RioTinto

Environmental Review Document – Updated Matters of National Environmental Significance Chapter

Greater Paraburdoo Iron Ore Hub Proposal

Hamersley Iron Pty Limited

December 2021

RTIO-HSE-0337176

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Document Status					
Rev	Author	Reviewer/s	Date	Approved for Issue	
				To Whom	Date
1	Danielle White, Sarah Muller, Briana Wingfield, Jeremy Mitchell	Lisa Adams	12 July 2019	Rio Tinto	12 July 2019
2	Danielle White, Sarah Muller, Briana Wingfield, Jeremy Mitchell	Lisa Adams / Joel McShane	27 September 2019	Rio Tinto	27 September 2019
3	Danielle White, Nicole McAlinden, Jeremy Mitchell	Lisa Adams / Joel McShane	25 October 2019	Rio Tinto	25 October 2019
4	Danielle White, Nicole McAlinden, Jeremy Mitchell, Lisa Adams	Joel McShane	31 October 2019	EPA Services	31 October 2019
5	Sarah Muller, Jeremy Mitchell, Lisa Adams	Joel McShane	21 February 2020	Rio Tinto	21 February 2020
6	Sarah Muller, Jeremy Mitchell, Lisa Adams	Joel McShane	10 March 2020	Rio Tinto	10 March 2020
7	Sarah Muller, Jeremy Mitchell, Lisa Adams	Joel McShane / Melinda Brand	17 March 2020	EPA Services	17 March 2020
8	Jeremy Mitchell, Lisa Adams	Joel McShane	23 April 2020	Rio Tinto	23 April 2020
9	Jeremy Mitchell, Lisa Adams	Joel McShane	29 April 2020	EPA Services	29 April 2020
10	Jeremy Mitchell, Lisa Adams	Joel McShane	1 May 2020	Public review	5 May 2020
11	Stephanie Stack (Updated MNES Chapter)	Brenton Laslett, Joel McShane	26 November 2021	EPA Services	10 December 2021

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10. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

To be consistent with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Proposal is referred to as the Proposed Action in this chapter. Further information regarding the Proposed Action is presented in Section 2 of the ERD.

10.1. Matters of National Environmental Significance

The Commonwealth EPBC Act provides a legal framework for the protection of Matters of National Environmental Significance (MNES). The EPBC Act requires that all actions that will or may have a significant impact on a MNES must be referred to the Minister for the Environment via the Department of Agriculture, Water and the Environment (DAWE). Protected matters under the EPBC Act include listed threatened species and ecological communities; and migratory species protected under international agreements that occur within the Development Envelope.

10.2. Proposed action and assessment process

The Proposed Action involves the extension of existing operations at the Paraburdoo and Eastern Range mines and development of a new mine at Western Range. The Proposed Action will sustain the current iron ore production from the Greater Paraburdoo Hub (currently around 25 Mt/a) for approximately 20 years and is critical to sustain the town of Paraburdoo and more broadly the Proponent's business activities in the Pilbara region.

Key elements of the Proposed Action include the additional clearing of up to 4,300 ha of vegetation within a 17,422 ha Development Envelope, groundwater abstraction at a rate of up to 14 GL/a, and surplus water discharge of up to 1.7 GL/a.

The Proposed Action was referred to DAWE (then DotEE) on 6 December 2018 (EPBC 2018/8341). On 24 January 2019, the Minister for the Environment and Energy determined that the Proposed Action constitutes a Controlled Action under s. 75 of the EPBC Act and; therefore, requires assessment and a decision about whether approval should be granted under the EPBC Act.

The assessment process was determined to be an accredited assessment under the *Environment Protection Act 1986* (EP Act).

10.3. Controlled action provisions

A comprehensive assessment of potential impacts on MNES has been undertaken in this chapter, including potential impacts on threatened species recorded in, likely to, or with potential to occur in the Development Envelope. The controlling provision of the EPBC Act is 'Listed threatened species and communities' (ss. 18 and 18A of the EPBC Act), with potential for significant impacts on the following matters:

- Northern Quoll (*Dasyurus hallucatus*) – Endangered;
- Pilbara Olive Python (*Liasis olivaceus barroni*) – Vulnerable;
- Ghost Bat (*Macroderma gigas*) – Vulnerable; and
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) – Vulnerable.

The potential impacts to these MNES from the Proposed Action as it relates to the EPBC Act have been determined through:

- a review of previous terrestrial fauna surveys and investigations within the Development Envelope, including desktop findings and field-based identification and mapping of fauna habitat types; and
- spatial analysis of fauna habitats and species records to determine potential impacts on species recorded or likely to occur in the Development Envelope.

The significance and management of potential impacts on MNES have been assessed in the context of:

- Matters of National Environmental Significance Significant Impact Guidelines 1.1 (DoE 2013);
- the application of the mitigation hierarchy including avoidance, minimisation, rehabilitation and offset measures to the design and implementation of the Proposed Action;
- a review of approved conservation advice and/or Recovery Plans, where available, for each relevant MNES, specifically, whether a population is an important population, whether available habitat in the Development Envelope is critical habitat for the local population or species; and
- ensuring the outcomes align with Recovery Plan or conservation advice actions for matters identified to have a potential impact from the Proposed Action.

10.4. Policy and guidance

10.4.1. Significant Impact Guidelines

The Significant Impact Guidelines inform the impact assessment required under the EPBC Act on matters and assesses the significance of potential impacts at a local and regional scale. In accordance with these guidelines, the assessment of 'Listed threatened species and communities' is presented within the context of the following key concepts:

- habitat critical to the survival of a species; and
- an important population (for species listed as Vulnerable under the EPBC Act - impacts to species listed as Endangered or Critically Endangered are considered in relation to any population).

'Habitat critical to the survival of a species,' refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long-term evolutionary development; and
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may include, but is not limited to, habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community, and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DoE 2013).

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and
- populations that are near the limit of the species range (DoE 2013).

An assessment of significance for each MNES species is presented in this chapter and reflects additional information provided by survey information presented after the submission of the EPBC referral.

10.4.2. Approved conservation advice and recovery plans

Approved conservation advice and recovery plans are in place for MNES known or likely to occur in the Development Envelope. These guidance documents identify overall conservation objectives, critical habitat, important populations, key threats and priority management actions. They are also relevant to the assessment process as the Minister must consider the content of approved conservation advice to ensure the Proposed Action aligns with objectives of the conservation advice and/or recovery plan.

Guidance and policy documents relevant to the Proposed Action are identified in Table 10-1 below.

Table 10-1: Relevant guidance on MNES

Guidance	Objective/Priorities
Conservation Advice *Macroderma gigas* Ghost bat (TSSC 2016a)	Identifies primary conservation actions as: 1. Protect roosts from mining, human disturbance and collapse. 2. Replace the top strands of barbed wire in fences near roost sites with single-strand wire. Also identifies key conservation and management actions, survey and research priorities.
Conservation Advice *Rhinonicteris aurantia* (Pilbara form) Pilbara Leaf-nosed Bat (TSSC 2016b)	Identifies national conservation objectives, which are summarised below: 1. Ensure that activities don't have a significant impact. 2. Eliminate key threats and halt the predicted decline. 3. Protect and manage known roosts. 4. Identify and protect high value foraging habitat around roost sites. 5. Support research on occurrence, population size and ecological requirements. The Conservation Advice also provides specific guidance about what does and does not comprise habitat critical to the survival of this species, and outlines guidance as to what impacts may be considered significant to Pilbara Leaf-nosed Bat.
National Recovery Plan for the Northern Quoll *Dasyurus hallucatus* (Hill and Ward 2010)	Identifies the national recovery objective as: *'To minimise the rate of decline of Northern Quoll in Australia, and ensure that viable populations remain in each of the major regions of distribution into the future.'* A number of recovery objectives are identified, including the following as relevant to the Proposed Action: 1. Identify potential refuge habitats in Western Australia where quolls might be most likely to persist in the long-term alongside cane toads. 2. Halt Northern Quoll decline in areas not yet colonised by cane toads. 3. Investigate factors causing declines in Northern Quoll populations not yet affected by cane toads. 4. Manage key Northern Quoll populations in areas not currently affected by cane toads to halt population declines. 5. Reduce the impact of feral predators on Northern Quolls.
EPBC Act referral guideline for the endangered northern quoll *Dasyurus hallucatus* (DoE 2016)	Identifies critical habitat and important populations, recommended survey methods, actions likely to result in significant impacts and management/mitigation measures that are effective and appropriate for this species.

Guidance	Objective/Priorities
Approved Conservation Advice for *Liasis olivaceus barroni* (Olive Python – Pilbara subspecies) (DEWHA 2008a)	Identifies research priorities, regional and local priority actions, which includes (but is not limited to) the following that are relevant to this Proposed Action: 1. Identify populations of high conservation priority. 2. Ensure development does not adversely impact known populations. 3. Manage changes to hydrology. 4. Raise awareness of the species.

10.4.3. Threat abatement plans

Threat abatement plans (TAPs) establish national frameworks to guide and coordinate Australia's response to threats to biodiversity. These documents identify research, management and other priority actions required to ensure the protection of threatened species. The Australian Government develops and facilitates the implementation of the TAPs by establishing partnerships and cooperative programs. When considering the approval of a project, the Minister must not act inconsistently with a TAP.

The TAPs relevant to the Proposed Action and the associated objectives for each plan are outlined in Table 10-2

Table 10-2: Relevant threat abatement plans for the Proposed Action

Threat Abatement Plan	Objectives
Threat abatement plan for predation by feral cats (DoE 2015a)	The goal of this TAP is to minimise the impact of feral cats on biodiversity by: • protecting affected threatened species; • preventing further species and ecological communities from becoming threatened. The TAP has four objectives: 1. Effectively control feral cats in different landscapes. 2. Improve effectiveness of existing control options for feral cats. 3. Develop or maintain alternative strategies for threatened species recovery. 4. Increase public support for feral cat management and promote responsible cat ownership.
Threat abatement plan for predation by the European red fox (DEWHA 2008b)	This TAP identifies localised fox control measures applicable in specific areas of high conservation value and where: • chances of reinvasion must be nil or very close to it • all foxes must be accessible and at risk during the control operation • foxes must be killed at a higher rate than their ability to replace losses through breeding • where local eradication is not practicable, two strategies for localised management can be used, as follows: • sustained management, where control is implemented on a continuing, regular basis; or • intermittent management, where control is implemented at critical periods of the year when damage is greatest and short-term control will reduce impacts to acceptable levels.

Threat Abatement Plan	Objectives
Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (DSEWPaC 2011c)	The focus of this TAP is how native animals and natural environments can be protected from cane toads. This plan aims to: • identify native species and ecosystems at risk due to cane toads • reduce the impact of cane toads on native species and ecosystems • communicate information about cane toads and their impacts. The TAP has three objectives as follows: 1. To identify priority native species and ecological communities (including those that are protected matters under the EPBC Act) at risk from the impact of cane toads. 2. To reduce the impact of cane toads on populations of priority native species and ecological communities. 3. To communicate information about cane toads, their impacts and this TAP.
Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (DSEWPaC 2012a)	The goal of this TAP is to minimise the adverse impacts of the five listed grasses on affected native species and ecological communities. To achieve this goal, the TAP has six main objectives, as follows: 1. Develop an understanding of the extent and spread pathways of infestation by the five listed grasses. 2. Support and facilitate coordinated management strategies through the design of tools, systems and guidelines. 3. Identify and prioritise key assets and areas for strategic management. 4. Build capacity and raise awareness among stakeholders. 5. Implement coordinated, cost-effective on ground management strategies in high-priority areas. 6. Monitor, evaluate and report on the effectiveness of management programs.

10.5. Listed threatened species and ecological communities

The following sections provide an overview of the findings for MNES 'Listed under threatened species and communities' under ss. 18 and 18A of the EPBC Act within 20 km of the Proposed Action.

10.5.1. Flora

No flora listed under the EPBC Act were recorded within the Development Envelope (Astron 2018a, b). No flora species protected under the EPBC Act were identified in a Protected Matters Search Tool (PMST) database search as having the potential to be present within 20 km of the Development Envelope (DotEE 2018).

10.5.2. Ecological communities

No ecological communities listed under the EPBC Act were recorded within the Development Envelope (Astron 2018a, b). No ecological communities protected under the EPBC Act were identified in a PMST database search as having the potential to be present within 20 km of the Development Envelope (DotEE 2018).

10.5.3. Fauna

Eight listed threatened fauna species, and nine migratory species protected under the EPBC Act were identified using the PMST (DotEE 2018) as likely to occur within 20 km of the Development Envelope.

Several fauna investigations, including a targeted survey to assess the presence of MNES have been undertaken within the Development Envelope. A summary of existing environmental values relating to MNES identified within the Development Envelope is provided in Section 10.6.

A summary of key MNES investigations are outlined below and provided in Appendix 6 of the ERD. These documents also consolidate historical fauna investigations (including Astron [2014]; Biota [2010, 2011]; and Ecologia [2012]) conducted within the Development Envelope:

- Western Range Project Detailed Terrestrial Vertebrate Fauna Survey (Biologic 2021a).
- Western Range Project Short-Range Endemic Invertebrate Fauna Survey (Biologic 2021b).
- Greater Paraburdoo Level 2 Fauna Survey (Astron 2018c).
- Western Range EPA Level 1 and Targeted Conservation Significant Fauna Assessment (Astron 2018d).
- Greater Paraburdoo Ghost Bat, *Macroderma gigas - Contextual Study* (Astron 2019).
- Rio Tinto, Ratty Spring and Paraburdoo Pools Pilbara leaf-nosed Bat monitoring program, 2015 to January 2020 (Bat Call 2020a).
- Greater Paraburdoo Acoustic Survey of Ghost Bat Activity, July 2018 to February 2020 (Bat Call 2020b).
- Western Range: Pilbara Leaf-nosed Bat VHF Pilot Study (Biologic 2019a).
- Western Range: Pilbara Leaf-nosed Bat VHF Study (Biologic 2020a).
- Memo: Western Range Ghost Bat VHF Study (Biologic 2020b).
- Western Range 2019 Ghost Bat Scat Analysis Report (Biologic 2020c).
- Eastern Range EPA Level 1 Targeted Fauna Survey (Astron 2018e).

The following sections provide an overview of fauna listed under the EPBC Act that may be affected by the Proposed Action.

Table 10-3 lists fauna species and likelihood of occurrence in the Development Envelope. Four EPBC listed species have been recorded within the Development Envelope:

- Northern Quoll (*Dasyurus hallucatus*);
- Ghost Bat (*Macroderma gigas*);
- Olive Python (Pilbara subspecies) (*Liasis olivaceus barroni*);
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*); and

Species considered unlikely to occur in the Development Envelope are not discussed further.

Table 10-3: EPBC Act fauna species and likelihood of occurrence in the Development Envelope

Species	Conservation status (EPBC Act)	Broad habitat type	Likelihood of occurrence in the Development Envelope
Listed threatened species			
Northern Quoll (*Dasyurus hallucatus*)	Endangered	Rocky hills, gorges, mesas, high and low plateaus, low slopes and stony plains with spinifex.	**Present.** Recorded at eight locations in the Development Envelope; six locations at Western Range (four scats and two motion sensitive camera records) and two scats at Paraburdoo (Astron 2018c, d). All eight records were in the Breakaway and Gorge/Gully habitats within the Development Envelope. A Northern Quoll footprint was previously recorded at Eastern Range in 2010, with a track identified in a cave within Gorge habitat close to the Eastern Range mining operations (Astron 2018c).
Olive Python (Pilbara subspecies) (*Liasis olivaceus barroni*)	Vulnerable	Escarpments, deep gorges, water holes and rock piles associated with permanent pools in rocky areas.	**Present.** Previously recorded in 2011 at Seven Mile Creek within the Development Envelope and at other locations within the vicinity of the Development Envelope. A sighting of the species was identified by the Proponent at Channar (outside of the Development Envelope) in 2018. Suitable habitat is present in the Development Envelope comprising Gorge/Gully, Breakaway and Riverine habitats within the Development Envelope.
Ghost Bat (*Macroderma gigas*)	Vulnerable	Rocky gorges and breakaways with caves and crevices.	**Present.** Recorded in the Development Envelope through echolocation recordings, secondary evidence such as scats and midden piles within caves, and observations of individual bats. The Development Envelope contains nine significant caves for Ghost Bats that have the attributes that provide roost sites for Ghost Bat.
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Vulnerable.	Deep caves with high humidity and stable temperatures, water courses, riparian vegetation, hummock grassland and sparse tree and shrub savannah.	**Present.** One permanent colony has been identified in the vicinity of Ratty Springs (Ratty Springs roost) within Breakaway habitat in the Development Envelope and has been confirmed as a permanent diurnal/maternal roost. VHF studies indicate that the Riverine habitat adjacent to the Ratty Springs roost is significant foraging habitat for this population (Biologic 2020a). Suitable habitat occurs in Gorge/Gully and Breakaway habitats in the Development Envelope, including the presence of a number of deep/humid caves that potentially support roost sites. Acoustic records, observations and secondary evidence confirm the presence of the Pilbara Leaf-nosed Bat within the Development Envelope

10.6. Existing environmental values

10.6.1. Habitat suitability for MNES

Eight broad habitat types have been identified in the Development Envelope. These represent habitats that are relatively common and widespread in the wider Pilbara region (Astron 2018d).

