. Commenced in July 2020. Klondyke Queen: Humidity monitoring prior to commencement of dewatering. Note – placement of the data logger is dependent on safe access to the workings. Humidity monitoring commenced in July 2020.	Pre and post construction: Bow Bells South, Criterion, Dawson City, Klondyke Boulder, Klondyke Queen and Mullins adit) and Copenhagen Pit (pre mining only) Two reference sites (Comet and Trump), Post construction infrastructure: (TSF, Exclusion Zone Water Dam – as per construction schedule and before and during key project developments (e.g. blasting for the first time, blasting at significantly closer locations (staged approach) , first outflow of TSF or when pooling starts etc).
Ghost Bat (*Macroderma gigas*)	Yes	Echolocation call recorders and where possible video recording at diurnal and maternity roosts (Appendix 8A and 8B), Pre-clearance Survey on	Presence/Absence, Call Counts, Humidity recording (Bow Bells	Continuous collection of echolocation call data (summarised on a	Pre and post construction: Bow Bells South, Criterion, Dawson City, Klondyke Boulder, Klondyke Queen and Mullins

Fauna Species	Recorded on Study Area	Method	Monitoring Parameters	Timing	Monitoring Locations
		nocturnal/night roosts requiring removal (Appendix 9) .	South and Klondyke Queen Roosts)	monthly basis) and pre clearance prior to clearing Bow Bells South: Humidity monitoring prior to commencement of dewatering. Commenced in July 2020. Klondyke Queen: Humidity monitoring prior to commencement of dewatering. Commenced in July 2020. Note – placement of the data logger is dependent on safe access to the workings.	adit) and Copenhagen Pit (pre construction only) Two reference sites (Comet and Trump), Post construction infrastructure: (TSF, Exclusion Zone Water Dam – as per construction schedule and before and during key project developments (e.g. blasting for the first time, blasting at significantly closer locations (staged approach) , first outflow of TSF or when pooling starts etc).
Northern Quoll *(Dasyurus hallucatus*)	Yes	Motion cameras study (Appendix 7A and 7B)	Presence/Absence, Population Estimate	Annual May to September (Annual)	Impact and Control sites within Rocky Breakaway, Medium/Minor Drainage and Hillcrest/ Hillslope and Rounded Hills habitats
Greater Bilby (*Macrotis lagotis*)	No	Pre-clearance Survey	Searches for tracks, burrows and other signs on road corridor prior to clearing	Before road construction on the sand plain habitat	Road corridor

Fauna Species	Recorded on Study Area	Method	Monitoring Parameters	Timing	Monitoring Locations
Mulgara *(Dasycercus blythi)*	Yes	Pre-clearance Survey	Searches for tracks, burrows and other signs on road corridor prior to clearing Mulgara habitat	Before road construction on the sand plain habitat	Road corridor
Pilbara Olive Python (*Liasis olivaceus barroni*)	Yes	Opportunistic searches and searches for scats and other signs, motion cameras	Presence/Absence	Running concurrent to NQ monitoring	Impact and Control (same sites as NQ)
Peregrine Falcon (*Falco peregrinus*), Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardti*), Northern Brushtail Possum (T*richosurus vulpecula arnhemensis)*, Grey Falcon (*Falco hypoleucos*), Long-tailed Dunnart (*Sminthopsis longicaudata*), Black-lined Ctenotus (*Ctenotus nigrilineatus*)	No	Opportunistic during Northern Quoll Monitoring and Bilby Pre-clearance	Presence/Absence	Opportunistic and as per NQ	As per NQ

Appendix 7A: Northern Quoll Monitoring Methods

Overview

This monitoring program aims to monitor the presence of Northern Quoll during the life of the Warrawoona Gold Project and to ensure the effectiveness of Calidus' management measures.

This monitoring program includes:

- Annual monitoring: The aim of this program is to monitor Northern Quoll population trends during the life of the Project.
- Opportunistic monitoring: The aim of this program is to provide additional data collected by site personnel to supplement the annual monitoring program and further the protection of the Northern Quoll.
- Rehabilitation monitoring: The aim of this program is to determine Northern Quoll recolonisation in rehabilitated Project areas and rehabilitation success.

Background

10-12 individuals have been detected via motion camera, over 3 sampling events within Hillcrest/Hill slope and Minor Drainage habitat at Warawoona. The estimated population size in the study area is comparable to that of Indee Station (annual population sizes between 3 -12 females and 0 – 3 males), considered to offer the area of highest suitability for northern quolls in the Pilbara (Hernandez-Santin et al., 2019).

Habitats

The Rocky Breakaway habitat type, provides high density denning and foraging habitat for the Northern Quoll. The Warrawoona Gold project will disturb 0.8ha of this habitat type, which represents just 4.6% of the Rocky Breakaway habitat type recorded across the project area, and only 0.2% of the total disturbance footprint. This habitat type is well represented outside the project area, across the Warrawoona Range and throughout other ranges of the Pilbara IBRA region more broadly.

The Medium/Minor Drainage Lines provide dispersal and foraging habitat for the Northern Quoll. The project will disturb 14.3ha of Medium and Minor drainage lines, which represents 28.9% of the recorded drainage line habitat types of the project area, which is just 3.6% of the total disturbance footprint. These drainage line habitat types are widespread throughout the Pilbara IBRA region

The Hillcrest/ Hillslope and Rounded Hills habitat types both contain small rocky breakaways that provide additional denning habitat for the Northern Quoll. The project will disturb 138.1ha of Hillcrest/Hillslope and 89.2ha of Rounded Hills, which represents 19.2% and 26.3% of their recorded habitat types in the project area respectively. Combined, these two widely distributed habitat types of the Pilbara make up 57% of the total disturbance footprint.

Monitoring Methods

Annual Monitoring

Calidus will undertake monitoring of Northern Quoll throughout the life of the Project. The various monitoring methods that will be deployed to ensure the continued presence of the Northern Quoll within the Development Area and wider region are discussed below.

Calidus will undertake annual Northern Quoll Monitoring between April and September in line with relevant guidelines (Dunlop 2014, DOE 2016).

Up to five locations, will be monitored across the Rocky Breakaway, Medium/Minor Drainage and Hillcrest/ Hillslope and Rounded Hills habitats of the study area. Ten cameras will be established at each monitoring site over four nights. Each camera will be established on permanent mounting posts or similar, to ensure the same locations can be monitored each year.

The setup of the remote sensor cameras will be undertaken in accordance with the Department of Environment and Conservation (now Department of Parks and Wildlife) Standard Operating Procedure – Remote operation of cameras (SOP No:5.2) (April 2011).

The benefits for this type of monitoring are:

- Maximise the chance of detecting the species;
- Positioned in habitat critical for the survival of the species;
- Monitor all representative habitat types;
- Less labour intensive, more practical for working in remote areas;
- Becoming the preferred form of monitoring;
- Detect other species present as well, which may pose a threat to the Northern Quoll (e.g. Cats) and allow for further management measures to be implemented to protect the Northern Quoll;
- More effective at capturing shy wildlife;
- Monitor how many different species are in the area; and
- Non-invasive.

Presence/Absence of Northern Quolls will be recorded using motion cameras across all sites. Cameras can also document patterns of movement and activity, and in certain circumstances individual Northern Quolls can be distinguished based on the timing of photos and the size and other physical characteristics of individuals captured (Hohnen et al. 2012).

Photo monitoring points will also be established at each monitoring location to document any changes to the site over time. The following parameters will be assessed and measured, where present:

- Landscape, soil features and structural composition.
- Vegetation cover, condition and species composition.
- The presence or absence of habitat structures.
- The presence or absence of water.
- Types of disturbance and levels of disturbance.

Opportunistic Monitoring

Opportunistic surveys will also be undertaken at each of the monitoring sites to obtain direct visual records of Northern Quolls, or indirect records such as bones, carcasses, tracks and scats. Any opportunistic observations of Northern Quolls will be documented. Other species of conservation significance will also be recorded, if observed.

Northern Quoll sightings (including scats and tracks), injuries and mortalities will be reported to the Site Environmental Advisor. All records will be entered into a site database and summaries will be included in the Annual Environmental Report (AER).

Reporting

A standalone report at the conclusion of each annual monitoring period will be prepared. This report will include the following sections; methods, results, discussion and recommendations. This report will also be appended to Calidus' AER.