Habitat types with the highest value for MNES within the Development Envelope include Gorge/Gully, Breakaway and Riverine habitat types. In a regional context, the Gorge/Gully and Breakaway habitats in the Pilbara are restricted to the Chichester and Hamersley Ranges but are well represented in these areas (Astron 2018d). These two habitat types contain high fauna species richness and provide important microhabitats in the form of caves and rock pools. They also provide potential roosting and denning habitat as well as potential foraging habitat for MNES species including Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat and Ghost Bat. Additional high value habitat locations within the Development Envelope include Riverine habitats including Ratty Springs, which supports semi-permanent surface water, and Seven Mile Creek, which is an ephemeral creek with an approximate 1 km section subject to artificial surface water flow as a result of discharge from the existing operations. The Riverine habitat provides high value foraging and shelter habitat for the Pilbara Olive Python.

Habitat types utilised for foraging and dispersal by MNES species (Rocky Hill and Drainage Line), and habitats that provide low value habitat (Low Hill, Alluvial Plain and Stony Plain habitats) do not provide significant features critical to survival of MNES species. Although moderate and low value habitat types are not expected to represent habitat critical to the survival of MNES species, these habitat types still provide foraging and dispersal value to MNES species. Previously disturbed/cleared areas provide limited value for MNES species and are not considered further in this chapter.

A summary of fauna habitat types and their associated value for recorded MNES in the Development Envelope is presented in Table 10-4 and provided in Appendix 6.

Table 10-4: Fauna habitat in the Development Envelope

Broad scale habitat type	Description	Values to MNES	Extent in Development Envelope (ha)
Riverine	Densely vegetated riparian zones often with permanent and semi-permanent water bodies on stony soils. Vegetation is comprised of *Eucalyptus camaldulensis*, *E. victrix* trees over *Acacia* spp., *Melaleuca glomerata* shrubland over *Cyperus vaginatus* sedgeland over *Cenchrus* spp. tussock grassland. This habitat is absent from Western Range in the Development Envelope. Where it is present in the remaining portion of the Development Envelope (i.e. Ratty Springs in Pirraburdu Creek), it often occurs as narrow linear isolated pockets of riparian vegetation, which is usually denser, taller and more diverse than the adjacent Drainage Line habitat. Where Riverine habitat has been mapped in Seven Mile Creek at Paraburdoo, it is primarily the result of surplus water discharge from the Paraburdoo Processing Plant which has augmented the riparian vegetation in this section of the creek.	**High value** potential shelter and foraging habitat for Pilbara Olive Python. **Moderate value** potential foraging and dispersal habitat for Northern Quoll, Ghost Bat and Pilbara Leaf-Nosed Bat.	131

Broad scale habitat type	Description	Values to MNES	Extent in Development Envelope (ha)
Gorge/Gully	At Western Range and Eastern Range in the Development Envelope, this habitat included shallow gullies and deep open gorges, sometimes with rainfall fed ephemeral pools. Vegetation is comprised of *Dodonaea pachyneura*, *Eremophila cryptothrix* tall shrubland over *Triodia epactia* hummock grassland. Shallow gullies are absent from the remainder of the Development Envelope, with the habitat consisting of deep, often rocky gorges, with rainfall fed ephemeral or semi-permanent pools. Vegetation in these areas is comprised of *Corymbia ferriticola* trees over *Acacia citrinoviridis*, *A. aneura* sens. lat. shrubland over *Triodia epactia* hummock grassland.	**High value** potential shelter, denning and/or roosting habitat for Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat and Ghost Bat. Potential foraging habitat for Pilbara Olive Python.	630
Breakaway	Breakaway or ridge line, falling away to steep scree slope or drainage line. Vegetation is comprised of *Acacia pruinocarpa*, *Grevillea berryana* tall open shrubland over *Eremophila* spp., *Eucalyptus* spp. shrubs over *Triodia epactia* hummock grassland.	**High value** potential shelter, denning and/or roosting habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.	291
Drainage Line	Open drainage areas on stony soils, where water bodies are only present during times of heavy inundation. Vegetation is comprised of *Eucalyptus victrix* woodland over *Acacia* spp., *Melaleuca glomerata* shrubs over *Cenchrus* spp. tussock grassland. Within the Development Envelope, this habitat generally has a lower vegetative cover when compared to Riverine habitat, with less dense and less complex vegetation.	**Moderate value** potential foraging and dispersal habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.	740
Rocky Hill	Stony hills on high ranges with dissected valleys and gorges. At Western Range in the Development Envelope, the vegetation is comprised of *Acacia aneura*, *A. pruinocarpa*, *Grevillea berryana* tall open shrubland over *A. tetragonophylla* and *Eremophila* spp. scattered shrubs over *Triodia epactia* hummock. In the remainder of the Development Envelope, the vegetation includes *Eucalyptus leucophloia* subsp. *leucophloia* trees over *Acacia* spp., *G. berryana, Eremophila* spp. shrubs over *Triodia. epactia*, *T. wiseana* hummock grassland.	**Moderate value** potential foraging and dispersal habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.	4,516
Low Hill	Low stony hills and slopes with dissected valley and drainage on stony soils. Vegetation is comprised of *Acacia* spp. shrubland over *Eremophila* spp. Shrubs over *Triodia epactia, Aristida contorta, Eriachne pulchella* grassland.	Low value habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.	3,947
Stony Plain	Broad flat low-lying plains to undulating plains on soft loamy soils. Vegetation is comprised of *Acacia aneura* sens. lat., *A. xiphophylla* shrubland over *A. tetragonophylla*, *Eremophila cuneifolia*, *Senna* spp. and scattered low shrubs.	Low value habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.	3,516

Broad scale habitat type	Description	Values to MNES	Extent in Development Envelope (ha)
Alluvial Plain	This habitat type has been mapped only in the Western Range portion of the Development Envelope. It consists of flood plain surrounding drainage areas with *Acacia aneura* sens. lat., *A. tetragonophylla* tall shrubland over *Triodia epactia* open hummock grassland. Where similar habitat exists in the remainder of the Development Envelope it has been mapped as Drainage Line.	**Moderate value** potential foraging habitat for Pilbara Leaf-nosed Bat but rated as low value for Northern Quoll, Pilbara Olive Python and Ghost Bat as this habitat type offers minimal ecological value to these species.	104

10.6.2. Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll (*Dasyurus hallucatus*) is listed as Endangered under Schedule 2 of the *Biodiversity Conservation Act 2016* (BC Act) and Endangered under the EPBC Act.

The species was originally found across northern Australia from the North-West Cape of WA to south-east Queensland; however, its abundance has significantly declined in recent years. The Northern Quoll is now restricted to five regional populations across Queensland, the Northern Territory and Western Australia on both the mainland and offshore islands (Rio Tinto 2018a). This species occurs in a variety of habitats but is commonly found in open lowland savannah forest and rocky escarpments. Rocky areas are particularly important for Northern Quolls in the Pilbara as these areas retain water and provide a diversity of microhabitats (Astron 2018c). These areas also tend to have greater floristic diversity and productivity resulting in greater prey density compared to non-rocky areas. These rocky areas also provide refuge from feral cats, fire and livestock and provide breeding potential (Astron 2018c).

A total of 8,172 records are located in the Pilbara and Kimberley regions of Western Australia (DBCA 2019b), of which approximately 4,153 historical records are from the Pilbara (Dunlop *et al*. 2018). The majority of these are recent records with 315 records, or less than 8%, dating prior to 2009. Records from the Pilbara bioregion are scattered across the four subregions; the Hamersley, Fortescue Plains, Chichester and Roebourne Plains subregions with records extending as far west as the Little Sandy Desert and as far south as Karijini National Park (DotEE 2019). The majority of recent records however have come from the Rocklea, Macroy and Robe land systems (DotEE 2019). The species distribution is now considered to be fragmented and mostly confined to the larger conservation reserves such as Millstream Chichester National Park (Henandez Santin *et al*. 2018) as well as to the Burrup Peninsula (DotEE 2019).

The Pilbara Northern Quoll Monitoring Project has been conducted by DBCA since 2012 to improve the understanding of distribution, ecology, abundance and demographics of Northern Quoll in the region (Rangelands 2018). Northern Quoll records from this project are uploaded to the DBCA online government database NatureMap. Extensive evidence of this species in the form of scats and motion camera captures have been identified in Karlamilyi National Park (approximately 403 km northeast from the Development Envelope) and in Karijini National Park (approximately 26 km northeast from the Development Envelope) (Dunlop 2017). The project's efforts have led to the confirmation of an eastern range extension of over 200 km into Karlamilyi National Park.

Populations that constitute an important population for Northern Quoll include (DoE 2016):

- high density quoll populations that occur in refuge-rich habitat that is critical to the survival of the species – this includes habitat where cane toads are present

- populations that are free of cane toads and are unlikely to sustain cane toad populations upon their arrival; for example, populations within a desert context and without permanent water; and
- populations subject to conservation or research programs – that is, populations that are monitored by government agencies or universities.

The *National Recovery Plan for the Northern Quoll* (Hill and Ward 2010) also identifies four categories of important populations, including populations in the Pilbara region as these are outside of the predicted range of cane toads. Cane toads have not yet reached the Pilbara, but are projected to naturally colonise the Pilbara mainland (and potentially its offshore islands) between 2026–2064 (Kearney *et al.* 2008 and Tingley *et al.* 2013 cited in DBCA 2018).

The referral guidelines (DoE 2016) for the species indicate that a high density population may be characterised by numerous camera triggers of multiple individuals across multiple cameras or trap sites. A low density population may be characterised by infrequent captures of one or two individuals confined to one or two traps or where trapping has captured no individuals, but there is latrine evidence.

Key threats to the Northern Quoll population are habitat clearing, modification and land use change, the cane toad, inappropriate fire regimes, weeds and feral predators (Hill and Ward 2010).

Survey effort within the Development Envelope

A targeted survey has been undertaken by Astron (2018e) for species at Eastern Range using motion sensing cameras in suitable microhabitats in Gorge habitats within the Development Envelope. Subsequent investigations for potential suitable habitat for Northern Quoll have been undertaken by Astron (2018c, d) to ascertain its presence in the remaining areas of the Development Envelope. The survey at Eastern Range was undertaken during the time of year that Northern Quolls in the Pilbara are most active (Astron 2018e). The survey effort for Northern Quoll covers the entire Development Envelope and results from baseline investigations are accurate in terms of the size and temporal presence and abundance of the local Northern Quoll population.

Local population

The Development Envelope is at the southern extent of the known distribution of the species (Astron 2018c, d).

Surveys within the Development Envelope have informed whether a 'low' or 'high' density of Northern Quoll occurs in the Development Envelope (Astron (2018c, d). This species has been recorded at eight locations in the Development Envelope including; six locations in Western Range (four scats and two motion sensitive camera records) and two scats in the Paraburdoo portion of the Development Envelope (Astron 2018c, d) (Figure 10-1). All eight records were within Breakaway and Gorge/Gully habitats. One Northern Quoll had been recorded prior to the 2018 survey (in 2010) in the Development Envelope, with a track being identified in a cave within Gorge habitat close to the Eastern Range mining operations (Astron 2018c) (Figure 10-1). No Northern Quolls were recorded as part of the targeted fauna survey at Eastern Range. A number of Northern Quoll records exist in the general vicinity of the Development Envelope with scats found at two locations at Turee Syncline (Astron 2018c).

Despite the use of both traps and motion sensitive cameras, no captures of Northern Quoll individuals have been recorded outside of the two camera records in the Western Ranges portion of the Development Envelope. The low number of records, despite extensive survey effort and the availability of suitable, good quality habitat, indicates that a low-density population exists within the Development Envelope. No known dens are present in the Development Envelope.

Whilst the overall Northern Quoll population in the Pilbara is considered important, the population in the Development Envelope would be expected to be classified as a 'low-density' population as defined by the Northern Quoll Referral Guideline (DoE 2016). The Northern Quoll population in the Paraburdoo Range is low density and the Pilbara is now viewed as within the future range of cane toads; therefore, this population does not meet the definition of an important population in DoE (2016) guidance.

Suitable/critical habitat

The *EPBC Act Referral Guideline for the Endangered Northern Quoll* (DoE 2016) (Northern Quoll Referral Guideline) defines critical habitat for Northern Quoll as habitat within the modelled distribution for the species which provides shelter for breeding, refuge from fire and/or predation by cane toad. This includes:

- offshore islands where Northern Quoll is known to exist;
- rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields and major drainage lines or treed creeks; and
- structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs.

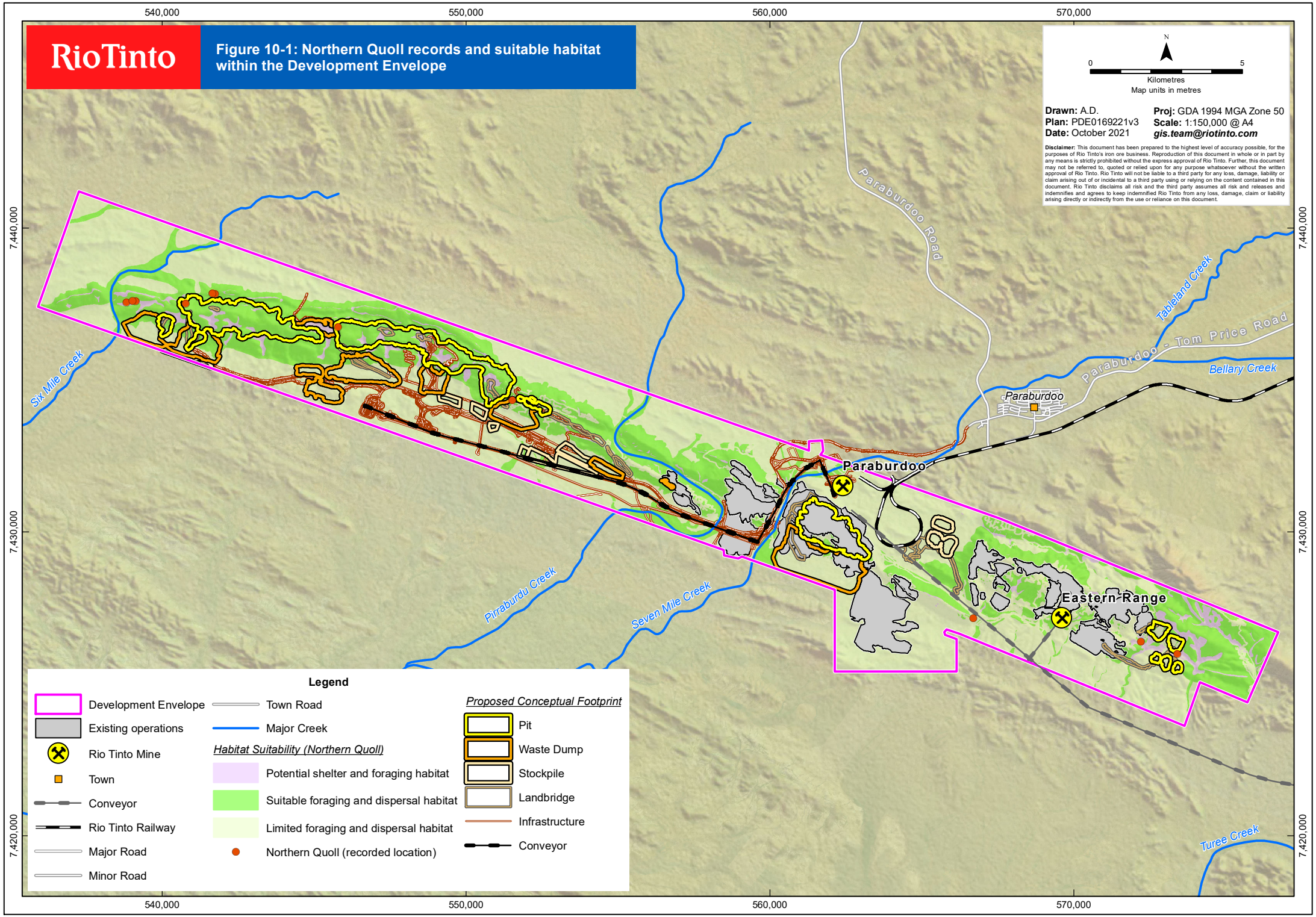
Habitat that is critical to the survival of this species also includes dispersal and foraging habitat associated with or connecting populations that are important to the long-term survival of the species (DoE 2016). As the population of Northern Quoll in the Development Envelope is low density and does not meet the definition of an important population, the foraging habitat in the Development Envelope is not defined as critical habitat. Critical habitat in the Development Envelope for Northern Quoll is limited to rocky habitats which include Breakaways and Gorge/Gully habitat where records and potential denning habitat for Northern Quoll exist. The Northern Quoll Rocky habitats adjoining drainage lines have a heightened level of importance given the proximity of denning habitat to foraging areas (Rio Tinto 2018a).