Performance Criteria and Management/Corrective Actions

Performance criteria for the Northern Quoll have been provided in the SSMP. Should this monitoring program indicate that these performance criteria are not being met; the relevant management/corrective actions will be implemented

Thresholds and Triggers

Refer to Appendix 7B

References

Davis, M. J. (2011). Standard Operating Procedure: Remote Operation of Cameras. Version 1.0 (April 2011). Prepared for Department of Environment and Conservation.

DoE. 2016. EPBC Act referral guideline for the endangered Northern Quoll *Dasyurus hallucatus*; EPBC Act Policy Statement. Department of the Environment. Canberra, ACT.

Dunlop, J., Cook, A. and Morris, K. (2014) Pilbara Northern Quoll project; Surveying and monitoring *Dasyurus hallucatus* in the Pilbara. Department of Parks and Wildlife, Perth, WA.

Hohnen, R., Ashby, J., Tuft, K. and McGregor, H. (2012) Individual identification of Northern Quolls (*Dasyurus hallucatus*) using remote cameras. *Australian Mammalogy* 35(2): 131-135.

Appendix 7B: Northern Quoll Monitoring Triggers and Thresholds

Biologic Environmental Survey Pty Ltd
PO Box 179
Floreat, WA, 6014

2 June 2020

Attn: Kate George
Principal Environmental Scientist
Rapallo / Calidus Resources

Dear Kate,

Please find enclosed a short report outlining proposed threshold criteria for determining whether development activities at the Warrawoona Gold Project have impacted upon the resident northern quoll *Dasyurus hallucatus* population.

The potential triggers outlined have been developed in consideration of guidance documents, previous surveys and EIA conducted at Warrawoona, and peer-reviewed research. It is intended that this document supplement and support the Calidus SSMP and inform future monitoring surveys.

The criteria have been designed with the intention of potentially initiating an investigation should the threshold value be met; it is not intended that triggering of the threshold criteria necessarily require a response in terms of the location, type, or scale of development activities occurring at Warrawoona.

Yours sincerely,

Morgan O'Connell
Director / Principal Ecologist
Morgan@biologicenv.com.au
(08) 6142 7119

1. INTRODUCTION

The Warrawoona Gold Project (Warrawoona) is located approximately 20 km south of Marble Bar in the Pilbara Region of Western Australia. Calidus Resources Limited (Calidus) is the proponent and is seeking to further develop the Warrawoona Gold Project.

The northern quoll is classified as Endangered under the *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) *1950* and *Biodiversity Conservation Act* (BC Act) *2016*, and as such is a Matter of National Environmental Significance (MNES). The species has been recorded within the Study Area over three consecutive years (2017 – 2019) (Biologic, 2017, 2019a, 2019c).

The northern quoll referral guidelines (DoE, 2016) define populations important for the long-term survival of the species as;

- high density quoll populations, which occur in refuge-rich habitat critical to the survival of the species, including where cane toads are present;
- occurring in habitat that is free of cane toads and unlikely to support cane toads upon arrival i.e. granite habitats in WA, populations surrounded by desert and without permanent water; or
- subject to ongoing conservation or research actions i.e. populations being monitored by government agencies or universities or subject to reintroductions or translocation.

A high density population may be characterised by numerous camera triggers of multiple individuals across multiple cameras and or traps on the site (DoE, 2016)**.** The continued annual presence of a similar number of animals in high densities as defined above (DoE, 2016) defines the likely resident population within the Study Area as important for the long-term survival of the northern quoll. The estimated population size in the Study Area is comparable to that of Indee Station (annual population sizes between 3 -12 females and 0 – 3 males), considered to offer the area of highest suitability for northern quolls in the Pilbara (Hernandez-Santin *et al.*, 2019).

Based on DoE (2013) and DoE (2016), Biologic (2019b) determined that the two significant impact criteria most likely to impact the northern quoll population from further development were;

- Decrease in the size of a population important for the long-term survival of the northern quoll and therefore interfere with the recovery of the species.
- The loss of habitat critical to the survival of the northern quoll.

This report outlines potential threshold levels based on these two criteria for the northern quoll at Warrawoona. Future monitoring surveys may consider these threshold criteria when monitoring for potential impacts to the population. The criteria have been designed with the intention of potentially initiating an investigation should the threshold value be met; it is not intended that triggering of the threshold criteria necessarily require a response in terms of the location, type, or scale of development activities at Warrawoona.

The threshold criteria have been developed in consideration of;

- EPA (2004b) Statement of Environmental Principles, Factors and Objectives (in particular the Precautionary Principle);
- DoE (2013) *Matters of National Environmental Significance: Significant Impact Guidelines 1.1;*
- DoE (2016) *EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus;*
- EPA (2004a) *Guidance Statement No. 56: Terrestrial fauna surveys for Environmental Impact Assessment;*
- EPA (2016) Environmental Factor Guideline: Terrestrial Fauna;
- Previous survey reports and EIA for the Study Area (Biologic, 2017, 2019a, 2019b, 2019c); and
- Relevant peer-reviewed research.

2. THRESHOLD CRITERIA

2.1 Monitoring methodology

Annual monitoring of the northern quoll population at Warrawoona is undertaken as part of the Calidus Significant Species Management Plan (SSMP) (Calidus, 2020). The Performance Objective given for the northern quoll is to "undertake northern quoll monitoring on an annual basis" with the Key Performance Indicator (KPI) given as "monitoring conducted in accordance with methods specified". This monitoring is conducted to better understand the estimated population size and track population trends at Warrawoona.

Five permanent motion camera sites will be established in July 2020 within known habitat for the species. In consideration of changes to the Warrawoona Development Envelope, four of the northern quoll monitoring sites used in both 2018 and 2019 monitoring surveys are no longer accessible. Instead, the proposed permanent monitoring sites will include one site inside the mining exclusion zone, and four in the Warrawoona Range to the north of the Development Envelope. Consideration will be given to designating the exclusion zone and other sites in proximity to active development as "Impact" sites, with the remaining sites designated as "Control" sites. In doing so, there is the potential to investigate whether there is a notable difference in northern quoll activity between Control and Impact due to mining related disturbance versus natural fluctuation. If possible, consideration will be given to accounting for an initial high loss of individuals due to habitat clearing within 500 metres of monitoring sites.

As recommended in DoE (2016), each camera site will comprise of ten cameras spaced 100 m apart, and will be deployed for four nights. The resulting footage will be analysed with spot-pattern recognition software to determine the number of unique individuals present, the re-occurrence of any individuals recorded in previous monitoring surveys, and determine the estimated population size across the monitoring sites. Photo monitoring points will also be established at each monitoring location to document any changes to the sites over time. The following parameters will be assessed and measured, where present:

- Landscape, soil features and structural composition.
- Vegetation cover, condition and species composition.
- The presence or absence of habitat structures.
- The presence or absence of water.
- Types of disturbance and levels of disturbance.

The abundance of the species is cyclical (Oakwood *et al.*, 2001), and in the Pilbara, abundance is lowest toward the end of winter into early spring after the mating season, as a significant proportion of adult males die off and young have not yet begun to forage independently (Braithwaite & Griffiths, 1994; Oakwood, 2000). Conversely, the population density is thought to be highest in the summer months, prior to the mating season and when juveniles have begun foraging independently (Oakwood, 2000). Hence, annual monitoring should occur at similar times of year (April to September) to provide a more comparative analysis of population trends over time.

2.2 Threshold Criteria for Changes in Population Size

One Level 1 fauna survey has been conducted within the Study Area to date (Biologic, 2017). This was the first survey to confirm the presence of northern quoll in the Study Area. Two unique individuals were recorded via motion camera on five separate occasions. The first monitoring surveys undertaken by Calidus within the Warrawoona Study Area began in September 2018, and two targeted fauna surveys have now been conducted to date (Biologic, 2019a, 2019c). Six northern quoll individuals were recorded from three motion cameras transects (each comprising ten cameras in place for 10 nights) during 2018 (Biologic, 2019c). A minimum of three individuals, and potentially (but unlikely) a fourth were recorded from two sites during the targeted survey in 2019 (Biologic, 2019a). Table 2-1 below summarizes the population results at the monitoring sites from the previous monitoring surveys.