A large area of habitat for this species is protected within Karijini National Park, approximately 32 km east northeast of the Development Envelope.

Up to 921 ha of the Development Envelope provides high value (critical) denning and foraging habitat for the Northern Quoll (Astron (2018c, d), including:

- Gorge/Gully – 630 ha of shelter (denning) and foraging habitat (critical habitat); and
- Breakaway – 291 ha of shelter (denning) and foraging habitat (critical habitat)

A further 131 ha of Riverine, 4,516 ha of Rocky Hill and 740 ha of Drainage Line moderate value foraging and dispersal habitats are present within the Development Envelope. This does not represent critical habitat for the species.


RioTinto
Figure 10-1: Northern Quoll records and suitable habitat within the Development Envelope
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Kilometres
Map units in metres
Drawn: A.D.
Plan: PDE0169221v3
Date: October 2021
Proj: GDA 1994 MGA Zone 50
Scale: 1:150,000 @ A4
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Paraburdoo - Tom Price Road
Bellary Creek
Six Mile Creek
Paraburdoo
Paraburdoo
Pirraburdu Creek
Seven Mile Creek
Eastern Range
Turee Creek
Legend
Development Envelope
Existing operations
Rio Tinto Mine
Town
Conveyor
Rio Tinto Railway
Major Road
Minor Road
Town Road
Major Creek
Habitat Suitability (Northern Quoll)
Potential shelter and foraging habitat
Suitable foraging and dispersal habitat
Limited foraging and dispersal habitat
Northern Quoll (recorded location)
Proposed Conceptual Footprint
Pit
Waste Dump
Stockpile
Landbridge
Infrastructure
Conveyor

10.6.3. Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python (*Liasis olivaceus barroni*) is listed as Vulnerable under the EPBC Act and Vulnerable under Schedule 3 of the BC Act.

The Pilbara Olive Python is restricted to ranges within the Pilbara region, is widespread in the region and occurs as scattered populations. This species prefers escarpments, deep gorges, water holes and rock piles associated with permanent pools in rocky areas in the ranges of the Pilbara region (Astron 2018c) and occurs in scattered populations. Microhabitat preferences of the Pilbara Olive Python are under rock piles, on top of rocks or under spinifex (Astron 2018c). Individuals spend the cooler winter months within caves and rock crevices away from water sources. In the warmer summer months, the pythons are found to move around widely, usually in proximity to water and rock outcrops. The species uses waterholes to hunt and ambushes prey on animal trails or by striking from a submerged position in water holes (DEWHA 2008a; DotEE 2019). Individuals occupy distinct home ranges (87–449 ha) and males can travel distances of up to 4 km during the breeding season (June to August) to locate females (DotEE 2019).

There are currently 190 records of this species across the Pilbara region (DBCA 2019b) including populations at Pannawonica, Millstream, Tom Price and the Burrup Peninsula. It also occurs within the Rangelands (Western Australia) Natural Resource Management Region and part of the species' habitat is conserved in Karijini National Park, approximately 26 km northeast of the Development Envelope.

At present, there is no species-specific policy guidelines on defining habitat critical to the survival of this python or what an important population is. This is likely due to the species' cryptic nature which makes conducting reliable surveys difficult (DEWHA 2008a).

Key threats to the Pilbara Olive Python population include predation by feral cats and foxes, competition for food sources with feral predators and loss of habitat (DEWHA 2008a).

Survey effort within the Development Envelope

Surveys to locate Pilbara Olive Python in the Development Envelope involved searches of suitable habitat. Targeted survey effort for the species involved active searches in microhabitats such as rocky habitats, waterbodies (including inside bore hole caps) suitable for Pilbara Olive Python and searching for secondary signs including tracks.

Local population

The Development Envelope is located within the modelled distribution of Pilbara Olive Python. The Pilbara Olive Python was recorded in 2011 in the Development Envelope at Seven Mile Creek, and in the vicinity of the Development Envelope within the Gorge/Gully, Breakaway and Riverine habitats, particularly at sites that contain semi-permanent water (Astron 2018c) (Figure 10-2). The species has also been sighted by a Rio Tinto ecologist at Channar in 2018.

An assessment of 'population' was made based on guidance within the Significant Impact Guidelines (DoE 2013). Although the species was not recorded during the most recent surveys and only one record from 2011 exists in the Development Envelope; lack of records is not indicative of the species' absence from an area or absence of an important population, given its cryptic nature. Consequently, the precautionary principle has been applied and it has been assumed that an important population of the species may be present within the Development Envelope.

Suitable/critical habitat

An assessment of 'critical habitat' has been made based on guidance within the Significant Impact Guidelines (DoE 2013). The Development Envelope contains high-quality habitat for the species in terms of potential denning, foraging and dispersal areas. The high value habitat present within the Development Envelope is expected to be important for long-term maintenance of the species or maintaining genetic diversity of the species and; therefore, may meet the definition of critical habitat.

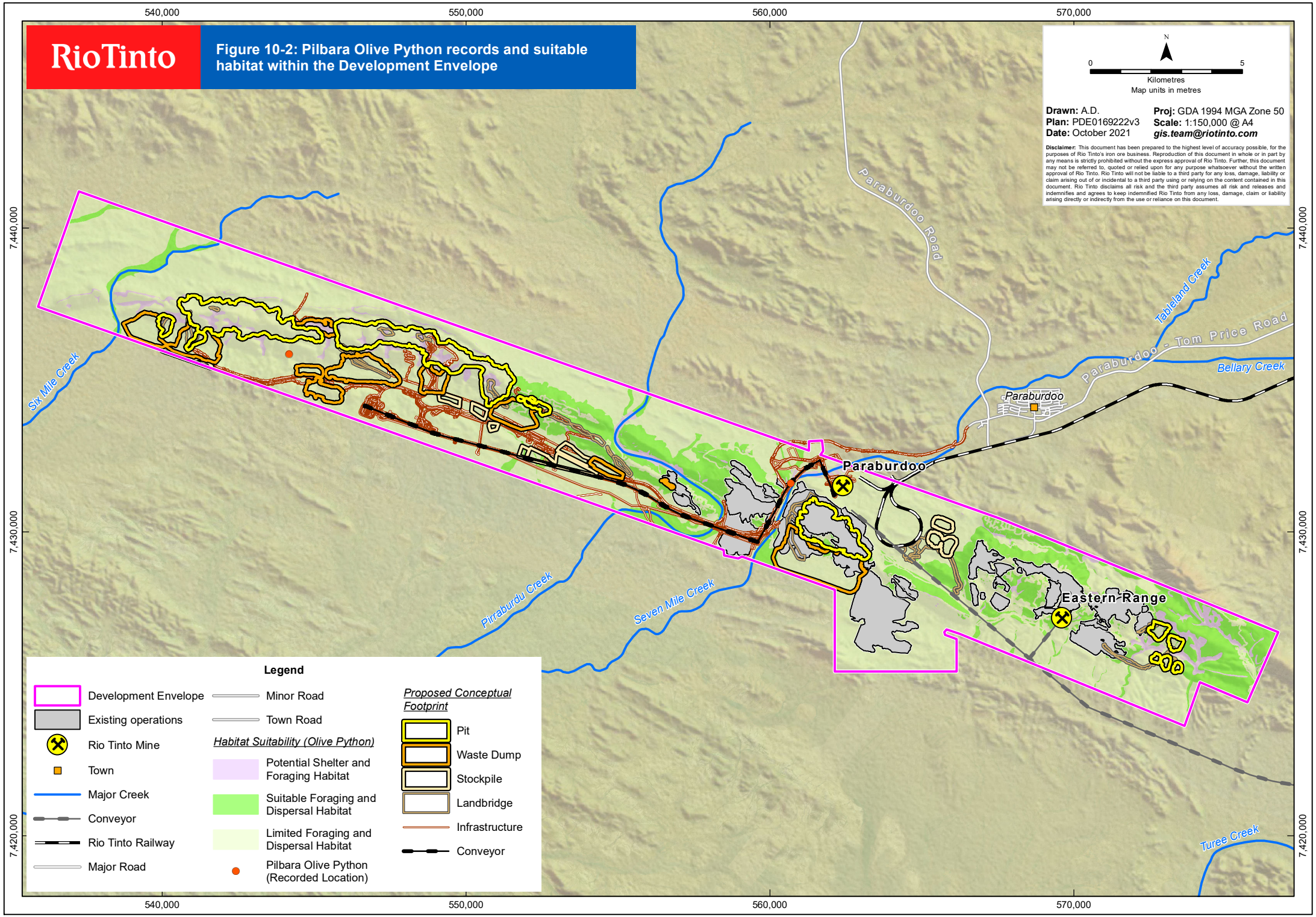
Riverine habitat has been mapped within the Development Envelope, at Ratty Springs and Seven Mile Creek. Numerous ephemeral rock pools also exist within the Development Envelope associated with gullies and gorges in Western Range and, to a lesser extent, Eastern Range.

Up to 1,052 ha within the Development Envelope provides high value (critical) shelter/denning and foraging habitat for Pilbara Olive Python, including:

- Gorge/Gully – 630 ha of shelter (denning) and foraging habitat (critical habitat);
- Breakaway – 291 ha of shelter (denning) and foraging habitat (critical habitat); and
- Riverine – 131 ha of foraging and dispersal habitat (critical habitat).

A further 4,516 ha of Rocky Hill and 740 ha of Drainage Line moderate value habitat provides dispersal and foraging opportunities for Pilbara Olive Python. This does not represent critical habitat for the species.

The remaining areas of the Development Envelope are considered by Astron (2018c, d) to provide limited foraging and dispersal habitat, consisting of Alluvial Plain, Stony Plain and Low Hill habitats.


RioTinto
Figure 10-2: Pilbara Olive Python records and suitable habitat within the Development Envelope
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Kilometres
Map units in metres
Drawn: A.D.
Plan: PDE0169222v3
Date: October 2021
Proj: GDA 1994 MGA Zone 50
Scale: 1:150,000 @ A4
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Paraburdoo Road
Tableland Creek
Paraburdoo - Tom Price Road
Bellary Creek
Six Mile Creek
Paraburdoo
Paraburdoo
Pirraburdu Creek
Seven Mile Creek
Eastern Range
Turee Creek
Legend
Development Envelope
Existing operations
Rio Tinto Mine
Town
Major Creek
Conveyor
Rio Tinto Railway
Major Road
Minor Road
Town Road
Habitat Suitability (Olive Python)
Potential Shelter and Foraging Habitat
Suitable Foraging and Dispersal Habitat
Limited Foraging and Dispersal Habitat
Pilbara Olive Python (Recorded Location)
Proposed Conceptual Footprint
Pit
Waste Dump
Stockpile
Landbridge
Infrastructure
Conveyor

10.6.4. Ghost Bat (*Macroderma gigas*)

The Ghost Bat (*Macroderma gigas*) is listed as Vulnerable under the EPBC Act and Vulnerable under Schedule 3 of the BC Act. The Ghost Bat occupies rocky gorges and breakaways that contain caves and crevices, which are used as nocturnal, diurnal (day) roosts, and maternity roosts. Ghost Bats are known to require a number of suitable caves, of varying shapes and sizes, throughout their home ranges to fulfil various ecological requirements. Individuals also move between roosts seasonally or according to weather conditions, and populations tend to be widely dispersed when not breeding and concentrate in relatively few roost sites when breeding (TSSC 2016a). Mating generally occurs in July and August, with gestation extending from August to October and birth occurring between September and November (Rio Tinto 2019j).

In the Hamersley Range in the Pilbara, preferred roosting habitat appears to be caves beneath bluffs of low rounded hills composed of Marra Mamba geology, and larger hills of Brockman Iron Formation. In the eastern Pilbara, caves beneath bluffs composed of Gorge Creek Group geology and granite rockpiles are preferred (TSSC 2016a). The presence of active roosts in an area is considered by DAWE to be the most important indicator of habitat for Ghost Bats, and these caves are generally the primary focus of conservation and/or monitoring (DoE 2015b).

The species' current range is discontinuous, with geographically disjunct colonies occurring in the Pilbara, Kimberley, Northern Territory, Gulf of Carpentaria, coastal and near coastal eastern Queensland from Cape York to near Rockhampton and western Queensland (TSSC 2016a). The Ghost Bat has a patchy distribution in the Pilbara with a total of 903 records existing in Western Australia (DBCA 2019b). The regional Pilbara Ghost Bat population is estimated at 1,300 to 2,000 individuals, and in the Hamersley subregion a population of approximately 350 individuals (TSSC 2016a). The Pilbara population of Ghost Bat is genetically distinct and divergent and has been assumed to be an important population based on the definition in the Significant Impact Guidelines.

There are no species-specific policy guidelines on what constitutes habitat critical to the survival of the Ghost Bat, or what is defined as an important population; persistence of this species in the Pilbara is recognised as being dependent upon the presence of day roosts which comprise humid, temperature-stable caves (TSSC 2016a). It is generally accepted that Ghost Bat utilise and require three types of roost regularly, including maternity, diurnal and nocturnal roosts. The three types of roosts used regularly by Ghost Bats are outlined below (TSSC 2016a):

- **Nocturnal roosts (or feed caves)** are used only at night, either habitually or for transitory visits. They are often high in the strata and are typically shallow, poorly insulated caves and shelters that are well lit during the day. The Ghost Bat hunts at night and uses nocturnal caves to consume prey it has captured in the surrounding area. Feed caves often contain Ghost Bat scats and/or feeding remnants (typically feathers and small animal bones).
- **Diurnal roosts (or day roosts)** are caves and disused mines that contain domed ceilings and are deeper and more complex than nocturnal roosts. They typically have one or more large chambers at or beyond the twilight area with additional fissures or chambers at the rear in the fully dark regions. They have a minimum roof height in the chambers of 2–3 m providing protection from attack by terrestrial predators. They are often at mid-levels or lower in the strata making them well insulated. The stable temperature and elevated humidity of these caves relative to the ambient conditions create physiologically benign conditions. Diurnal roosts can vary in importance from almost continued use to occasional use by small numbers of Ghost Bats.
- **Maternal roosts** are diurnal roosts that usually include an interior chamber that rises toward the rear trapping warmer, more humid air at the top. Maternal roosts have a stable temperature of 23°C to 28°C and moderate to high relative humidity of 50% to 100%.

Bat Call (2020b) also provides a classification of caves within the Development Envelope based on the categories above but also taking into account their level of use.

To persist in an area, the Ghost Bat requires a group of caves/shelters that provide diurnal and nocturnal sites and a gully or gorge system that opens onto a plain or riparian line that provides good foraging opportunities. The persistence of the species in the Pilbara is believed to depend on the availability of diurnal roosts that have stable temperature and humidity (TSSC 2016a).

The EPBC Act conservation advice identifies a number of known threats to Ghost Bats (TSSC 2016a). Loss of roost sites, in particular maternity roosts containing breeding females, and nearby areas is rated as having potentially severe consequences. Disturbance to roosts from human visitation is rated as having moderate to severe consequences on the bat, and both the modification to foraging habitat and collision with barbed wire fences have been given moderate consequence ratings (TSSC 2016a). Potential population decline associated with competition for prey with foxes and feral cats has been rated of 'unknown' consequence. Other threats identified in the conservation advice are not relevant to the Proposed Action.

Survey effort in Development Envelope

Historical surveys at Western Range recorded limited Ghost Bat activity. They included a Level 2 Fauna Survey (Biota 2011) which recorded Ghost Bats via acoustic calls at two locations at the 66W end of Western Range, and a Level 1 Vegetation, Flora and Fauna Survey (Astron 2013) which recorded a single Ghost Bat scat.

A Level 1 Targeted Fauna survey of the Western Range area of the Development Envelope was commissioned to support the Proposed Action (Astron 2018d). This survey recorded Ghost Bats at four different locations, with two records from sightings in diurnal roosts and two from ultrasonic recordings, all within Gorge/Gully and Breakaway habitats in the 36W area.