Table 2-1 Summary of previous northern quoll records from Warrawoona (2017 – 2019), including estimated population size (Biologic, 2019a)

Survey Title	Year of survey	Life stage for species	Capture rate	Number individuals recorded	Estimated population size at monitoring sites
Warrawoona Level 1 Vertebrate Fauna, and Desktop SRE and Subterranean Assessment (Biologic, 2017)	Sept 2017	End of breeding season, into male die-off	WAR_NQ01: 22.2 % WAR_NQ04: 100 %	2	4
Warrawoona Gold Project: Habitat Assessment and Targeted Vertebrate Fauna Survey (Biologic, 2019c).	July 2018	Breeding season	WAR_NQ01: 20 % WAR_NQ02: 5.1 % WAR_NQ03: 7.5 %	5-6	6
Warrawoona Gold Project: 2019 Significant Species Monitoring (Biologic, 2019a)	April 2019	Prior to breeding season, post weaning	WAR_NQ03: 12.5 % WAR_NQ05: 55 %	3-4	7

The DoE (2016) guidelines for the northern quoll state that the significant impact criteria for a given population is that a disturbance will “Decrease the size of a population important for the long-term survival of the northern quoll and therefore interfere with the recovery of the species”. In consideration of this, the threshold criteria for triggering this impact is that a decrease in capture rates greater than 50 % has occurred over two consecutive annual monitoring periods. Retrospective application of this criteria to previous survey results from 2017 – 2019 would not have resulted in the threshold criteria being triggered.

In the instance that this threshold criteria is triggered, corrective action may be required as outlined in the SSMP (Calidus, 2020). This may include identification of the likely cause of decline, including a review into factors that have potentially contributed to a two season decline (e.g. lower productivity, fire, extreme weather etc), and a review of the effectiveness of management measures. Table 2-2 below summarises this threshold criteria.

Table 2-2 Threshold criteria for population trends in the Warrawoona northern quoll population

MNES significant impact criteria	Threshold Criteria
Decrease the size of a population important for the long-term survival of the northern quoll and therefore interfere with the recovery of the species	A decrease in capture rates greater than 50 % has occurred over two consecutive annual monitoring periods.

2.3 Threshold Criteria for Changes in Habitat Size

For the northern quoll, habitat critical to the survival of the species is defined as: Habitat within the modelled distribution of the northern quoll, which provides shelter for breeding, refuge from fire or predation and potential poisoning from Cane Toads (DoE, 2016). Critical denning habitat for the northern quoll comprises rugged, rocky areas, often in close association with permanent water (Molloy, 2015; Oakwood, 2000), consistent with Rocky Breakaway habitat within the Study Area. Dispersal and foraging habitat associated with or connecting populations important for the long-term survival of the northern quoll are also considered habitat critical to the survival of the northern quoll (DoE, 2016). Foraging or dispersal habitat is recognised to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of shelter habitat, quoll records or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (DoE, 2016).

Approximately 19 ha (1 % of the Study Area) of Rocky Breakaway habitat is present in the Study Area (Biologic, 2017), although this denning habitat and foraging habitat continues outside the Study Area. The Medium and Minor Drainage Lines, Rounded Hills, and Hillcrest/Hillslope habitats are also considered significant habitat due to providing potential foraging and dispersal habitat for the species. Approximately 1,126 ha (62 % of the Study Area) of such habitats are present in the Study Area, of which 242.4 ha occurs within the Development Envelopment (Calidus, 2020) (Table 2-3). In the western Pilbara, minimum activity areas for northern quoll have been recorded as 75 – 443 ha for females and 5 – 1,109 ha for males (King, 1989).

Table 2-3 Summary of significant habitat present for northern quoll within the Study Area (Biologic, 2019b; Calidus, 2020)

Habitat	Habitat Value Score	Reason for significance	Area within Study Area		Area of habitat type in Development Footprint (ha)	% of total habitat type occurring in the Development Footprint
			ha	%		
Rocky Breakaway	High	Provides core denning and foraging habitat	19	1.03	0.80	4.6
Medium Drainage Line	Moderate	Provides dispersal and foraging habitat	19	1.02	14.3	28.9
Minor Drainage Line	Moderate	Provides dispersal and foraging habitat	31	1.69		
Rounded Hills	Moderate	Provides dispersal and foraging habitat	339	18.61	89.2	26.3
Hillcrest/ Hillslope	Moderate	Provides dispersal and foraging habitat	718	39.42	138.1	19.2
		Total	**1126**	**62**	**242.4**	**-**

Fauna habitat loss as a direct result of land clearing and excavation is considered the most significant potential impact of the Project on terrestrial vertebrate fauna (Biologic, 2019b). Habitat loss and degradation is expected to occur throughout most of the habitats present, including those considered of high significance. The DoE (2016) guidelines for the northern quoll give a significant impact criteria for a given population as that a disturbance will "Result in the loss of habitat critical to the survival of the northern quoll". For the Warrawoona project, the threshold criteria for considering this decrease to have occurred is the loss of significant habitat types for northern quoll in excess of the disturbance values specified in the SSMP, as given above in Table 2-3. An additional threshold criterion is considered to be the clearing of significant northern quoll habitat outside the Development Envelope, as specified in the SSMP. These threshold criteria are summarised below in Table 2-4.

In the instance of these threshold criteria being triggered, corrective action may be required as outlined in the SSMP. This may include undertaking corrective rehabilitation and implementation of other relevant corrective actions.

Table 2-4 Threshold criteria for habitat loss in the Warrawoona northern quoll population

MNES significant impact criteria	Threshold Criteria
Result in the loss of habitat critical to the survival of the northern quoll	Loss of significant northern quoll habitat within the Development Envelope in excess of the values specified in the SSMP
	Clearing of significant habitat outside the Development Envelope

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Appendix 8A: Significant Bat Monitoring Methods – Bat Call (2019).

Calidus commissioned Bat Call WA (Bat Call) to commence a baseline monitoring program for the Pilbara leaf-nosed bat and Ghost Bat at three sites at the Warrawoona Project. The aim of the monitoring programme is to measure and detect changes in population levels of the two bat species that occur within and proximal to the Warrawoona Gold Project and to measure effectiveness of the prescribed management actions undertaken by Calidus.

The monitoring program will include:

- Collection of pre-mining operation baseline data collected in a continuous manner at Klondyke Queen, Bow Bells South and Copenhagen historical mines based on echolocation call levels at the three sites;
- Ongoing continuous monitoring of Pilbara leaf-nosed and Ghost Bat population levels during the mine's operation; and
- Review of trends in species population levels in a near real-time manner.

The monitoring programme design aims to provide for evaluation of objectives and targets.

Baseline monitoring will begin in November 2019 with the installation of a permanent bat echolocation call detectors. The monitoring includes the nightly recording of PLNb and Ghost bat activity at the entrances to the Klondyke Queen and Bow Bells South main adits where the presence of permanent diurnal roosts have been confirmed. Continuous recording of both species at the eastern most corner of the Copenhagen flooded pit will also be carried out. All three locations have been periodically surveyed for the bat species activity between 2017 and 2019 and a systematic data reduction procedure developed allowing comparison with future year data.

Baseline call detection levels will be summarised on a monthly basis and run charts for the three sites will be prepared. These charts will present for each site and for each species the monthly mean (average) and standard distribution (sd) of the call numbers. These values will be plotted on typical statistical process control "run chart" (Schonberger 1986, pp130-131) against time using an EXCEL spreadsheet. The total pre-mining baseline long-term data set for each site will then be averaged and Upper and Lower Control Limits (UCL/LCL) calculated as the long-term mean +/- 1sd. These control limits are then added to the run charts to develop "control charts" including level 1 trigger values.

For each site, the average of each month during the baseline period will then be compared to the sites UCL and LCL trigger values. For survey events that exceeded the trigger values, further interrogation of the call data will be undertaken to understand what may have caused the variation.

Once mining operations have begun, call numbers for each site will be compared to level 1, 2 and 3 trigger values being long-term UCL/LCL, mean +/- 2sd and +/- 3sd respectively. Relevant management response suggested by incursions above these levels is provided in the Significant Species Management Plan. During significant mining events such as near-by blasting or the initial release into the tailings dam, that may directly impact the roosts, real-time monitoring of the data will be undertaken to ensure that timely implication of management responses is applied should a steep reduction in population levels be indicated by the data.