Historical surveys at Eastern Range identified three records for Ghost Bat (Biota 2010; Astron 2014; Bat Call 2014), two of which were acoustic records and one from feeding debris. The Greater Paraburdoo Level 2 Fauna Survey (Astron 2018c) undertaken to support the Proposed Action covered the Paraburdoo and Eastern Range portion of the Development Envelope and recorded Ghost Bat at one location (from two possible acoustic calls) in Breakaway habitat north of the Eastern Range operations near the Development Envelope boundary.

The Proponent subsequently commissioned the Greater Paraburdoo Ghost Bat Contextual Study (Astron 2019), which included a desktop survey over a 30 km radius of Greater Paraburdoo and a targeted field search across Western Range, Paraburdoo, Eastern Range and Channar, to identify significant habitats for Ghost Bat within and surrounding the Development Envelope. The field survey effort was concentrated around Western Range, eastern Paraburdoo and Eastern Range, specifically in deeply incised, generally south facing gorges and gullies where typical roost caves are known to occur. In total 18 caves were identified at Western Range as being utilised by Ghost Bats. A number of these caves were targeted for further acoustic monitoring to measure levels of Ghost Bat activity and to assess the relative importance of identified caves (Bat Call 2020b). These targeted echolocation surveys undertaken by Astron (2018a) and more recently by Biologic and Rio Tinto Ecologists (Bat Call 2020b), and analysis of the recordings, combined with the physical properties of the caves and the physical presence of Ghost Bats, has led to five caves being selected for longer term monitoring. These are Caves 6, 11, 14, 15 and 18 (Figure 10-3). Fifteen cave assessments were undertaken at Eastern Range in 2014, with seven of these caves revisited during the 2018 field survey as part of the Ghost Bat Contextual Study (Astron 2019). Further to the visited seven caves, four more Eastern Range caves were seen from afar and observed as being north facing and high in the landscape; as such they were not considered by Astron as conducive to diurnal and maternal roosting for conservation significant bats due to their orientation and position. No Ghost Bat roosts have been identified at Eastern Range; however, evidence of Ghost Bat presence was recorded in the form of scats at three locations in Gorge/Gully habitat in the vicinity of the proposed 42EE and 47E pits (Figure 10-3).

To provide a better understanding of the habits and movements of the Ghost Bats in Western Range the Proponent commissioned a Very High Frequency (VHF) tracking survey and a faecal scat analysis

study to be undertaken (Biologic 2020b, c). The VHF study involved the capture and tagging of eight Ghost Bats and tracking them via 35 towers installed across the development envelope and its wider surrounds (Turee and Mount Truchanas). The VHF study was designed to record the movement patterns of the Ghost Bats in Western Range, particularly identifying roosting habitat and their favoured foraging grounds.

Supporting this study was faecal scat analysis that was completed in seven caves within Western Range and a further five caves from Mount Trucanas (approximately 35 km north of the Development Envelope), all of which have previously shown evidence of use by Ghost Bats. Genetic analysis of the scats collected provides a snapshot of the number of individual Ghost Bats using the caves during the survey period and an indication of cave usage. The survey effort within the Development Envelope, combined with publicly available data is expected to be an accurate representation of the presence of this species in the Development Envelope and surrounding areas.

Local population

Ghost Bats have been recorded in the Development Envelope through echolocation recordings, secondary evidence such as scats and midden piles within caves, and observations of individual bats. Ghost Bats are present at Western Range and this area is likely to support a small population. Fourteen of the eighteen caves at Western Range have had nineteen months of acoustic monitoring with echolocation recordings of Ghost Bats being confirmed at 13 of the 14 caves (Bat Call 2020b). Echolocation recordings and scats indicated regular, long term use of four caves (Cave 6, 11, 15 and 18) with Cave 6 having the most consistent use (Figure 10-3).

Eighteen sightings of individuals were recorded by Astron (2019) roosting within caves at Western Range. Astron (2019) inferred the population of Ghost Bats within the Development Envelope to range between five and 11 individuals using results from acoustic records. Further work by Bat Call (2020b) based on additional acoustic surveys conducted from late 2018 to February 2020 also concluded that up to 10 individuals are likely to be using the ridge lines within the Western Range area, probably on a seasonal basis with low numbers present year-round (Bat Call 2020b). These results are consistent with other Hamersley Range ridge lines where Ghost Bats occur in small numbers and utilise a number of caves for varying times throughout the year and occasionally come together in larger groups for short periods (Bat Call 2020b).

A total of 43 unique individuals were identified as using the monitored caves during the survey period (September 2018 to September 2019). Of these, nine individuals appear to use the caves on a regular basis. Caves 6 and 14 supported the highest number of different individuals (16 and 10 respectively) (Biologic 2020c).

In the Eastern Range portion of the Development Envelope, given that there are limited records and no maternal or diurnal roost sites have been recorded despite significant survey effort, it is likely that a small number of individuals are utilising the gorge habitats within the Eastern Range area for foraging and/or drinking purposes. However, the Gorge/Gully and Breakaway habitats were characterised as providing suitable foraging and shelter habitat due to the potential presence of diurnal roost caves and nocturnal feed caves (Astron 2018c).

Individuals of the species recorded within the Development Envelope likely meet the definition of an important population outlined in the Significant Impact Guidelines (DoE 2013).

Suitable/critical habitat

Foraging habitat

The VHF study was designed to provide information regarding the foraging habits of the Western Range population of Ghost Bats (Biologic 2020b). Of the eight tagged Ghost Bats only one individual spent any time foraging within the Development Envelope. This individual appeared to forage around the Rocky Hill and Gorge/Gully habitats of central Western Range and across the plains to the north of the

Development Envelope. The remaining individuals spent most of the night outside of the detection range of all towers suggesting they were foraging on the plains north and south of Western Range. The data from this study suggests that the Riverine, Drainage Line, Low Hill and Stony Plain habitats of the Development Envelope are not frequently used for foraging by Ghost Bats.

Roosting habitat

The persistence of genetically disjunct populations in key areas including the Pilbara is dependent on the presence of day roosts in humid, temperature stable caves (TSSC 2016a). Day roosts are important for long-term maintenance of the species or maintaining genetic diversity of the species and are expected to meet the definition of critical habitat.

The Development Envelope contains 18 caves that have the attributes to provide roost sites for Ghost Bats. The multiple bat surveys conducted for the Western Range area has provided a consistent picture of cave usage (Astron 2019, Bat Call 2020b, Biologic 2019d, Biologic 2020b, c). Suitability of the caves within the Development Envelope are presented below and in Figure 10-3:

- One cave (Cave 6) is a confirmed maternal roost, with hormone analysis recording high levels of progesterone indicating the occurrence of pregnant females;
- Three caves (Cave 11, 15 and 18) classified as potential maternal roosts;
- Four caves (Caves 1, 4, 14 and 16) classified as confirmed diurnal roosts;
- Nine caves classified as potential diurnal roosts; and
- One cave as a nocturnal feed cave.

The 18 caves identified are all at the Western Range end of the Development Envelope and stretch from Cave 14 located approximately 1 km east of the 27W pit to Cave 7 located approximately 2.7 km west of the 66W pit (Figure 10-3).

This assessment was further refined by the extensive echolocation survey and consideration of previous records by Bat Call (2020b). This work concluded that Cave 6, 11, 15 and 18 were all used regularly by small numbers of bats. Cave 6 had the largest number of records. Monitoring indicated that Caves 1–4, 12–14, 16 and 17 were used occasionally for diurnal roosting. No roosting was identified at the remaining cave locations (Bat Call 2020b). No echolocation recordings were detected at Cave 5.

Three important groupings of caves were identified for the species based on detected usage and activity (Bat Call 2020b):

- Caves 6 and 18 with 1 km separation and has Caves 16 and 17 between them;
- Cave 11 has Cave 2 approximately 250 m west of its location; and
- Cave 15 has Cave 12 approximately 500 m east of its location.

These cave systems have demonstrated regular and consistent usage by the Ghost Bat (Bat Call 2020b).

There was limited usage of Caves 1, 3, 4 and 5 despite its proximity to Cave 6, therefore these are not considered part of the important groupings. These caves had inconsistent ultrasonic call recordings and had no large middens present (Bat Call 2020b). Cave 13 and 14 are isolated from other caves, however both had regular usage by Ghost Bats (Bat Call 2020b).

The VHF and scat analysis studies confirmed earlier assessments of cave usage, with Cave 6, 11 and 14 being used as diurnal roost sites (Biologic 2020b, c).

Ghost Bat roosting in the significant caves (outlined in Table 10-5) in the Development Envelope is expected to be more frequent than documented due to the infrequent and intermittent nature of this species' calling when entering and exiting roost caves (Astron 2019).

Based on the presence of one confirmed maternity roost, confirmed diurnal roosts and potential maternity roosts; critical habitat is present within the Development Envelope for the Ghost Bat.

Table 10-5: Summary of roost/feed caves for Ghost Bat recorded in the Development Envelope

Site ID	Category	Location	Entrance description/ orientation	Internal description	Details
Cave 1	Confirmed diurnal roost with low usage.	Western Range 36W deposit	**Entrance:** narrow and pinched (1 m wide x 0.6 m high). Orientation: southwest.	**Internal:** 1 dome with 2 side pockets (12 m deep x 4 m wide x 3 m high). **Conditions:** Raised humidity and elevated temperature.	Ghost Bat (x1) observed by Astron (2018c), Ghost Bat calls recorded. Scats present. No roosting detected; limited usage/activity by the species between 16–26 July and 4–9 December 2018 (Bat Call 2020b).
Cave 2 (significant as is within the Cave 11 group)	Potential diurnal roost	Western Range	**Entrance:** narrow (2 m wide x 1 m high) Orientation: south	**Internal:** forked cave, corkscrew to the right (25 m deep) and straight to the left (10 m deep), 2 domes (2 m high x 3 m wide), lots of crevices and solution pipes. C**onditions**: microbats present, scats, raised humidity, elevated temperature, rear passages.	Cave properties conducive to diurnal roosting. Ghost Bat scats present (Astron 2018c). Ghost Bat calls recorded in July 2018, February 2019 and March 2019 (Bat Call 2020b) Roosting detected by one suggested individual in February 2019 (Bat Call 2020b). Activity and usage of this cave is regular and relatively consistent (Bat Call 2020b).
Cave 3	Potential diurnal roost	Western Range 36W deposit	**Entrance:** narrow (5 m wide x 1 m high) Orientation: west	**Internal:** narrow with two side caverns (30 m deep x 1 m to 15 m wide x 1 m high). **Conditions:** raised humidity and elevated temperature.	Cave properties conducive to diurnal roosting. Ghost Bat calls recorded in December 2019 (Bat Call 2020b).
Cave 4	Confirmed diurnal roost.	Western Range 36W deposit	**Entrance:** overhang that is open/wide (5 m wide x 2 m high). Orientation: west.	**Internal:** large cavernous dome with solution pipes (10 m deep x 4 m wide x 5 m high). **Conditions:** Raised humidity and elevated temperature.	Ghost Bat present (x3), scats present (Astron 2018c). Ghost Bat calls recorded inn July 2018 (Bat Call 2020b). No roosting has been detected. Limited usage/activity recorded in the cave by the species (Bat Call 2020b).

Site ID	Category	Location	Entrance description/ orientation	Internal description	Details
Cave 5	Feed cave	Western Range 36W deposit	**Entrance:** overhang that is open/wide (5 m wide x 1.5 m high) Orientation: west	**Internal:** single dome (5 m deep x 5 m wide x 1.5 m high)	Ghost Bat scats present (Astron 2018c). No echolocation recordings have been detected in this cave (Bat Call 2020b). No roosting has been detected. Limited usage/activity recorded in the cave by the species (Bat Call 2020b).
Cave 6 (Significant)	Confirmed maternal roost. Highest significance	Western Range	**Entrance:** open/wide (6 m wide x 1 m high). Orientation: southwest.	**Internal:** two domed caverns, left dome has solution pipes 5 m to 7 m in height, right dome is large cavern (15 m deep x 10 m wide x 15 m high). **Conditions:** High humidity and high elevated temperatures.	Ghost Bats detected roosting: • on two occasions (four individuals and one individual from separate recording events) (Astron 2018c); • between July–September 2018; and December 2018–February 2020 by Bat Call (2020a) between 32–100% of overnight recordings at the cave; and • a single Ghost Bat was captured and tagged at this cave (Biologic 2020b). Scat analysis indicates that 10 different individuals were recorded using this cave over the survey period but was only used regularly by one or two resident individuals (biologic 2020c). Two large midden piles present (Astron 2018c) Ghost Bat calls recorded across 2018–2020 (Bat Call 2020b). Activity and usage of this cave is regular and consistent. Hormone analysis of scats indicating presence of pregnant females.

Site ID	Category	Location	Entrance description/ orientation	Internal description	Details
Cave 7	Potential diurnal roost	Western Range	**Entrance:** narrow (0.5 m wide x 2 m high) Orientation: southeast	**Internal:** narrow long tube (14 m deep x 1 m wide x 1 m high). **Conditions:** microbats present, raised humidity and elevated temperature.	Cave properties conducive to diurnal roosting.
Cave 8	Potential diurnal roost	Western Range	**Entrance:** narrow (2 m wide x 0.5 m high). **Orientation:** northeast.	**Internal:** deep slanted cave (20 m deep) with rear passages. **Conditions:** raised humidity and elevated temperature.	Cave properties conducive to diurnal roosting.
Cave 9	Potential diurnal roost	Western Range	**Entrance:** narrow (1 m wide x 0.5 m high) Orientation: west	**Internal:** deep, right slant (15 m deep x 1 m wide x 1 m high)**.** **Conditions:** microbats present, raised humidity and elevated temperature.	Cave properties conducive to diurnal roosting.
Cave 10	Potential diurnal roost	Western Range	**Entrance:** open/wide (4 m wide x 1.5 m high) with pinch portion (0.5 m wide x 0.5 m high) Orientation: southeast	**Internal:** single dome (15 m deep x 2 m wide x 3 m high). **Conditions:** microbats present, raised humidity and elevated temperature.	Cave properties conducive to diurnal roosting.

Site ID	Category	Location	Entrance description/ orientation	Internal description	Details
Cave 11 (Significant)	Potential maternal roost/ Confirmed diurnal roost	Western Range	**Entrance:** narrow (4 m wide x 0.5 m high). Orientation: south.	**Internal:** pinched section that opens into a higher dome on a side chamber (20 m deep x 8 m wide x 4 m high).	Ghost Bat present (x5) and Ghost Bat calls recorded (which indicate roosting) during Astron (2018c) investigation. Five Ghost Bats were captured and tagged at this cave (Biologic 2020b). Scat analysis indicates that 16 different individuals were recorded using this cave over the survey period but was only used regularly by one or two resident individuals (Biologic 2020c). Between one and seven Ghost Bats suggested to be roosting in the cave. Cave usage from February 2019 to March 2019 and July 2019 to February 2020 (Bat Call 2020b) One large midden pile present.
Cave 12 (Significant as is within the Cave 15 group)	Potential diurnal roost	Western Range	**Entrance:** narrow (1 m wide x 1 m high). Orientation: west.	**Internal:** long tunnel shaped cave (18 m deep x 1 m wide x 1 m high) with a large, narrow top chamber (>15 m deep x 1 m wide x 3 m high) **Conditions:** raised humidity and elevated temperature	Ghost Bat scats present. Cave properties conducive to diurnal roosting, located near pools. Ghost Bat call recordings were detected in February and March 2019 and had recorded regular usage and activity of the species in this cave during this time. No roosting was identified (Bat Call 2020b).