Refer to Appendix 8B for UCL and LCL trigger values

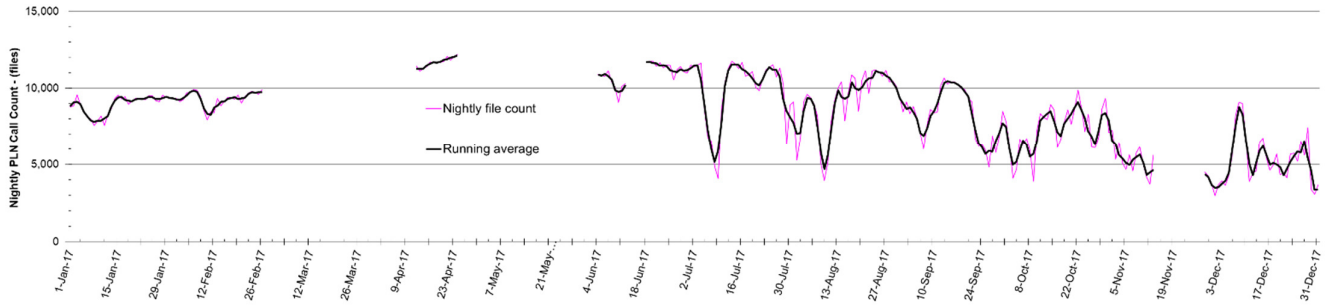


Fig 1 Example of continuous monitoring data at a PLNb roost.

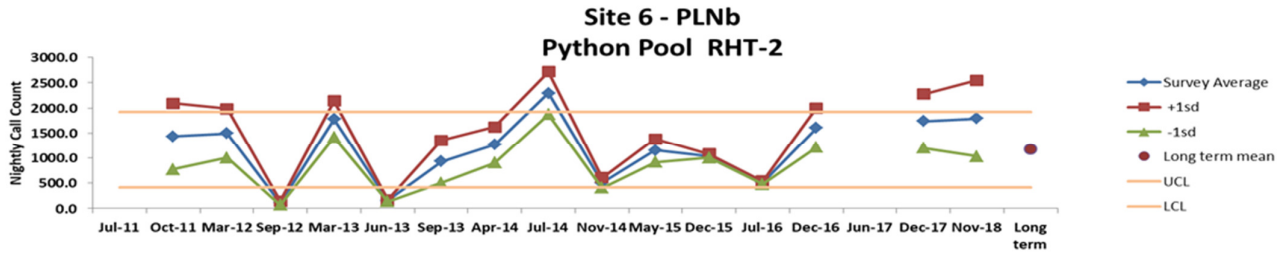


Fig 2 Example of a control chart for PLNb activity. Note that this example is from a periodically monitored site.

Appendix 8B: Significant Bat Monitoring Upper and Lower Control Limit (UCL/LCL) trigger values

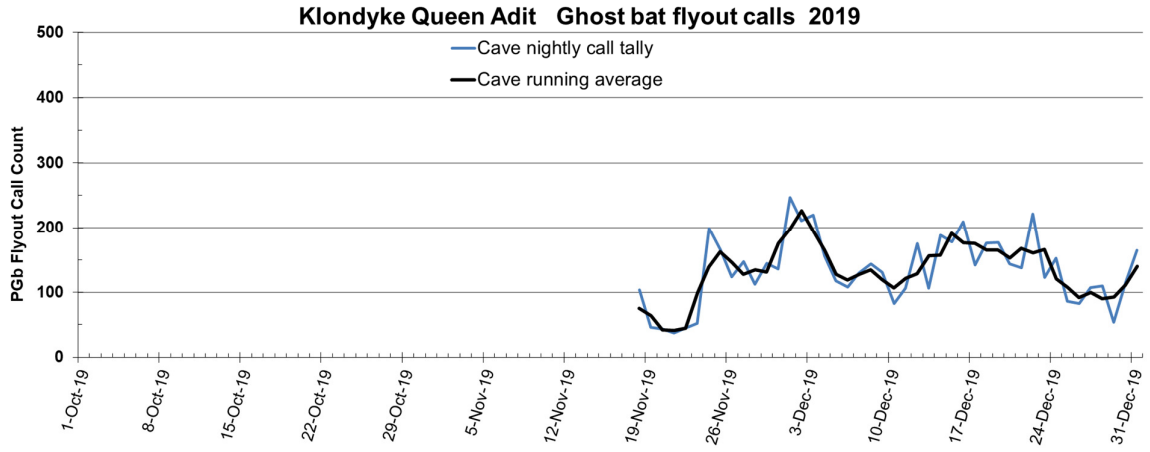
Draft Lower Control Limits as recommended by Bat Call.

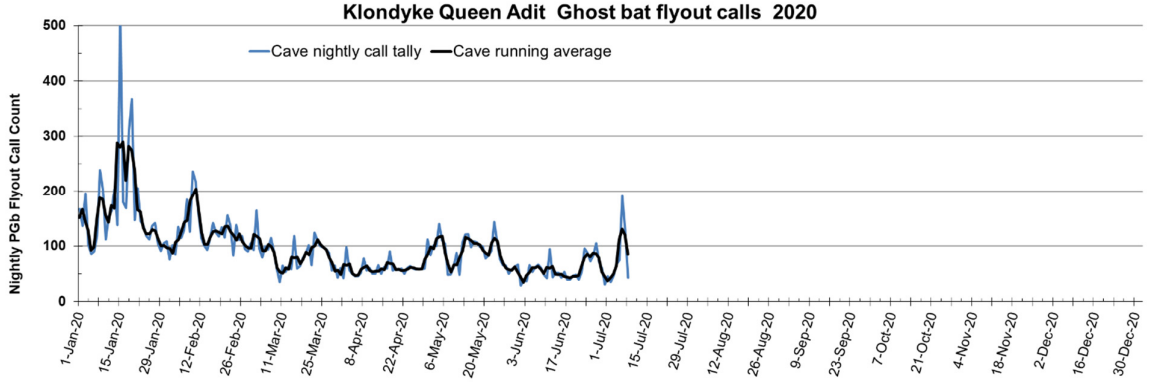
Lower Control Limits have been determined from 7 calendar months of data from Nov 2019 to early June 2020. These are round numbers that represent each sites long term mean nightly call count minus between 1 and 1.5 st dev values.

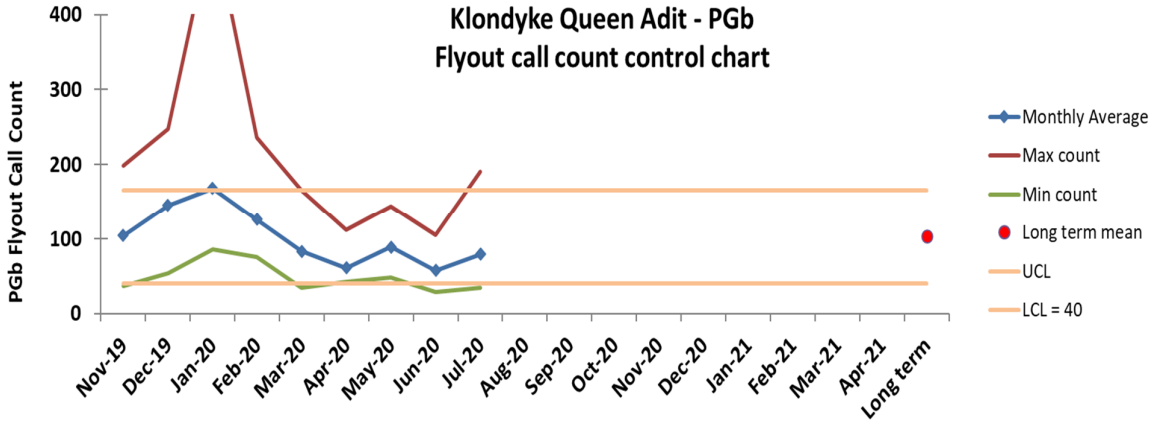
- Klondyke Queen PGb – 40 calls per night
- Bow Bells Sth PGb – 5 calls per night
- Klondyke Queen PLNb – 40 calls per night
- Bow Bells Sth PLNb – 500 calls per night
- Copenhagen PLNb – 10 calls per night