Site ID	Category	Location	Entrance description/ orientation	Internal description	Details
Cave 13	Potential diurnal roost	Western Range 36W deposit	**Entrance:** narrow (10 m wide x 2 m high). Orientation: south.	**Internal:** two chambers, one left (10 m deep x 5 m wide x 2 m high) and one right (10 m deep x 3 m wide x 3 m high). **Conditions:** Raised humidity and elevated temperature	Ghost Bat scats present (Astron 2018c). Cave properties conducive to diurnal roosting. Ghost Bat calls recorded in February and March 2019, and roosting indicated by Bat Call (2020). Cave 13 demonstrated regular usage by Ghost Bats in February and March 2019 (Bat Call 2020b).
Cave 14 (Significant)	Confirmed diurnal roost.	Paraburdoo	**Entrance:** open/wide, large cathedral (12 m wide x 6 m high). Orientation: south.	**Internal:** one large rear domed cavern, left dome with multiple cracks and crevices and mini roosting spots, main dome is 5 m to 8 m in height, 25 m deep x 12 m wide.	Ghost Bat present (two individuals and one individual observed roosting on separate occasions, and Ghost Bat calls recorded (indicate roosting) by Astron [2018c]). A single Ghost Bat was captured and tagged at this cave (Biologic 2020b). Scat analysis indicates that the caves is used regularly by one or two resident individuals (Biologic 2020c). A single Ghost Bat regularly using this cave to roost. Cave usage from October 2018 to October 2019 (Bat Call 2020b).
Cave 15 (Significant)	Potential maternal/ Confirmed diurnal roost	Western Range	**Entrance:** narrow (0.5 m wide x 0.4 m high). Orientation: east.	**Internal:** three domed caverns (potential), front dome 1.5 m high x 2 m wide x 2 m high, rear caverns dome dimensions unknown **Conditions:** Multiple Ghost Bats present, midden piles, high humidity and high elevated temperatures	Ghost Bat present (x3) and observed roosting on one occasion by Astron (2018c). Large midden pile present. Ghost Bat calls recorded (indicate roosting). Regular and consistent usage by the Ghost Bat with 2–3 suggested individuals roosting between October 2018 and February 2020 (Bat Call 2020b).
Cave 16 (Significant as is within the Cave 6/18 group)	Confirmed diurnal roost	Western Range	**Entrance:** wide (3.0 m wide x 2.5 m high). **Orientation:** east/southeast.	**Internal:** one long tunnel (~15 m to 20 m) leading to one high rear domed cavern.	Ghost Bat (x1) observed roosting on one occasion by Astron (2018c). Large midden piles present. No roosting detected (Bat Call 2020b).

Site ID	Category	Location	Entrance description/ orientation	Internal description	Details
Cave 17 (Significant as is within the Cave 6/18 group	Potential diurnal roost	Western Range	**Entrance:** narrow (0.5 m wide x 0.5 m high). **Orientation:** east-southeast.	**Internal:** two chambers, one left (15 m deep x 2.5 m wide x 1.5 m high) and one right (15 m deep x 2.5 m wide x 1.5 m high) **Conditions:** Raised humidity and elevated temperature.	Cave properties conducive to diurnal roosting. Ghost Bat calls recorded by Astron (2018c); and by Bat Call (2020b) in January and February 2019.
Cave 18 (Significant)	Potential maternal roost	Western Range	**Entrance:** wide (3 m wide x 3 m high). Orientation: south.	**Internal:** three chambers, one main (10-15 m deep x 8 m wide), side and rear chambers (6 m deep x 4 m wide x 3 m high domes).	A single Ghost Bat regularly using this cave to roost. Cave usage from October 2018 to October 2019 (Bat Call 2020b).

Critical habitat

An assessment of 'critical habitat' has been made based on guidance within the Significant Impact Guidelines (DoE 2013). To persist in an area, the Ghost Bat requires a group of caves/shelters that provide diurnal and nocturnal sites and a gully or gorge system that opens onto a plain or riparian line that provides good foraging opportunities. The persistence of the species in the Pilbara is believed to depend on the availability of diurnal roosts that have stable temperature and humidity (TSSC 2016a). Ghost Bats do not require free surface water for drinking and forage after sunset and again before sunrise, and utilise habitats including gullies and gorges with vertical vegetation complexity, that open on to riparian drainage lines and plains that are typically within 5 km of roosts (TSSC 2016a). On this basis, suitable foraging habitats that are located within approximately 5 km of recorded roosts are expected to be utilised.

High value Ghost Bat habitats correspond to the locations where diurnal or potential maternal roosts were identified or areas where aerial photography shows topography corresponding with significant gorges or landforms likely to contain suitable caves for roost sites (Astron 2019). Moderate value habitats correspond to rocky breakaways and cliffs where feeding sites were recorded or considered by Astron likely to occur and sites where semi -permanent water sources occur (Astron 2019). Semi-permanent pools exist in the Development Envelope at Ratty Springs and numerous ephemeral rock pools associated with gullies and gorges occur throughout Western Range and, to a lesser extent, Eastern Range. Semi-permanent water also exists to the east of Eastern Range at Doggers Gorge. Rocky Hill habitat contains microhabitats such as boulder piles, cracks and crevices that support a wide range of prey species for the Ghost Bat (Astron 2018c).

Based on suitable cave locations and likely locations of higher quality foraging areas containing pools, the Development Envelope contains up to 921 ha high value (critical) shelter/denning and foraging habitat for Ghost Bat, including:

- Gorge/Gully – 630 ha of potential roosting and foraging habitat (critical habitat); and
- Breakaway – 291 ha potential roosting and foraging habitat (critical habitat).

A further 4,516 ha of Rocky Hill, 131 ha of Riverine and 740 ha of Drainage Line habitat provide dispersal and foraging opportunities for Ghost Bat. This does not represent critical habitat for the species.

The remaining habitats present in the Development Envelope are considered by Astron (2018c, d) of low value to Ghost Bat.

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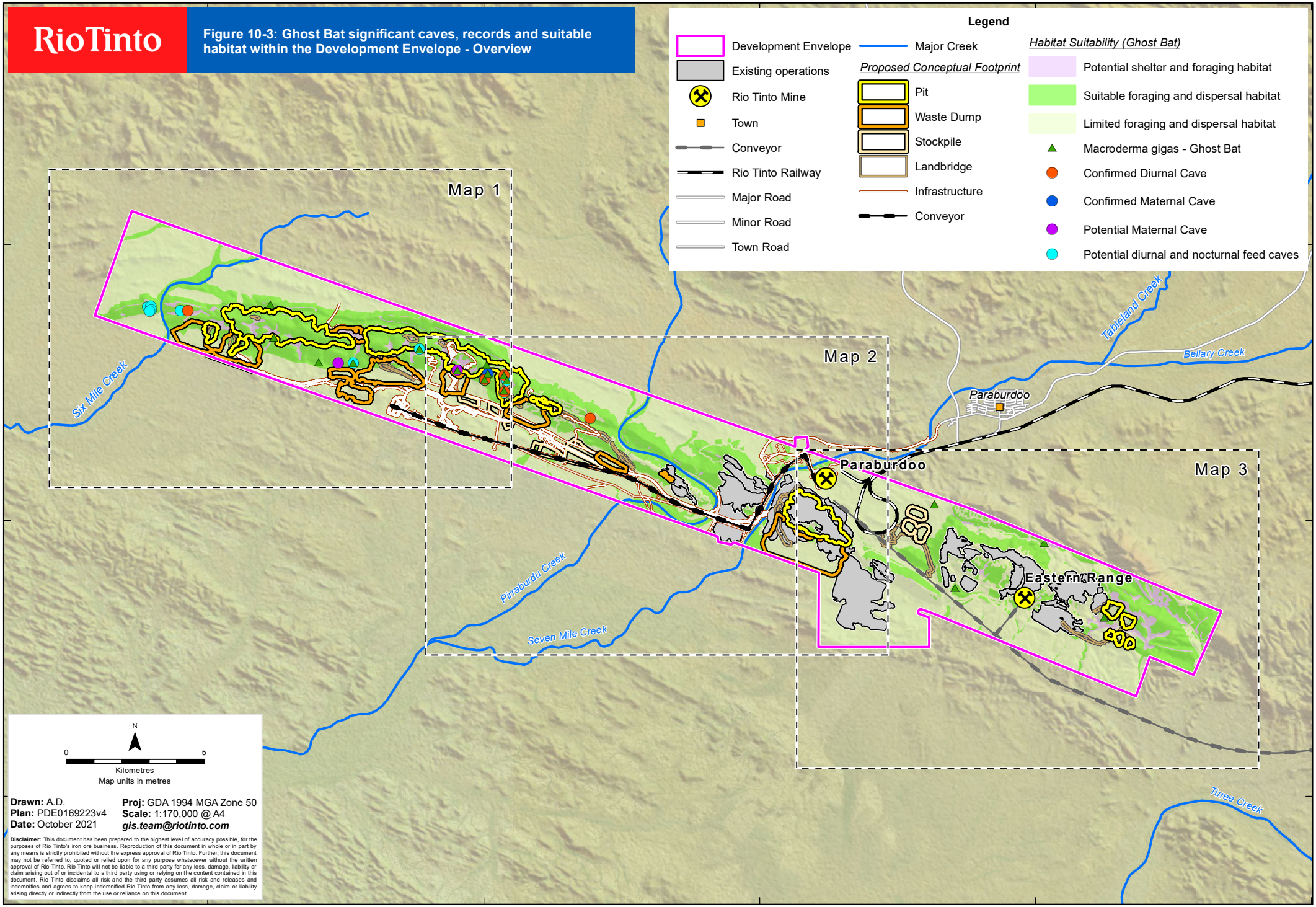
Figure 10-3: Ghost Bat significant caves, records and suitable habitat within the Development Envelope - Overview



Drawn: A.D.
Plan: PDE0169223v4
Date: October 2021

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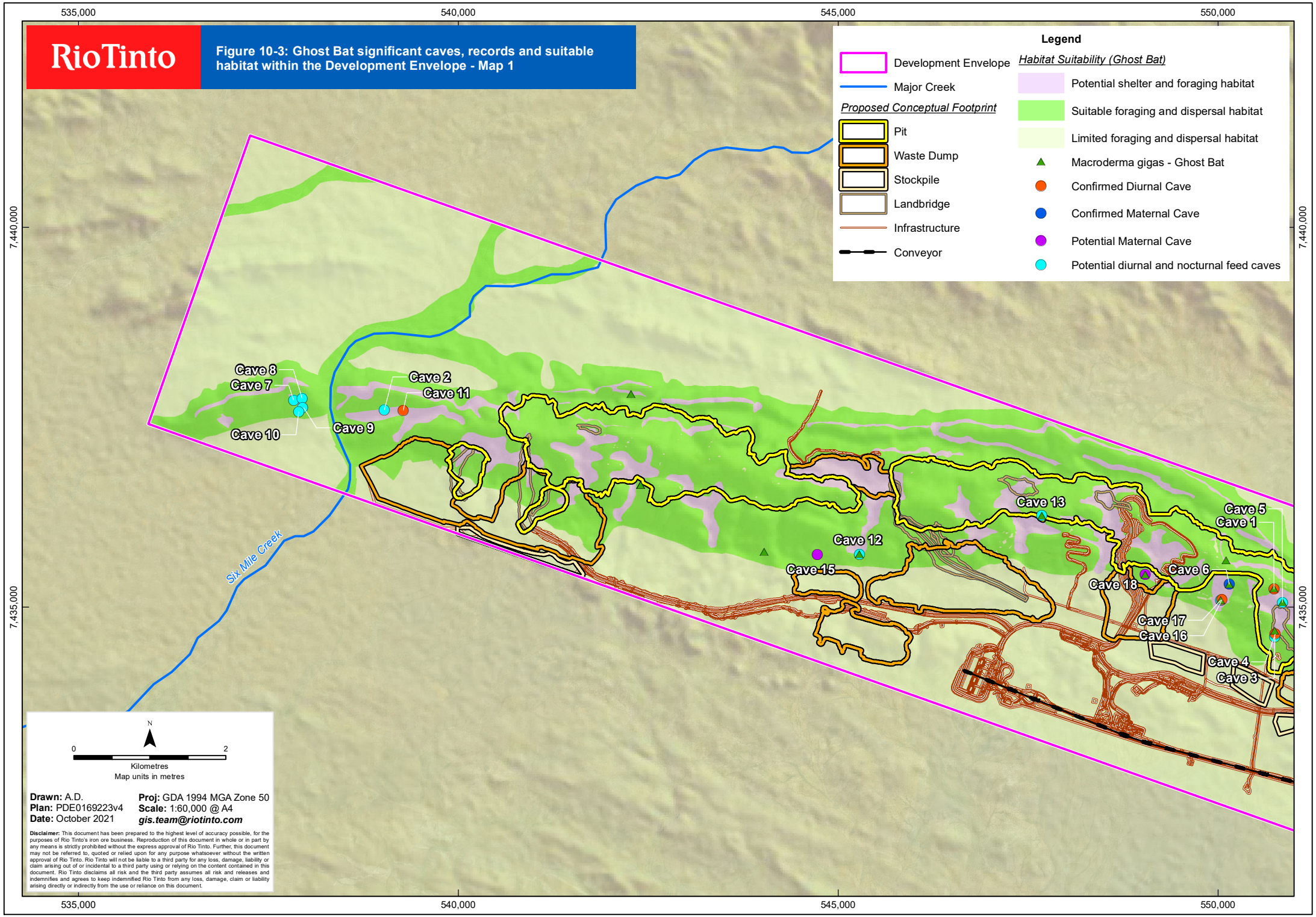
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Figure 10-3: Ghost Bat significant caves, records and suitable habitat within the Development Envelope - Map 1
Legend
Development Envelope
Major Creek
Proposed Conceptual Footprint
Pit
Waste Dump
Stockpile
Landbridge
Infrastructure
Conveyor
Habitat Suitability (Ghost Bat)
Potential shelter and foraging habitat
Suitable foraging and dispersal habitat
Limited foraging and dispersal habitat
Macroderma gigas - Ghost Bat
Confirmed Diurnal Cave
Confirmed Maternal Cave
Potential Maternal Cave
Potential diurnal and nocturnal feed caves
535,000
540,000
545,000
550,000
7,440,000
7,435,000
Cave 8
Cave 7
Cave 10
Cave 9
Cave 2
Cave 11
Cave 13
Cave 12
Cave 15
Cave 5
Cave 1
Cave 6
Cave 18
Cave 17
Cave 16
Cave 4
Cave 3
Six Mile Creek
N
0
2
Kilometres
Map units in metres
Drawn: A.D.
Plan: PDE0169223v4
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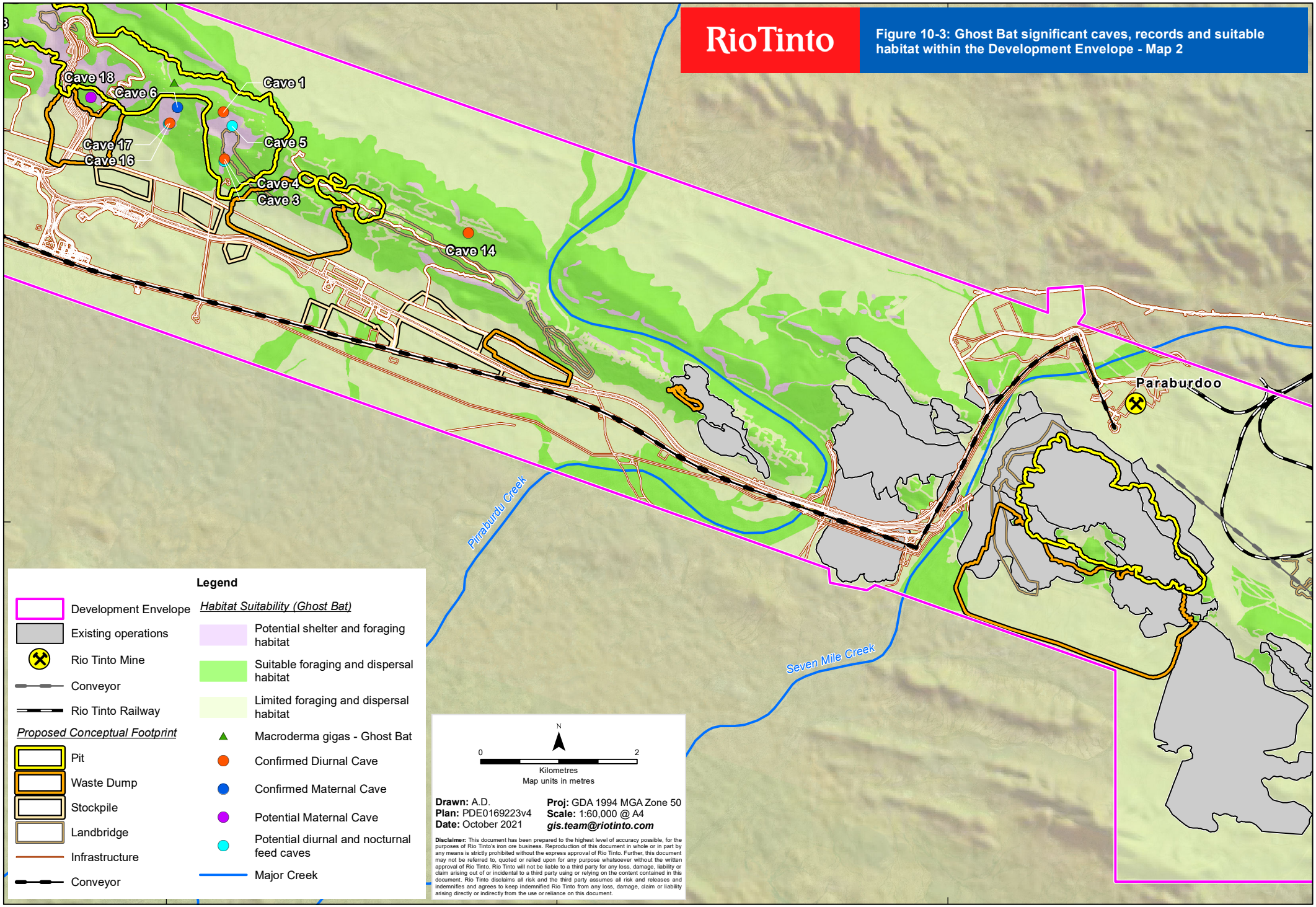
RioTinto
Figure 10-3: Ghost Bat significant caves, records and suitable habitat within the Development Envelope - Map 2
550,000
555,000
560,000
7,435,000
7,430,000
Cave 18
Cave 6
Cave 1
Cave 17
Cave 16
Cave 5
Cave 4
Cave 3
Cave 14
Paraburdoo
Pirraburdu Creek
Seven Mile Creek
Legend
Development Envelope
Existing operations
Rio Tinto Mine
Conveyor
Rio Tinto Railway
Proposed Conceptual Footprint
Pit
Waste Dump
Stockpile
Landbridge
Infrastructure
Conveyor
Habitat Suitability (Ghost Bat)
Potential shelter and foraging habitat
Suitable foraging and dispersal habitat
Limited foraging and dispersal habitat
Macroderma gigas - Ghost Bat
Confirmed Diurnal Cave
Confirmed Maternal Cave
Potential Maternal Cave
Potential diurnal and nocturnal feed caves
Major Creek
N
0
2
Kilometres
Map units in metres
Drawn: A.D.
Plan: PDE0169223v4
Date: October 2021
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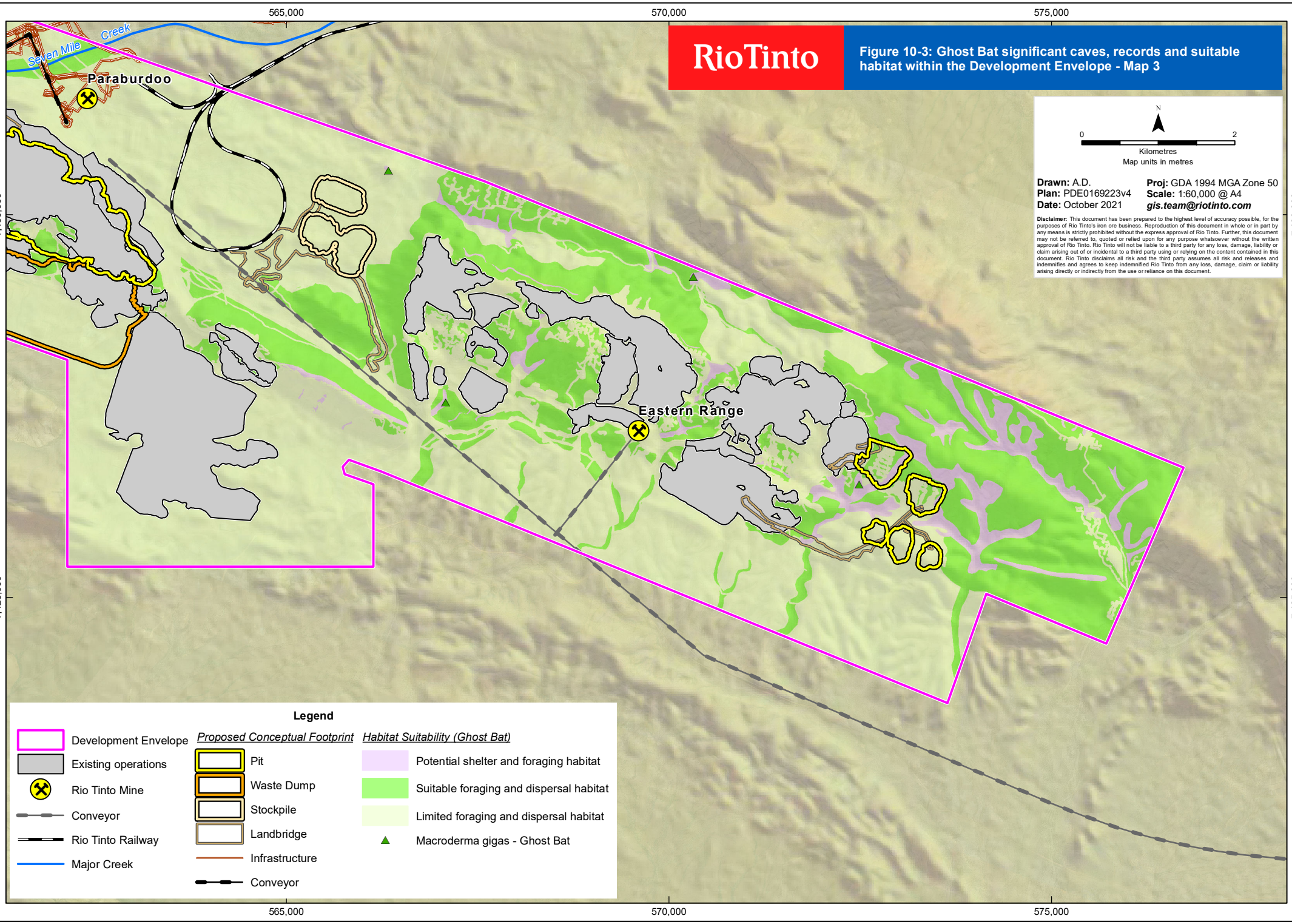
RioTinto
Figure 10-3: Ghost Bat significant caves, records and suitable habitat within the Development Envelope - Map 3
565,000
570,000
575,000
7,430,000
7,425,000
Seven Mile Creek
Paraburdoo
Eastern Range
N
0
2
Kilometres
Map units in metres
Drawn: A.D.
Plan: PDE0169223v4
Date: October 2021
Proj: GDA 1994 MGA Zone 50
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Legend
Development Envelope
Existing operations
Rio Tinto Mine
Conveyor
Rio Tinto Railway
Major Creek
Proposed Conceptual Footprint
Pit
Waste Dump
Stockpile
Landbridge
Infrastructure
Conveyor
Habitat Suitability (Ghost Bat)
Potential shelter and foraging habitat
Suitable foraging and dispersal habitat
Limited foraging and dispersal habitat
Macroderma gigas - Ghost Bat

10.6.5. Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is listed as Vulnerable under the EPBC Act and Vulnerable under the BC Act. In the Pilbara, roosts are thought to be restricted to caves formed in gorges where at least semi-permanent water is nearby (TSSC 2016b). The distribution of this species includes the Pilbara and Kimberley regions of Western Australia, the Top End of the Northern Territory, and parts of several bioregions across the Gulf of Carpentaria in the Northern Territory and western Queensland (DotEE 2019).

This species is known to require deep caves characterised by high levels of humidity and stable temperatures (Astron 2018c). Caves deep enough to create this environment are relatively uncommon in the Pilbara, with only 20 to 25 roost sites being known (Astron 2018c). The species is generally encountered in rocky areas that provide opportunity for roosting in caves or disused underground mines—particularly the ironstone hills of the Hamersley Range, the granite boulder piles and disused mines in greenstone ranges of the eastern Pilbara, and the massive metamorphosed folded silcretes at the southern margins of the region (DotEE 2019). Foraging habitat for the species is diverse and includes riparian vegetation, hummock grassland, and sparse tree and shrub savannah (Astron 2018c). In the Pilbara, the species has been observed in *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks.

The population of Pilbara Leaf-nosed Bat in the Pilbara and upper Gascoyne is identified as an important population and is comprised of one isolated interbreeding population of national significance, which shows evidence of genetic divergence (TSSC 2016b). A total of 526 records of occurrence of the Pilbara Leaf-nosed Bat are currently spread throughout the region (DBCA 2019b).

Habitat critical to the survival of the Pilbara Leaf-nosed Bat includes three Priority levels of diurnal roosts as follows (TSSC 2016b):

- Permanent diurnal roosts (Priority 1) – occupied year round and likely the focus for some parts of the breeding cycle.
- Non-permanent breeding roosts (Priority 2) – evidence of some usage during some part of the breeding cycle but not occupied year-round.
- Transitory diurnal roosts (Priority 3) – occupied for part of the year, outside of breeding season and which could facilitate dispersal in the region.

In addition to the above critical habitat, nocturnal refuges (Priority 4) are caves occupied at night for resting or feeding and are not considered critical habitat.

The type and quality of foraging habitat can also be critical to the survival of the species. Foraging habitats utilised by Pilbara Leaf-nosed Bat can be categorised as follows:

- Gorges with pools (Priority 1);
- Gullies (Priority 2);
- Rocky outcrop (Priority 3);
- Major watercourses (Priority 4); and
- Open grassland and woodland (Priority 5)

Known threats to the species include the loss of roosts, vegetation clearing, excavation, blasting and vehicle activity in the species' habitat, interruption of breeding activity, mine collapse and flooding, human entry of roosts, fencing and predation.

Survey effort in Development Envelope

The presence of the Pilbara Leaf-nosed Bat population and their movements is well documented across the Development Envelope (Astron 2018c) with targeted surveys for the species being conducted within

the Development Envelope since 1998, including Armstrong (1998; 2001-2003); Specialised Zoological (2008a, b; 2009); Biota (2010); Bat Call WA (2014); and Rio Tinto (2016). In addition, periodic monitoring with an omni directional microphone began at the Ratty Springs roost following its discovery in November 2015 and continuous monitoring has been undertaken since November 2017. This also includes collections of ultrasonic call data at nearby permanent pools to characterise variations of Pilbara Leaf-nosed Bat roosting activity (Bat Call 2020a). Most recently, a VHF Pilot Study (Biologic, 2019a) tagged and tracked the movements of 14 Pilbara Leaf-nosed Bats via 15 towers within and around the Development Envelope. The pilot study was followed by the second phase of the study (Biologic 2020a) where 20 Pilbara Leaf-nosed Bats were tagged and tracked via 35 towers over a wider area encompassing the Development Envelope and its surrounds (Turee and Mount Truchanas, approximately 30 km northeast and 40 km north of the Ratty Springs Roost, respectively).

This survey effort, combined with publicly available data is considered to provide an accurate representation of the presence of this species in the Development Envelope and surrounding areas.

Local population

The Pilbara Leaf-nosed Bat has been recorded in the vicinity of the existing operations at Paraburdoo since 1998 (Armstrong 1998).

Multiple surveys have confirmed the continual presence of the species at the Priority 1 Ratty Springs roost, which is located within Breakaway habitat with nearby pools. According to Bat Call (2020a; Appendix 6), the Ratty Springs roost holds a permanent colony of at least 400 to 600 individuals of the species. This permanent colony is comparable to the average size of a Pilbara Leaf-nosed Bat population (based on census counts) for the species in the Pilbara (Bat Call 2014; 2015; 2020a). Monitoring results confirm that the colony continues to persist alongside Rio Tinto's current operations at Paraburdoo.

Individuals recorded within the Development Envelope are considered a part of the important Pilbara population.

Suitable habitat

Roosting habitat

In 2015, a confirmed diurnal / maternity roost (Priority 1) was identified in Breakaway habitat in the Development Envelope in the vicinity of Ratty Springs vicinity (Ratty Springs roost) (Plate 1). As described above, this roost supports the continual presence of a Pilbara Leaf-nosed Bat colony and is considered a high value roost.

Echolocation and tracking data indicate an additional diurnal roost site for the species (the Paraburdoo East roost) occurs to the south-east of Paraburdoo town. Despite ongoing and comprehensive searches, especially within the Development Envelope (mining lease ML4SA), the exact location of the Paraburdoo East roost is yet to be determined. However, survey and monitoring data, including VHF tracking of tagged bats, indicate the roost is located outside the Development Envelope. The data suggest the roost is located north of the current Eastern Range mining operations outside the Development Envelope, approximately 15–18 km east of the Ratty Springs roost and approximately 4–6.5 km southeast of Paraburdoo town (Astron 2018c; Biologic 2019b). Although its particular characteristics remain unknown, as a suspected diurnal roost the Paraburdoo East roost is expected to be classed as of significant value for the regional Pilbara Leaf-nosed Bat population.

One individual has been previously recorded travelling approximately 170 km from the Ratty Spring roost west of Paraburdoo, to the Koodaideri roost east of Karijini (Rio Tinto 2019j). This is the first time an individual has been recorded travelling such a large distance, which may be due to previous lack of adequate tracking, or this movement may be an exception. The VHF study also indicated that a tagged individual roosted at an unknown site in Mount Truchanas for one night, approximately 40 km north of

the Ratty Springs roost (Biologic 2020a). These results indicate that individuals of this species can undertake regional movements.

Source: Bat Call (2015); Note: The entrance is approximately 1.0 m wide and 1.5 m high and goes back an indeterminate distance.

Plate 1: Ratty Springs roost for Pilbara Leaf-nosed Bat

Foraging habitat

A number of surface water features are present in the Development Envelope, in the vicinity of the Ratty Springs roost. These include semi-permanent pools: Ratty Spring Pool East, Ratty Spring Pool West, Seven Mile Creek (created by surplus water discharge from Paraburdoo Processing Plant approximately 5 km to the east of the Ratty Springs roost), Kelly's Pool (approximately 11 km to the east) and Western Range Pool 5 (approximately 11 km to the west in central Western Range) (Bat Call 2020a). The ridge containing the Ratty Springs roost is drained by the ephemeral Pirraburdu Creek which includes Ratty Springs approximately 800 m northwest of the roost (Bat Call 2020a). These surface water features and the associated riparian vegetation are known to support foraging of the species.

Targeted survey effort has reported that besides the Ratty Springs roost, the location with the greatest number of Pilbara Leaf-nosed Bat calls in any one night is within Ratty Springs (Bat Call 2020a), which indicates the importance of the semi-permanent springs as a foraging and/or water source for the colony. On comparison with other acoustic records in the surrounding drainage lines of Ratty Springs, nearby riparian vegetation was identified to also be significant to the ongoing survival of Ratty Springs roost population. Fewer numbers of foraging individuals were recorded in Breakaway, Drainage Line and Riverine habitats within the Development Envelope (Astron 2018c).

Typically, Pilbara Leaf-nosed Bats emerge at dusk from their roosting sites to forage up to 10 km from their roost. The tracking study (Biologic 2019a, 2020a) which monitored Pilbara Leaf-nosed Bats tagged at the Ratty Springs roost was undertaken in 2018 and 2019 to determine:

- habitat use and broad flight paths utilised in the Development Envelope and beyond; and
- preferred foraging areas used by the local Ratty Springs colony.

A total of 14 Pilbara Leaf-nosed Bats (nine males and five females) were captured and tagged under the VHF pilot tracking study (Biologic 2019a) and 20 Pilbara Leaf-nosed Bats (nine males and 11 females) were captured and tagged under the second phase of the VHF tracking study (Biologic 2020a). The VHF studies re-affirmed that Ratty Springs and associated riparian vegetation is the most significant Pilbara Leaf-nosed Bat feature within the Development Envelope as recordings indicate that the roost not only provides a diurnal roosting site for this species but is also used throughout the night for night resting, feeding and/or social interactions (Biologic 2019a, 2020a). In addition, the VHF studies also suggested the species are not limited to roosting at the Ratty Springs roost as six individuals appeared to roost at a location northeast of Seven-Mile Creek, adding further evidence that a second diurnal roosting site (Paraburdoo East Roost) is located nearby (Biologic 2019a, 2020a).

Results from both phases of the VHF studies indicate that the Pilbara Leaf-nosed Bats resident at the Ratty Springs roost rarely forage within the Western Ranges. Only 11 of the 34 tagged Pilbara Leaf-nosed Bats flew into Western Range. Of these, only one individual visited the area on a regular basis. The majority of detection events represent fly bys where the individuals did not spend much time in the area (Biologic 2020a).

The VHF studies indicate that the Pilbara Leaf-nosed Bats spend most of their time foraging within the small section of Pirraburdu Creek near the Ratty Springs Roost (2018 survey period) and on the plains to the north, north-east and south of the Paraburdoo Ranges (both 2018 and 2019 survey periods). This is supported by other studies that found that the high number of acoustic records combined with the late dry season timing of the detections indicates that Ratty Spring is a primary location for the bats from the Ratty Springs roost to drink and forage immediately after leaving the roost (Astron 2018c). During the second phase of the VHF study, Pilbara Leaf-nosed Bats spent most of their time outside the detection range of the towers, suggesting that their preferred foraging areas at the time of the survey were located outside of the Development Envelope. The plains surrounding the Paraburdoo Ranges contain several drainage lines and ephemeral watercourses that provide suitable foraging habitat (Biologic 2019a).