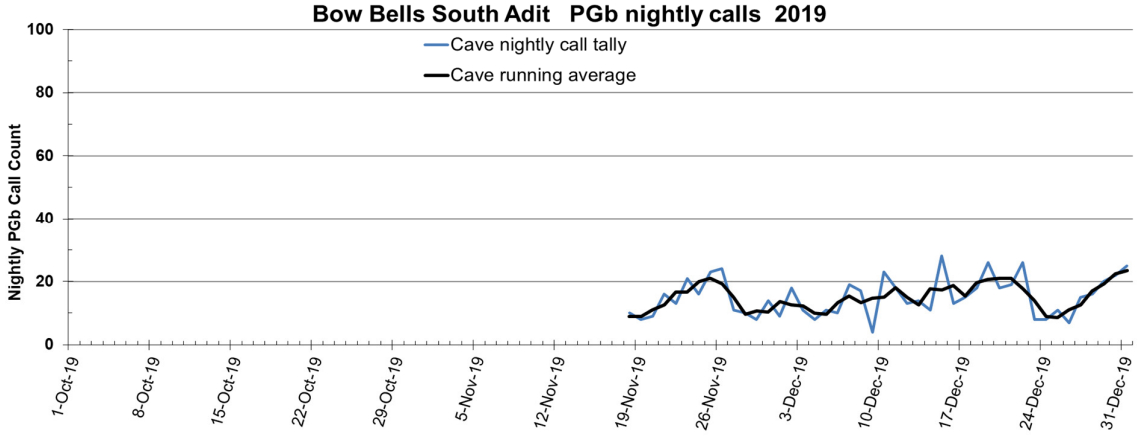
Note, Control limits will remain in draft until mining operation commences to allow for minor changes to long-term mean and LCL values.

Warrawoona PGb and PLNb Activity Summary November 2019 to 8 July 2020






Klondyke Queen Adit - PGb
Flyout call count control chart
PGb Flyout Call Count
400
300
200
100
0
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
Long term
Monthly Average
Max count
Min count
Long term mean
UCL
LCL = 40


Bow Bells South Adit PGb nightly calls 2019
Cave nightly call tally
Cave running average
Nightly PGb Call Count
100
80
60
40
20
0
1-Oct-19
8-Oct-19
15-Oct-19
22-Oct-19
29-Oct-19
5-Nov-19
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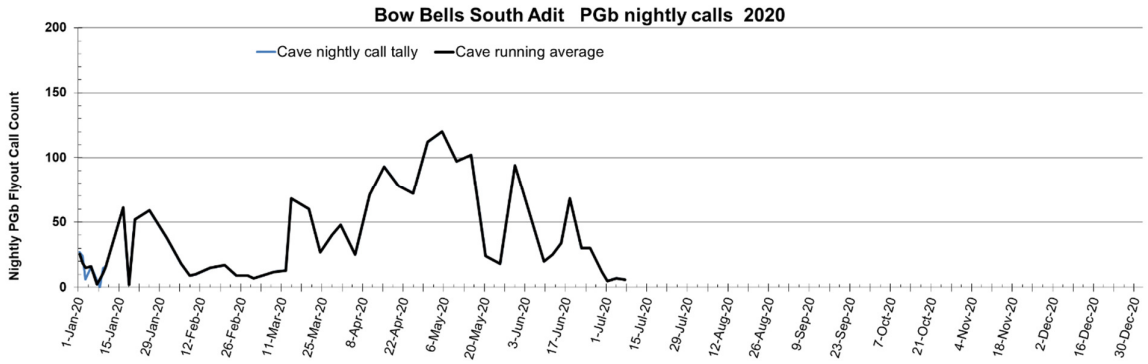
17-Dec-19
24-Dec-19
31-Dec-19


Bow Bells South Adit PGb nightly calls 2020
Cave nightly call tally
Cave running average
Nightly PGb Flyout Call Count
200
150
100
50
0
1-Jan-20
15-Jan-20
29-Jan-20
12-Feb-20
26-Feb-20
11-Mar-20
25-Mar-20
8-Apr-20
22-Apr-20
6-May-20
20-May-20
3-Jun-20
17-Jun-20
1-Jul-20
15-Jul-20
29-Jul-20
12-Aug-20
26-Aug-20
9-Sep-20
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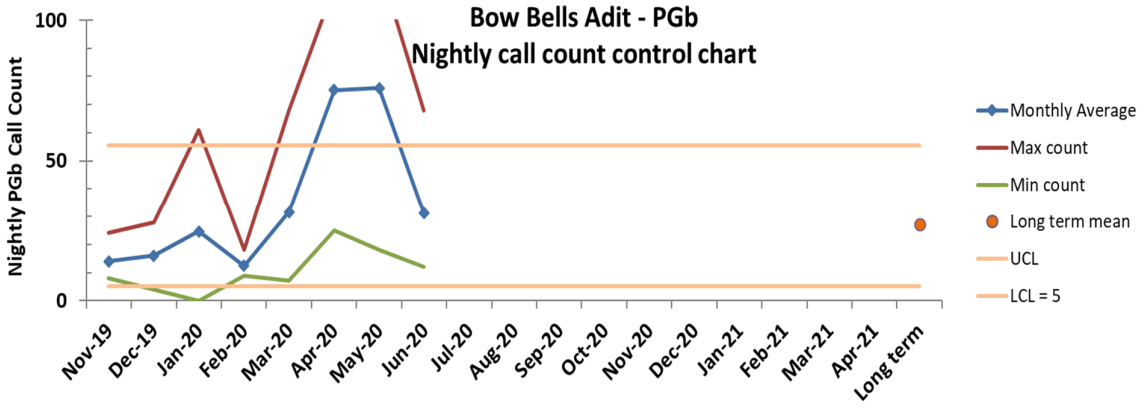
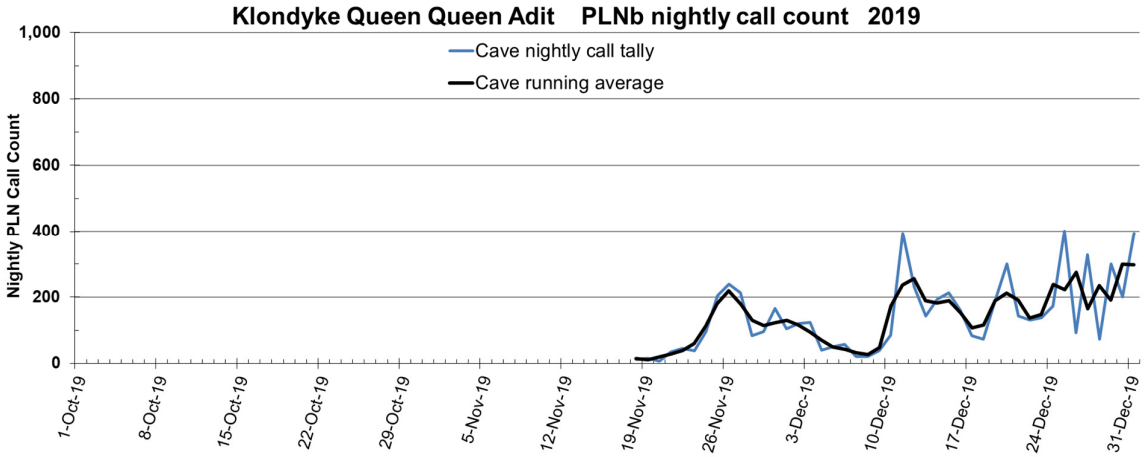
2-Dec-20
16-Dec-20
30-Dec-20


Bow Bells Adit - PGb
Nightly call count control chart
Nightly PGb Call Count
100
50
0
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
Long term
Monthly Average
Max count
Min count
Long term mean
UCL
LCL = 5


Klondyke Queen Queen Adit PLNb nightly call count 2019
Cave nightly call tally
Cave running average
Nightly PLN Call Count
1,000
800
600
400
200
0
1-Oct-19
8-Oct-19
15-Oct-19
22-Oct-19
29-Oct-19
5-Nov-19
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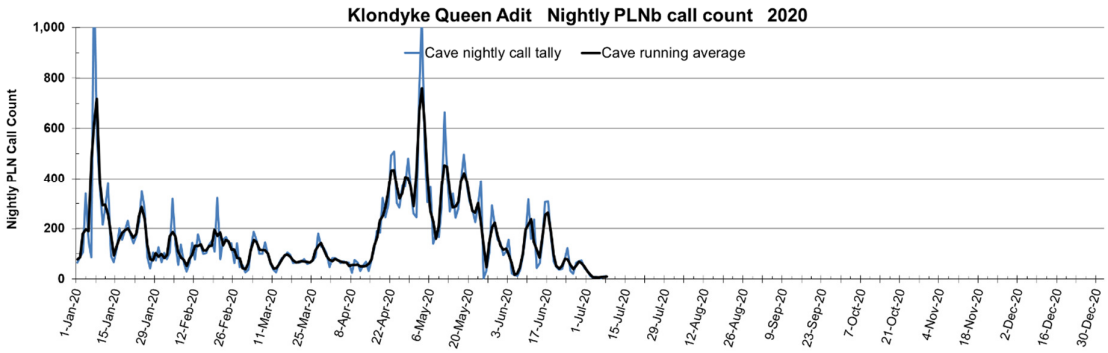
24-Dec-19
31-Dec-19