Overall, areas to the east of the Ratty Springs Roost, north of the Paraburdoo Range and outside the Development Envelope, may represent significant foraging area or fly ways for the Pilbara Leaf-nosed Bats (Biologic 2019a, 2020a). The species is expected to forage across all habitat in the Development Envelope, with Gorge/Gully, Breakaway, Alluvial, Drainage Line and Riverine habitat types expected to provide better foraging opportunities than other habitat types in the area.

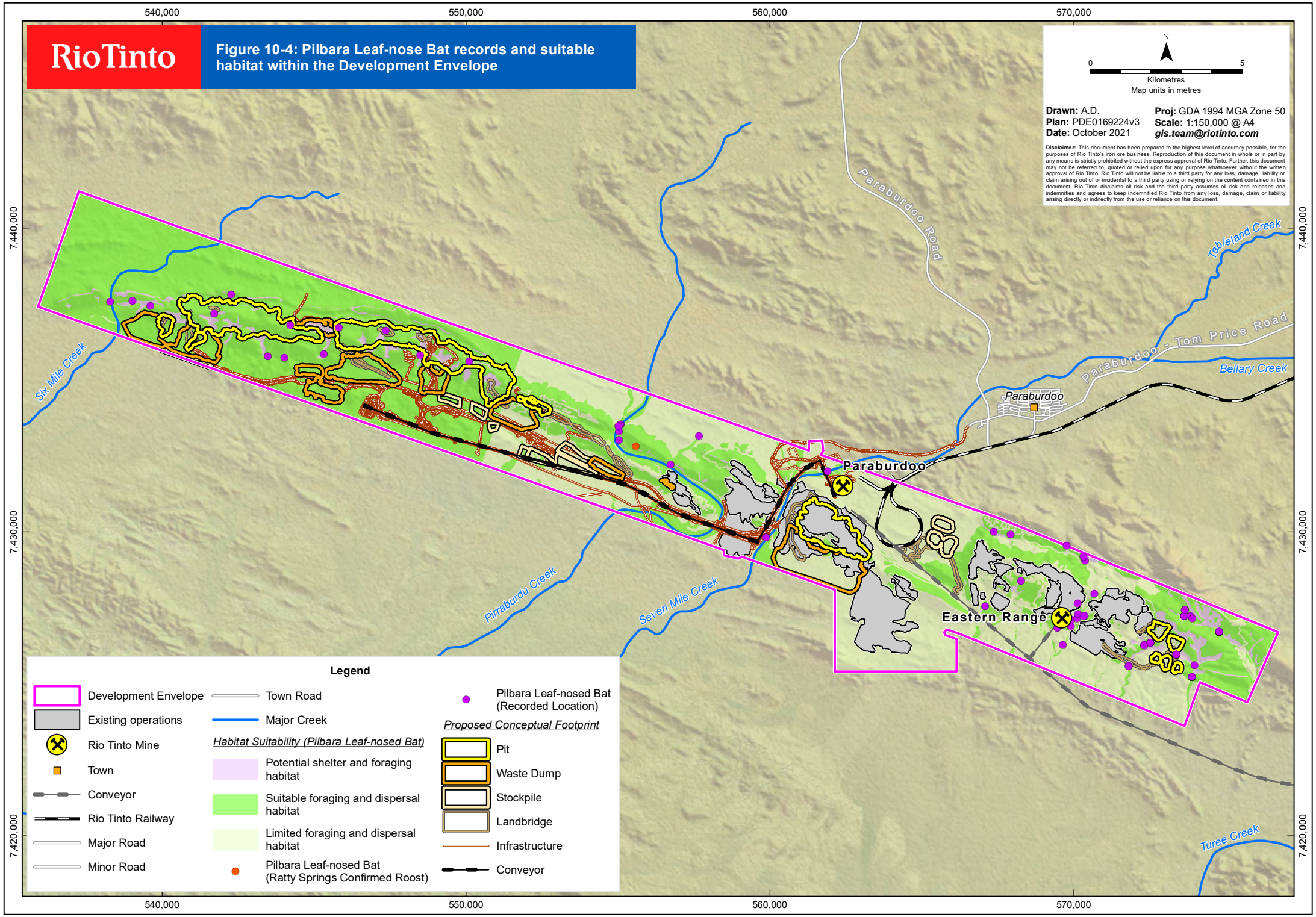
Up to 921 ha of habitat within the Development Envelope is considered high value roosting and foraging habitat including:

- Gorge/Gully – 630 ha of shelter (roosting) and foraging habitat (critical habitat); and
- Breakaway – 291 ha of shelter (roosting) and foraging habitat (critical habitat).

Up to 131 ha of Riverine, 4,516 ha of Rocky Hill and 740 ha of Drainage Line comprising moderate value foraging and dispersal habitat is also present in the Development Envelope. Generally, this does not represent critical habitat for the species; although based on the findings from the VHF studies (Biologic 2019a, 2020a) the Riverine habitat and Drainage Line habitats found at Ratty Springs and in Pirraburdu Creek (immediately adjacent to the Ratty Springs roost) are recognised as high value foraging habitat.

Alluvial Plain, Low Hill and Stony Plain is considered by Astron (2018c, d) as low value habitat for the species, and is widespread outside of the Development Envelope and in the Pilbara bioregion. None of these habitat types represent critical habitat to the species.

The balance of the Development Envelope comprises disturbed areas that have low value as foraging and dispersal habitat for the species.


RioTinto
Figure 10-4: Pilbara Leaf-nose Bat records and suitable habitat within the Development Envelope
N
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5
Kilometres
Map units in metres
Drawn: A.D.
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7,420,000
Paraburdoo Road
Tableland Creek
Paraburdoo - Tom Price Road
Bellary Creek
Six Mile Creek
Paraburdoo
Paraburdoo
Eastern Range
Pirraburdu Creek
Seven Mile Creek
Turee Creek
Legend
Development Envelope
Existing operations
Rio Tinto Mine
Town
Conveyor
Rio Tinto Railway
Major Road
Minor Road
Town Road
Major Creek
Habitat Suitability (Pilbara Leaf-nosed Bat)
Potential shelter and foraging habitat
Suitable foraging and dispersal habitat
Limited foraging and dispersal habitat
Pilbara Leaf-nosed Bat (Ratty Springs Confirmed Roost)
Pilbara Leaf-nosed Bat (Recorded Location)
Proposed Conceptual Footprint
Pit
Waste Dump
Stockpile
Landbridge
Infrastructure
Conveyor

10.7. Potential impacts

The following provides a summary of aspects of the Proposal that may result in direct and indirect impacts on MNES. Key impact pathways include:

- potential loss of fauna habitat as a result of clearing;
- loss of fauna individuals as a result of clearing (or other interactions);
- degradation/alteration of habitat as a result of altered hydrological regimes;
- habitat fragmentation and barriers to movement;
- habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust and increased abundance of introduced fauna species; and
- disturbance from light, noise and/or vibration, and possible displacement of fauna associated with construction activity and mining operations.

10.7.1. Direct impacts

Loss of fauna habitat

The Proposal will result in the clearing of up to 299 ha of high value habitat for MNES comprising:

- 292 ha of high value shelter/denning and foraging habitat for Northern Quoll, Ghost Bat and Pilbara Leaf-nosed Bat, representing 31.7% of high value habitat in the Development Envelope; and
- 299 ha is high value denning/shelter and foraging habitat for Pilbara Olive Python, representing 28.4% of the high value habitat for the species in the Development Envelope.

The remaining habitat to be cleared is of low to moderate value for MNES.

The high value habitat to be removed provides shelter/denning and foraging habitat for all MNES species.

Most clearing will occur in Rocky Hill habitat, with up to 943 ha to be affected. This habitat provides moderate value foraging and dispersal opportunities for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.

Of the 18 Ghost Bat caves identified within the Development Envelope, five will be removed, including two confirmed diurnal roosts for Ghost Bats (Caves 1 and 4, both classified as having low usage), two potential diurnal roosts (Caves 3 and 13) and one feed cave (Cave 5) (Figure 10-3). There will be no impact to the Pilbara Leaf-nosed Bat roost or semi-permanent pools at Ratty Springs.

The indicative clearing for each habitat type and for habitat types grouped into potential high and moderate value habitat for MNES recorded in the Development Envelope is outlined Table 10-6 and and Table 10-7.

Table 10-6: Proposed clearing of MNES fauna habitat in the Development Envelope

Broad scale habitat type	Extent in Development Envelope (ha)	Proposed to be cleared ha)	% habitat to be cleared	Value to MNES
Riverine	131	7	5.4	**High value** potential shelter and foraging habitat for Pilbara Olive Python. **Moderate value** potential foraging and dispersal habitat for Northern Quoll, Ghost Bat and Pilbara Leaf-Nosed Bat
Gorge/Gully	630	256	40.7	**High value** potential shelter, denning and/or roosting habitat for Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat and Ghost Bat. Potential foraging habitat for Pilbara Olive Python.
Breakaway	291	35	12.1	**High value** potential shelter, denning and/or roosting habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat
Drainage Line	740	68	9.2	**Moderate value** potential foraging and dispersal habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.
Rocky Hill	4,516	943	20.9	**Moderate value** potential foraging and dispersal habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat
Low Hill	3,947	No value specified*	Not specified	Low value habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.
Stony Plain	3,516	No value specified*	Not specified	Low value habitat for Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.
Alluvial Plain	104	0	0	**Moderate value** potential foraging habitat for Pilbara Leaf-nosed Bat. Low value for Northern Quoll, Pilbara Olive Python and Ghost Bat.

**The balance of clearing outside of high and moderate value MNES habitat will mostly occur in low value Stony Plain and Low Hill habitat type (up to approximately 2,990 ha combined total).*

Table 10-7: Extent of high to moderate value MNES habitat estimated to be cleared for the Proposed Action within the Development Envelope

MNES / habitat type	Extent in Development Envelope (ha)*	Proposed to be cleared (ha)*	% habitat to be cleared
Northern Quoll			
High value potential shelter and foraging habitat (Gorge/Gully, Breakaway)	921	292	31.7
Moderate value foraging and dispersal habitat (Riverine, Drainage Line, Rocky Hill)	5,387	1,018	18.9
Total high and moderate value habitat	**6,308**	**1,310**	**20.8**
Pilbara Olive Python			
High value potential shelter and foraging habitat (Gorge/Gully, Breakaway, Riverine)	1,052	299	28.4
Moderate value suitable foraging and dispersal habitat (Drainage Line, Rocky Hill)	5,256	1,011	19.2
Total high and moderate value habitat	**6,308**	**1,310**	**20.8**
Ghost Bat			
High value potential shelter and foraging habitat (Gorge/Gully, Breakaway)	921	292	31.7
Moderate value foraging and dispersal habitat (Riverine, Drainage Line, Rocky Hill)	5,387	1,018	18.9
Total high and moderate value habitat	**6,308**	**1,310**	**20.8**
Pilbara Leaf-nosed Bat			
High value potential shelter and foraging habitat (Gorge/gully, Breakaway)**	921	292	31.7
Moderate value foraging and dispersal habitat (Riverine, Alluvial Plain, Drainage Line, Rocky Hill)**	5,492	1,018	18.9
Total area (ha) high and moderate value habitat	**6,413**	**1,310**	**20.4**

**Note: Total numbers are subject to rounding; **No high value Riverine or Drainage Line habitat for Pilbara Leaf-nosed Bats at Ratty Springs or in Pirraburdu Creek will be cleared.*

Loss of fauna individuals

Injury and mortality of MNES may result from both direct and indirect impacts from the Proposed Action.

Fauna may be directly impacted from construction, operation and closure activities which have the potential to decrease local fauna abundance, particularly species which are attracted to roads for basking or foraging activities. This includes:

- fauna being injured/killed by collisions with earthmoving equipment and/or vehicles during construction works or operation; and
- injury or mortality as a result of entanglement in fencing, especially to Ghost Bat and Pilbara Leaf-nosed Bat.

Interaction with vehicles and fencing has the potential to reduce the local abundance of fauna, particularly if habitats are in proximity to activity or infrastructure.

10.7.2. Indirect impacts

Degradation/alteration of habitat as a result of altered hydrological regimes

Groundwater drawdown resulting from increased dewatering in the 4EE pit at Paraburdoo has the potential to impact riparian vegetation within Riverine habitat areas of Seven Mile Creek; specifically, the area to the north of the low permeability Mount McRae Shale/Mount Sylvia Formation, where the creek intersects the Paraburdoo Range. This stretch of riparian vegetation is degraded but provides high value habitat for Pilbara Olive Python and may be used by a number of species for both foraging and dispersal. Groundwater abstraction has the potential to affect GDE's over an area of up to approximately 27 ha area and reduce canopy cover of phreatophytic species and potentially reduce the abundance of understorey vegetation along Seven Mile Creek. This may in turn impact foraging and dispersal habitat for MNES in the Development Envelope.

There will be minor dewatering required at Western Range, however there are no shallow watertables that support GDEs in this area. Mining at Eastern Range is AWT. Therefore, there is no potential change to habitat values associated with groundwater abstraction outside of the Paraburdoo mining area.

Surplus water discharge to Riverine and Drainage Line fauna habitat may be required at Six Mile Creek, Pirraburdu Creek and the existing Joe's Crossing discharge location at Seven Mile Creek (refer to Section 8 of the ERD). Surface water discharge may result in increased vegetative cover within the creekline that may experience flow during natural no flow conditions. The area of flow will be managed to be limited to the extent of the Development Envelope. Increased vegetation cover may provide increased shelter and foraging habitat for fauna.

Habitat fragmentation and barriers to fauna movement

Fragmentation, the process by which contiguous areas of habitat are interrupted and/or separated into two or more smaller areas, can result in the following impacts to MNES:

- altered movement patterns and/or reduced ability to disperse;
- genetic isolation; and
- increased competition for resources.

The Proposed Action extends along the east-west Paraburdoo Range, with the greatest potential for habitat fragmentation occurring in the Western Range area where disturbance of the range will result in fragmentation of habitat in a north-south direction. Habitat connectivity will be largely maintained in an east-west direction to the north of Western Range. Additionally, north-south habitat connectivity will be maintained along the major creeklines in the Development Envelope which will not be directly impacted beyond the construction of essential infrastructure and crossings at Seven Mile Creek and Pirraburdu Creek connecting Paraburdoo and Western Range. These linkages facilitate the connection of foraging habitats for MNES and enable dispersal and connection between individuals and populations of MNES.

Habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust and increased abundance of introduced fauna species

Construction activity and vehicle movements have the potential to increase dust and spread weeds. However, these risks will be effectively managed by the Proponent and are not expected to affect habitat values.

Vegetation clearing can increase access of feral predators to fauna habitats, resulting in increased predation causing injury or mortality, impacting local populations of fauna. Feral cat control is not currently undertaken within the Development Envelope. However, the Proponent will undertake feral animal control within the Development Envelope.

Disturbance from light, noise and/or vibration, and possible displacement of fauna associated with construction activity and mining operations.

Light, noise and vibration emissions during mine construction and operations have the potential to impact MNES in proximity to these activities.

The Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat and Ghost Bat utilise caves and shelters in Breakaways and Gully/Gorge habitats for denning and shelter or roosting. The Proposal will involve open cut mining by conventional drill and blast techniques. This has the potential to result in vibration disturbance to major Gorge/Gully habitat adjacent to mining operations which provides potential denning and roosting habitat for MNES recorded in the Development Envelope. Blast vibrations may also result in damage to the structural integrity of bat roosts.

Noise and vibration from clearing, construction and blasting may disturb MNES and cause individuals to temporarily or permanently vacate shelters and diurnal/maternal roosts. If these disturbances occur during the breeding season or while pups remain in the roost, the breeding cycle of the local bat population may be impacted.

Research and anecdotal evidence indicate the potential for artificial lighting to influence the behaviour of both nocturnal and diurnal species (Gaston & Bennie 2014). Increased night time light emissions within the Development Envelope may attract invertebrate species and in turn, alter nocturnal foraging behaviour of MNES.

10.8. Assessment of impacts

The following provides a summary of aspects of the Proposed Action which may result in direct and indirect impacts to MNES. Further description of potential impacts is provided in Section 10.7.

10.8.1. Northern Quoll

Direct impacts

Loss of fauna habitat

The Development Envelope includes denning habitats which satisfy the definition of critical habitat in accordance with the Northern Quoll Referral Guideline (DoE 2016), including rocky habitats such as Breakaways and Gorges/Gullies. This habitat within the Development Envelope does not support a high-density important population of the species, as demonstrated by limited recorded captures; despite appropriate survey effort in areas of suitable, good quality habitat within the Development Envelope. As evidenced by the location of records, the local Northern Quoll population appears to have a strong association with the Breakaway and Gorge/Gully habitat. This is consistent with records across the Pilbara.