Klondyke Queen Adit Nightly PLNb call count 2020
Cave nightly call tally
Cave running average
Nightly PLN Call Count
1,000
800
600
400
200
0
1-Jan-20
15-Jan-20
29-Jan-20
12-Feb-20
26-Feb-20
11-Mar-20
25-Mar-20
8-Apr-20
22-Apr-20
6-May-20
20-May-20
3-Jun-20
17-Jun-20
1-Jul-20
15-Jul-20
29-Jul-20
12-Aug-20
26-Aug-20
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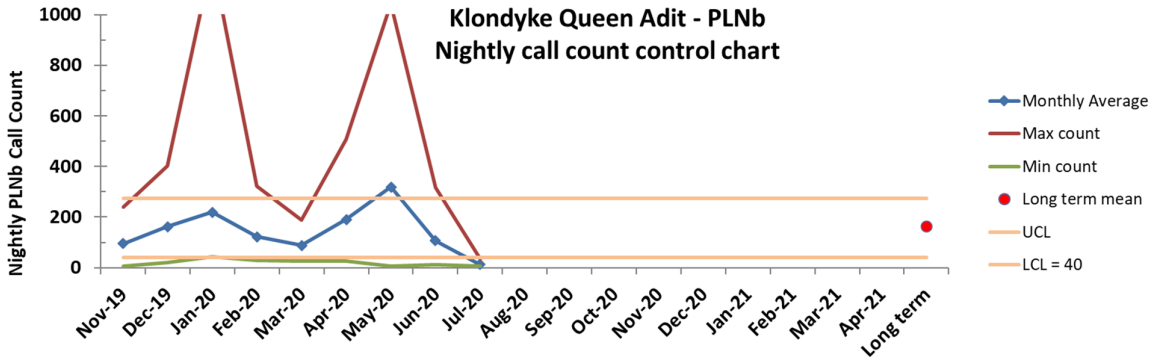
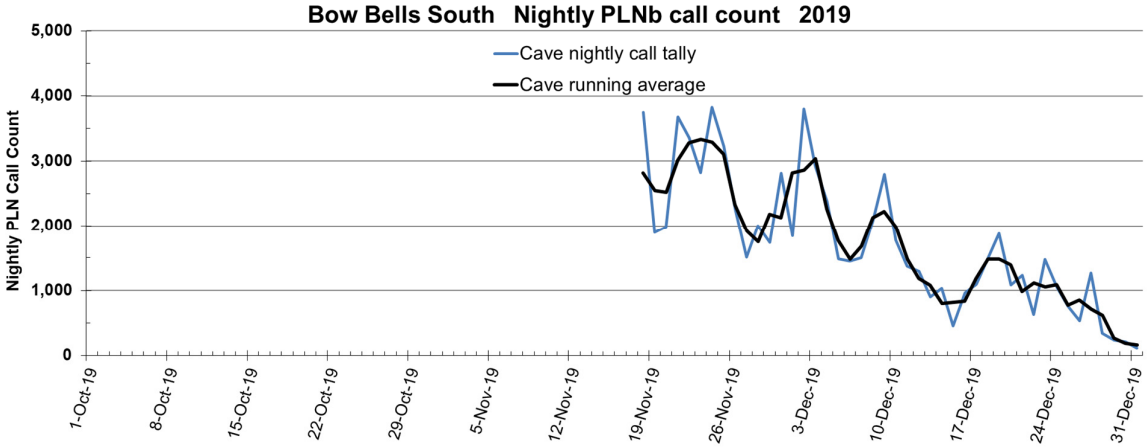
16-Dec-20
30-Dec-20


Klondyke Queen Adit - PLNb
Nightly call count control chart
Nightly PLNb Call Count
1000
800
600
400
200
0
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
Long term
Monthly Average
Max count
Min count
Long term mean
UCL
LCL = 40


Bow Bells South Nightly PLNb call count 2019
Nightly PLN Call Count
5,000
4,000
3,000
2,000
1,000
0
Cave nightly call tally
Cave running average
1-Oct-19
8-Oct-19
15-Oct-19
22-Oct-19
29-Oct-19
5-Nov-19
12-Nov-19
19-Nov-19
26-Nov-19
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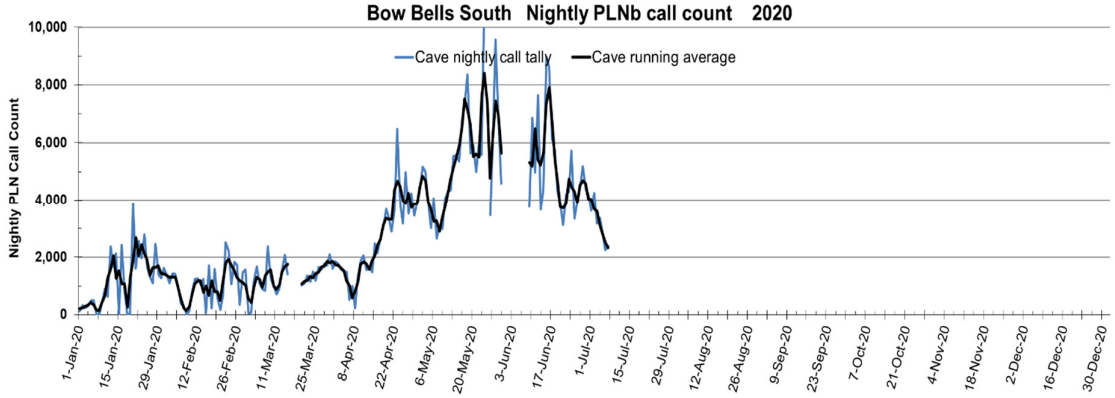
24-Dec-19
31-Dec-19


Bow Bells South Nightly PLNb call count 2020
Nightly PLN Call Count
10,000
8,000
6,000
4,000
2,000
0
Cave nightly call tally
Cave running average
1-Jan-20
15-Jan-20
29-Jan-20
12-Feb-20
26-Feb-20
11-Mar-20
25-Mar-20
8-Apr-20
22-Apr-20
6-May-20
20-May-20
3-Jun-20
17-Jun-20
1-Jul-20
15-Jul-20
29-Jul-20
12-Aug-20
26-Aug-20
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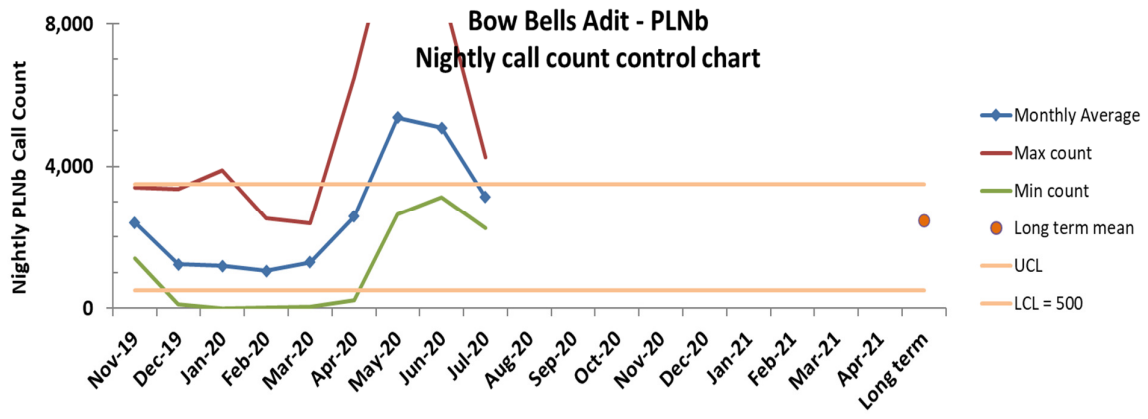
16-Dec-20
30-Dec-20


Bow Bells Adit - PLNb
Nightly call count control chart
Nightly PLNb Call Count
8,000
4,000
0
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
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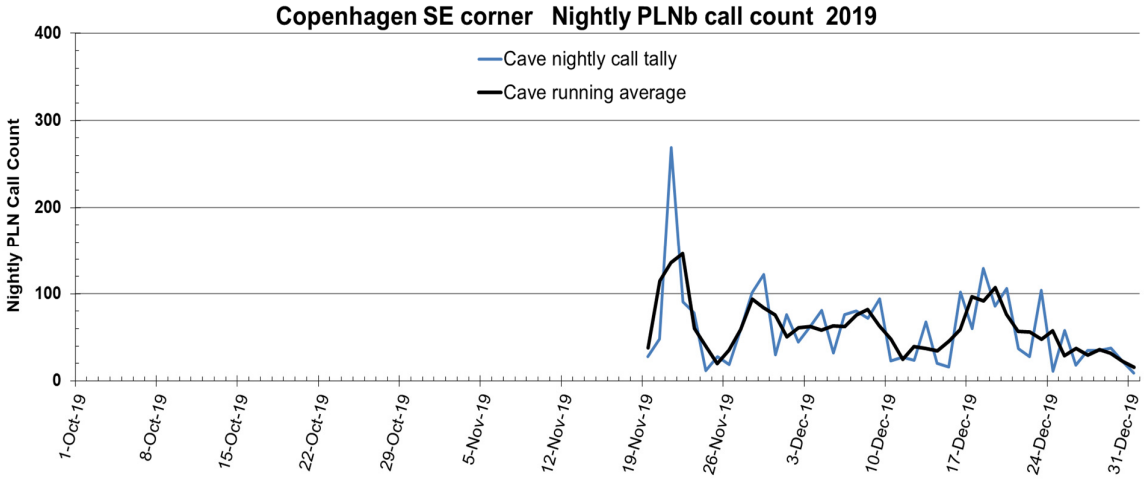
Feb-21
Mar-21
Apr-21
Long term
Monthly Average
Max count
Min count
Long term mean
UCL
LCL = 500


Copenhagen SE corner Nightly PLNb call count 2019
Nightly PLN Call Count
400
300
200
100
0
Cave nightly call tally
Cave running average
1-Oct-19
8-Oct-19
15-Oct-19
22-Oct-19
29-Oct-19
5-Nov-19
12-Nov-19
19-Nov-19
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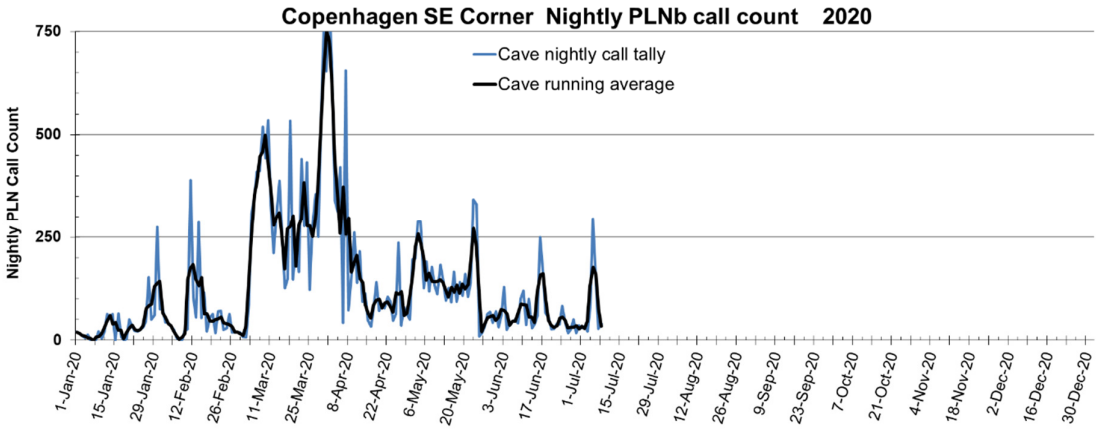
24-Dec-19
31-Dec-19


Copenhagen SE Corner Nightly PLNb call count 2020
Nightly PLN Call Count
750
500
250
0
Cave nightly call tally
Cave running average
1-Jan-20
15-Jan-20
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12-Feb-20
26-Feb-20
11-Mar-20
25-Mar-20
8-Apr-20
22-Apr-20
6-May-20
20-May-20
3-Jun-20
17-Jun-20
1-Jul-20
15-Jul-20
29-Jul-20
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26-Aug-20
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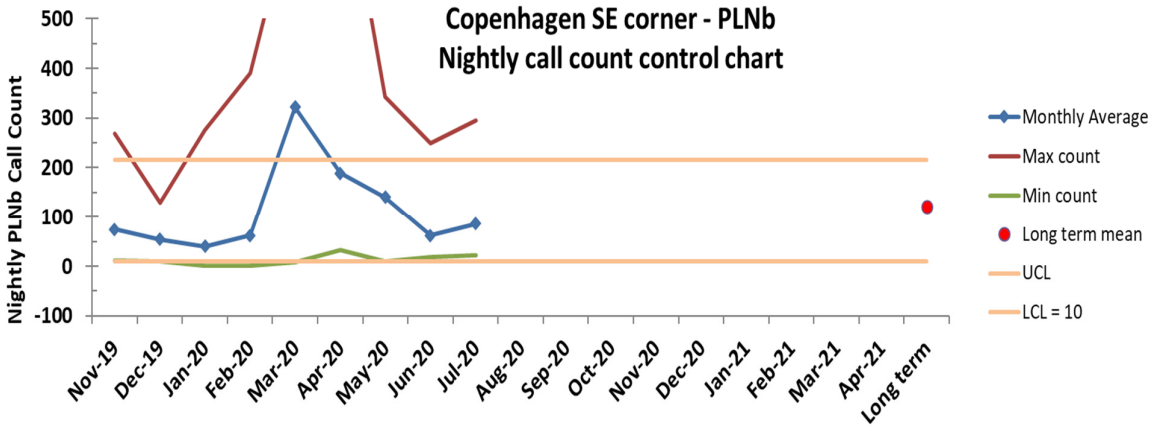
16-Dec-20
30-Dec-20


Copenhagen SE corner - PLNb
Nightly call count control chart
Nightly PLNb Call Count
500
400
300
200
100
0
-100
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
Long term
Monthly Average
Max count
Min count
Long term mean
UCL
LCL = 10

Appendix 9: Underground Workings Clearance Procedure – Significant Bats

Underground Workings Clearance Procedure – Significant Bats

CRL-ENV-PRO-024-19

+61 8 6245 2050 info@calidus.com.au
Suite 12, 11 Ventor Ave West Perth WA 6005 AUSTRALIA
calidus.com.au

Underground Workings Clearance Procedure – Significant Bats
CRL-ENV-PRO-024-19

Rev	Revision Details	Prepared	Reviewed	Authorised	Date
0	Final	Kate George-Rapallo	Robert Bullen (Bat Call Pty Ltd) Paul Brennan Calidus	Paul Brennan Calidus	14 November 2019
1		Kate George-Rapallo	Paul Brennan Calidus	Paul Brennan Calidus	11 September 2020

Calidus Resources Limited
ACN 006 640 553
PO Box 1240
West Perth WA 6872
Australia 6005
+61 8 6245 2050
info@calidus.com.au
https://www.calidus.com.au/

This document has been prepared based on assumptions as reported throughout and upon information and data supplied by others.

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1 Introduction

Two species of threatened bat occur on the Warrawoona Gold Project: the Pilbara Leaf nosed Bat and the Ghost Bat.

Numerous historical underground workings occur across the Warrawoona Gold Project, many of these workings are being utilised by Ghost Bat and Pilbara Leaf-nosed Bat as roosts. Five known nocturnal/night roosts fall within the proposed Klondyke/St George Pit footprints (Table 1.1) and Figure 1.

Table 1.1 – Historical workings within the proposed Klondyke/St George Pit footprint

Site	Easting	Northing	Site Description	Pilbara Leaf-nosed Bat Use	Ghost Bat Use
Britannia	800932	7637260	Two deep shafts if unknown depth	Nocturnal refuge	-
Cuban	800767	7637335	4 vertical shafts of unknown depth, but not very deep	Nocturnal refuge	Night roost
KQ 488	800270	7637670	Deep cut with shaft. Good potential habitat	Nocturnal refuge	Night roost
St George	800626	7637694	Deep shaft	Nocturnal refuge	
Kopckes Rewards	801126	7637179	Two deep shafts	Nocturnal refuge	

1.1 Purpose

The purpose of this procedure is to outline how the existing underground workings in the Klondyke Pit footprint will be removed ensuring Ghost Bat and Pilbara Leaf-nosed Bat are not trapped within the workings prior to clearing.

1.2 Scope

This procedure applies to all Calidus controlled sites and their activities, employees, contractors, and visitors, and is subject to the requirements of the Calidus Health, Safety and Environment (HSE) Standards and applicable environmental legislation.

2 Roles and Responsibilities

All Calidus employees and contractors are required to comply with the requirements of this procedure.

Accountability for fulfilling the requirements of this procedure is dependent on the stage of Project development (exploration, construction, operations, decommissioning).

During exploration, the Exploration Manager will be accountable for ensuring the requirements of the procedure are met.

During construction stages, whether activities are undertaken by an external service provider or internal Calidus personnel, the Project Manager / Registered Manager will be accountable for ensuring the requirements of this procedure are met.

During operational, decommissioning and closure stages, the General Manager (Registered Manager) will be accountable for ensuring the requirements of this procedure are met.

Table 2.1 – Calidus' roles and responsibilities for significant bat preclearance implementation

Role	Responsibility
Exploration Manager/ Project Manager / Registered Manager/ General Manager	Accountable for ensuring the requirements of the plan are met dependent on the stage of project development.
Senior Environmental Advisor	Implement and maintain this procedure. Review the procedure. Assess ground disturbance and access applications. Ensure all personnel involved in fauna surveys are appropriately licensed and qualified. Investigate any incidents involving conservation significant bats and implement findings where relevant. Annual Audit of Compliance. Deliver monitoring/reporting data to the AWE, DBCA, DMIRS and DWER.
Ecologist	Implement significant bat clearance protocol Apply for appropriate DBCA Licences, Ministerial Approval, and permits Provide monitoring records to Calidus.
Construction and Operation Managers	Endorse implementation of this procedure by Project personnel and contractors. Follow ground disturbance protocols (CRL-ENV-PRO-001-19 Ground Disturbance Permit Procedure). .
All personnel, contractors and visitors	Participate in awareness training prior to commencing duties. Report all sightings and/or incidents involving conservation significant bats

3 Procedure

(a) Underground workings being utilised as significant bats are to be demarcated on site GIS and mine planning maps.

(b) Prior to clearing the Ground Disturbance Permit Procedure (CRL-ENV-PRO-001-19) must be followed

(c) Removal of the underground workings (Table 1.1) to occur outside of October to February to avoid potential impacts to young in workings.

(d) Pre-clearance of old workings to be undertaken by a suitably qualified ecologist (bat specialist)

(e) Biodiversity Conservation Act (2016) Section 40 Ministerial Approval to be sought by the above ecologist prior to the preclearance survey in-case bats require handling or become injured during the preclearance (allow minimum 20 days) further information via sacl@dbca.wa.gov.au.

(f) Old deep workings to be completely blocked off using 10 mm bird netting once all bats have departed, typically 1 to 2.5 hours after sunset.

(g) bat activity inside the roost to be monitored by the ecologist via SM4 recorder overnight and via handheld detector prior to the installation of the netting and prior to dawn the morning after the underground workings were netted.

(h) Once the ecologist is satisfied there are no significant bats remaining within the underground workings the workings are to be filled in that day prior to sunset.

(i) Should there be evidence that Significant Bats remain within the workings the procedure is to be repeated over the next evening.

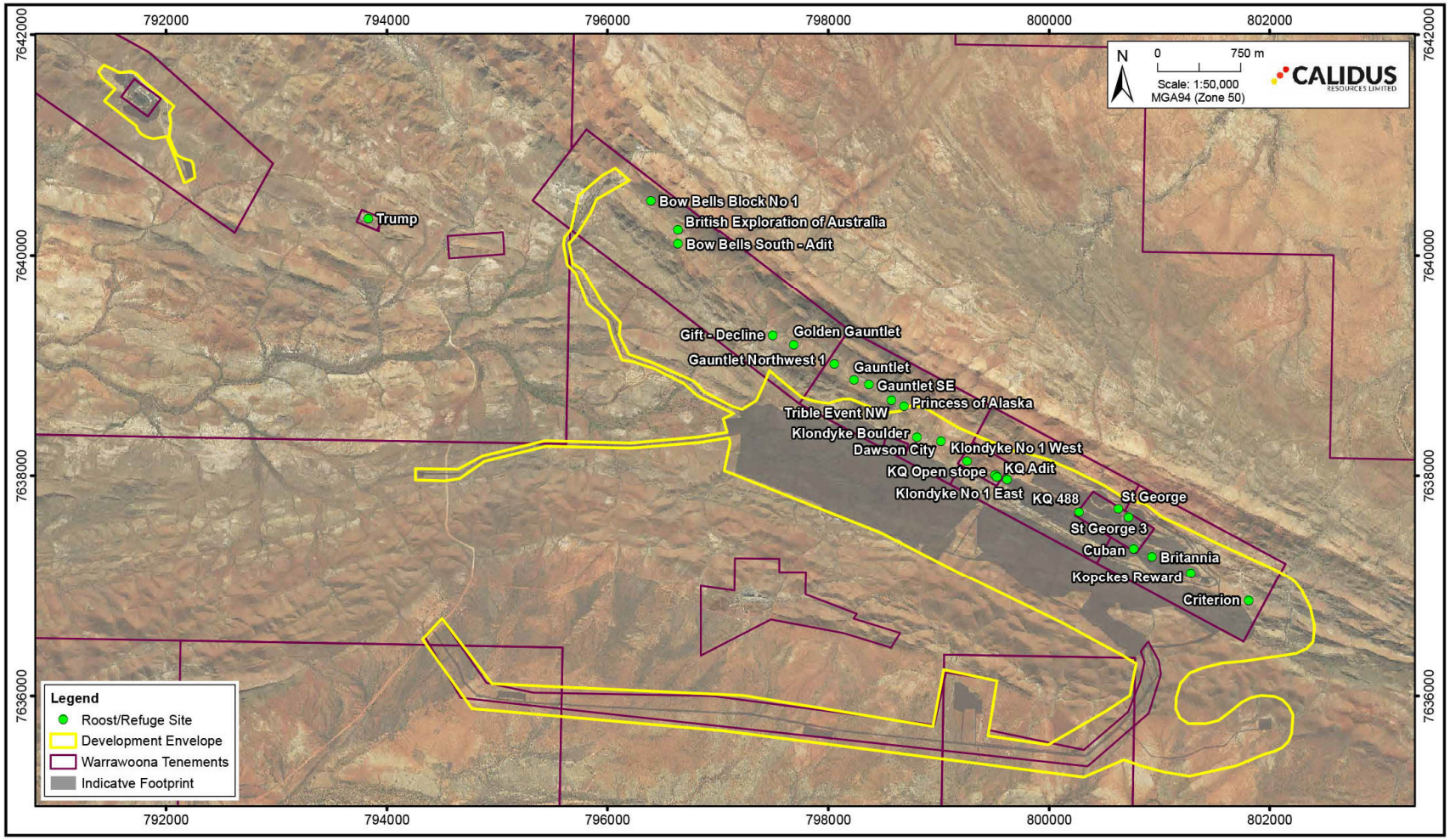
(j) The ecologist is to provide preclearance data to Calidus and to DBCA as per Biodiversity Conservation Act (2016) Section 40 Ministerial Approval.

4 Documentation

For further information, please also refer to:

CRL-ENV-PRO-001-19 Ground Disturbance Permit Procedure

CRL-ENV-PLN-006-19 Significant Species Management Plan



Source: DMIRS - Tenements, Biologic - Fauna
Drawn: CAD Resources (08 9246 3242), Date: Nov 2019, CAD Ref: a2738_F001_18, Rev: A

Figure 1: Development envelope and roost/underground workings