The Northern Quoll has been recorded at eight locations in the Development Envelope, six records from the Western Range and two in the balance of the Development Envelope (Astron 2018c, d). No Northern Quoll dens were recorded in the Development Envelope (Astron 2018c, d). Northern Quoll are common in the Robe Valley, approximately 192 km northwest from the Development Envelope, with 906 records in that location. Northern Quoll have also been recorded in historical mining areas in this region, particularly where mesa escarpments are largely intact (Rio Tinto 2018a). In contrast to the Robe Valley, the population of Northern Quoll in the Development Envelope is expected to be relatively small and be classified as a 'low density' population in accordance with Northern Quoll Referral Guideline (DoE 2016), based on the low number of observations and historical records in the Development Envelope.

Breakaway and Gorge/Gully habitats are rated as being of high importance, or critical habitat, for Northern Quoll locally and the Proposed Action has been designed to largely avoid these habitats. Vegetation clearing in the Development Envelope will result in the direct loss of up to 292 ha of Breakaway and Gorge/Gully habitat, which represents 31.7% of the available critical habitat for Northern

Quoll within the Development Envelope. A further 1,018 ha of moderate value foraging and dispersal habitat will be removed; however, these habitats are common and widespread in the Pilbara region and do not represent critical habitat for the species and their removal is not expected to be characterised as a significant residual impact. The balance of clearing will occur in Stony Plain and Low Hill habitats, widespread and of low value to Northern Quoll, as such there will be no significant residual impact on this species in these areas.

The direct loss of up to 292 ha of Breakaway and Gorge/Gully critical habitat for Northern Quoll within the Development Envelope represents a locally significant impact and is proposed to be offset (refer to Section 12 of the ERD).

Loss of fauna individuals

Northern Quoll may be vulnerable to injury or mortality from vehicle and machinery movements, particularly when foraging nocturnally. Given the local population is expected to be low, the potential for injury or mortality is also expected to be very low. To avoid and minimise the potential for interaction with vehicle and machinery movements, most construction activities for the Proposed Action will occur during daylight hours, reducing the risk of encounters with Northern Quoll during the construction phase. While vehicle movements will increase temporarily during the construction period and roads will expand into the proposed new mining areas, overall vehicle movements during the operational phase will not increase from the existing number and/or frequency of vehicle movements associated with the existing operation.

The Proponent will implement the following measures to mitigate potential indirect impacts to Northern Quoll:

- progressive clearing to allow fauna to migrate away from clearing activities or machinery movements;
- all relevant personnel to undergo training to identify Northern Quolls and their habitat, relevant management measures, personnel/contractor responsibilities, and incident reporting requirements (i.e. reporting of fauna observations and/or incidents); and
- progressive rehabilitation of cleared areas no longer required for operational purposes.

On this basis, vehicle and machinery movements for the Proposed Action are not expected to result in significant impacts to Northern Quoll and will not result in a change to the conservation status of this species.

Indirect impacts

Degradation/alteration of habitat as a result of altered hydrological regimes

Groundwater drawdown and surface water discharge have the potential to affect Riverine and Drainage Line habitat. As Riverine and Drainage Line habitat is not considered high value for the Northern Quoll, any change in habitat value as a result of altered hydrological regimes is not expected to have a significant impact on the species. In addition, there is no potential for impacts to riparian/GDE vegetation at Western Range where the majority of the Northern Quolls have been recorded.

Habitat fragmentation and barriers to fauna movement

Extensive tracts of intact Northern Quoll habitat will remain around the Proposed Action in the Development Envelope. A total of approximately 4,998 ha (79.2%) of high and moderate value habitat for shelter/denning, foraging and dispersal will remain available in the Development Envelope. Significant corridors in different landforms such as ridges, hillsides and drainage lines will remain in place to allow movement around the mining area and through the landscape. Northern Quolls have also been recorded within operational areas at Pilbara mine sites and so can disperse through these areas. Habitat fragmentation will also be mitigated through the staging of the Proposed Action to ensure areas proposed to be cleared will not all be disturbed at once. Progressive rehabilitation of areas no longer

required for mine operation will also occur to minimise the presence of disturbed areas. As such, habitat fragmentation caused by the Proposed Action is not expected to result in significant overall effects on Northern Quoll habitat or movement.

Habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust, and increased abundance of introduced fauna species

The invasion of introduced grasses such as Gamba Grass (*Andropogon gayanus*) and other weeds are recognised threats to Northern Quoll as they out-compete native grasses. Gamba Grass has not been recorded in the Development Envelope. The Proponent will undertake weed control in areas of retained native vegetation close to disturbance such as roads, tracks and infrastructure. In addition, vehicle and machinery movements will be restricted to roads and access pathways within the conceptual footprint to avoid spread or introduction of weeds. Weed management is outlined in Section 5.5.2 of the ERD.

The Pilbara region is naturally dusty, and the Proposed Action is located in and near an existing operational mine. A study examining the impacts of dust on plant health in semi-arid environments found no evidence dust deposition up to 77 g/m^2/month results in detrimental effects (Matsuki *et al*. 2016). Any decline in vegetation health, and hence Northern Quoll foraging habitat, due to dust deposition is expected to be limited to areas immediately adjacent to the active mining operations. Potential impacts to vegetation from dust emissions may occur in only a small proportion of the available Northern Quoll foraging habitat adjacent to mine operations, and naturally occurring high dust events are possible at exposed locations at dry and windy times of the year. Continued implementation of existing dust suppression strategies to avoid prolonged dust emissions and dust cover on adjacent vegetation is expected to result in a low likelihood of Northern Quoll being adversely affected by dust.

The cane toad is the invasive species which poses the greatest threat to Northern Quoll but is not currently established in the Pilbara. The Proposed Action will not increase the potential for cane toads to become established in the Development Envelope and the Proponent will undertake feral animal control within the Development Envelope.

After the application of mitigation measures, no significant impacts on Northern Quolls are expected from the habitat degradation from dust emissions and/or the introduction or spread of weeds into fauna habitat.

Disturbance from light, noise and/or vibration, and possible displacement of fauna associated with construction activity and mining operations.

The indirect impacts of noise and vibration emissions are not expected to impact Northern Quoll. A low-density population of Northern Quoll exists in the Development Envelope despite noise and vibration from current mining operations within Paraburdoo. No dens have been identified in the Development Envelope and therefore, vibrations from mining operations will not significantly alter the number or quality of available shelters. The sporadic and brief nature of blasting also means that blasting related vibrations are not expected to interfere with the Northern Quoll's foraging or breeding behaviour. As such, it is not expected that noise and vibrations from the Proposed Action will result in a significant impact to the species.

Light emissions from the Proposed Action are not expected to significantly alter nocturnal foraging activities as light emissions are already present in the current operational mining area at Paraburdoo. Additional light emissions from the Proposed Action is not expected to significantly impact Northern Quoll denning or foraging behaviour as:

- lighting in the mining area will be directed into the pit, away from Northern Quoll potential denning formations in Breakaway and Gorge/Gully habitat; and
- lighting will be installed only where required, that is, mainly in-pit and operational areas.

No significant impacts on Northern Quolls are expected from light, noise and/or vibration.

Significance of direct and indirect impacts to Northern Quoll

An assessment of the Proposed Action on Northern Quoll is detailed in Table 10-8, with reference to the Significant Impact Guidelines (DoE 2013).

Table 10-8: Assessment of the significance of impacts to Northern Quoll

Significant impact criteria	Assessment of impacts to Northern Quoll
Potential to cause a long-term decrease in the size of a population	The local population of Northern Quoll that may be present in the Development Envelope is not expected to be characterised as 'important' due to its low density. This local, low density, population is expected to have a strong association with Gorges/Gully and Breakaway habitat, based on the location of records. Given approximately 79.2% of high and moderate value habitat will remain in the Development Envelope, and the widespread availability of foraging and dispersal habitat beyond, the removal of 292 ha of high value Northern Quoll habitat is not expected to cause a long-term decrease to the low density population that may occur within the Development Envelope.
Potential to reduce the area of occupancy of the species	The species is expected to continue to exist within the Development Envelope and therefore the Proposed Action is not expected to reduce the area of occupancy of the species.
Potential for fragmentation of an existing population into two or more populations	The Proposed Action is not expected to fragment an existing population into two or more populations given the limited numbers within the Development Envelope and the mobile nature of the species. Significant corridors in different landforms such as ridges, hillsides and drainage lines will remain in place to allow movement around the mining area and through the landscape. Available habitat will also still occur within the Development Envelope and the areas surrounding the Development Envelope (including within mining leases such as Turee Syncline as well protected areas such as Karijini National Park), which will continue to support the overall Pilbara population of Northern Quoll.
Potential to adversely affect habitat critical to the survival of a species	The Development Envelope supports habitats which satisfy the definitions of critical habitat, including rocky habitats such as gorges, gullies and breakaways, which are all potential shelter/denning and foraging habitats. However, these habitats do not support an important population of Northern Quoll. The listing advice and Northern Quoll Referral Guidelines indicate that the removal, degradation and fragmentation of habitat as a consequence of mining activities, transport infrastructure or agricultural activities has the potential to adversely affect the survival of the species (TSSC 2005; DoE 2016). Consequently, the Proposed Action has the potential to adversely affect habitat defined as critical to the survival of the species locally due to the clearing of 292 ha of high value shelter/denning and foraging habitat. Therefore, this potential impact is proposed to be offset.
Potential to disrupt the breeding cycle of a population	No evidence of Northern Quoll dens has been identified in suitable denning habitat within the Proposed Action or Development Envelope. It is not expected that the removal of habitat from the Proposed Action will disrupt the breeding cycle of the population based on the lack of evidence of active dens, and the proportion and extent of habitat remaining in the Development Envelope.
Potential to modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Proposed Action will result in the loss of up to 292 ha of potential and suitable high value habitat associated with Breakaway and Gorge/Gully areas. A further 1,018 ha of moderate value foraging and dispersal habitat from Riverine, Drainage and Rocky Hill areas will also be disturbed, however, these areas provide moderate value foraging and dispersal opportunities. The balance of clearing will occur in widespread Low Hill and Stony Plain habitats of low value to Northern Quoll. The Proposed Action has the potential modify, destroy, remove or isolate or decrease the availability or quality of Northern Quoll habitat due to the clearing of high value potential shelter/denning and foraging habitat. However, this will not be at an extent at which the species is likely to decline.

Significant impact criteria	Assessment of impacts to Northern Quoll
Potential for the establishment of invasive species in the endangered species' habitat that are harmful to the endangered species	The cane toad is the invasive species which poses the greatest threat to Northern Quoll but is not currently established in the Pilbara. The Proposed Action will not increase the potential for cane toads to become established in the Development Envelope and the Proponent will undertake feral animal control within the Development Envelope.
Potential for the introduction of disease that may cause the species to decline	Currently there are no known diseases harmful to Northern Quoll. There is no evidence to suggest that the Proposed Action would introduce disease that may cause the species to decline.
Potential interference with the recovery of the species	The Proposed Action will impact a portion (approximately (292 ha; 31.7%) of the available Northern Quoll high value habitat within the Development Envelope. The Proposed Action has been designed to limit disturbance within highest value denning and foraging habitat (Gorge/Gully habitat) where practicable. The Proposed Action is not expected to interfere with the recovery of the Northern Quoll or affect its conservation status based on the available habitat remaining locally and regionally in the Pilbara.

10.8.2. Pilbara Olive Python

Direct impacts

Loss of potential habitat

The Pilbara Olive Python has previously been recorded in the Development Envelope at Seven Mile Creek in Gorge/Gully habitat (Astron 2018c) and there are further records in the vicinity of the Development Envelope. The Development Envelope contains suitable high-quality habitat including Breakaway, Gorge/Gully and Riverine habitats which likely support denning, foraging and dispersal. These habitats are likely to meet the definition of critical habitat.

The species could potentially be found throughout the Development Envelope at sites that contain semi-permanent water.

The Proposed Action has been designed to limit disturbance to Breakaway, Gorge/Gully and Riverine habitats as far as practicable. Vegetation clearing for the Proposed Action will result in the direct loss of up to 299 ha of high value habitat, which represents 28.4% of potential denning, foraging and dispersal habitat available for Pilbara Olive Python within the Development Envelope. The three persistent surface water fed pools at Western Range will remain post mining. No impacts are predicted to groundwater fed Gardagarli (Ratty Springs) and Gurungu (Doggers Gorge), as a result of the Proposal.

A further 1,011 ha of moderate value foraging and dispersal habitat will be removed as part of the Proposed Action; however, this is not considered high value habitat and its removal is not expected to be characterised as a significant residual impact. The balance of clearing will occur in Stony Plain and Low Hill habitats, widespread and of low value to Pilbara Olive Python, as such there will be no significant residual impact on this species in these areas.

The direct loss of up 299 ha of Breakaway, Gorge/Gully and Riverine habitat for Pilbara Olive Python within the Development Envelope represents a locally significant impact and is proposed to be offset (refer to Section 12).

Loss of fauna individuals

The Pilbara Olive Python is slow moving and nocturnal and is vulnerable to injury or mortality from vehicle and machinery movements; particularly when foraging at night, when basking or during mating season when movements are more frequent. Construction of the Proposed Action will occur predominantly during daylight hours and will therefore minimise potential for interaction with this species.

Vehicle movements during the operational phase will not increase from the existing number and/or frequency of vehicle movements associated with the current mining activity at the existing operational site. The Proponent will implement range of management measures to mitigate loss of fauna individuals, such as:

- progressive clearing to allow fauna to migrate away from clearing activities or machinery movements;
- awareness training to identify conservation significant fauna and habitat, relevant management measures, personnel/contractor responsibilities, and incident reporting requirements (i.e. reporting of fauna observations and/or incidents); and
- vehicle speed limits.

Indirect impacts

Degradation/alteration of habitat as a result of altered hydrological regimes

Groundwater drawdown in the alluvial aquifer in Seven Mile Creek as a result of dewatering activities at Paraburdoo 4EE pit has the potential to impact approximately 27 ha of GDE vegetation including mapped Riverine habitat areas, which provides high value habitat for Pilbara Olive Python. As discussed in Section 5.3.2 of the ERD, vegetation in this section of Seven Mile Creek has been augmented by historical surplus water discharge from Paraburdoo Plant, resulting in the occurrence of persistent surface water and denser and more extensive vegetation than would otherwise exist naturally, thus creating an artificially enhanced habitat for the Pilbara Olive Python. The Proposal will alter the hydrological regime in this section of Seven Mile Creek, likely reducing the availability of surface water and density of understory vegetation. Whilst this may reduce the area of suitable habitat available to the Pilbara Olive Python; it is expected that suitable habitat will remain in this section of Seven Mile Creek and; therefore, the Proposal is not expected to have a significant adverse effect on the Pilbara Olive Python locally or regionally.

Discharge of dewatering water into Pirraburdu Creek and/or Seven Mile Creek has been proposed and dewatering of 36W and 66W pits in the Western Range section of the Proposal is also proposed to be discharged into Six Mile Creek and Pirraburdu Creek or tributaries. However, no adverse impacts to Pilbara Olive Python are expected.

Habitat fragmentation and barriers to fauna movement

Extensive tracts of intact Pilbara Olive Python habitat will remain around and within the Development Envelope. Significant corridors in Gorge/Gully, Breakaways and Riverine habitats will remain in place to allow movement around the mining area and through the landscape. As such, habitat fragmentation caused by the Proposed Action is not expected to result significant detrimental overall effects on Pilbara Olive Python habitat or movement.

Habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust, and increased abundance of introduced fauna species

Potential impacts to vegetation from dust emissions will occur in only a small proportion of the available Pilbara Olive Python habitat. Consequently, dust emissions are not expected to have a significant impact on the species. Dust will be managed by the Proponent and is expected to be of a short-duration. As such, dust will not result in permanent impacts to Pilbara Olive Python.

Key threats to the Pilbara Olive Python include predation by feral cats and foxes, however the Proposed Action is not expected to cause an increase in feral cat or fox populations; however, feral animal control will be undertaken as needed by the Proponent in the Development Envelope. While the Pilbara Olive Python is susceptible to cane toad poison, they are not known to eat cane toads but can be poisoned from secondary consumption (Rio Tinto 2018a). The cane toad is not currently established in the

Pilbara; the Proposed Action is not expected to increase the opportunity for the cane toad to become established in the area.

No significant impacts on Pilbara Olive Python are expected from the risk of habitat degradation from increased weeds, dust emissions, or introduced fauna.

Disturbance from light, noise and/or vibration and displacement of fauna

Snakes use the inner ear to identify prey and avoid predators by detecting ground vibrations (Rio Tinto 2019b). Noise and vibration from blasting associated with the Proposed Action will be intermittent, lasting for approximately two to ten seconds at a time. The sporadic and brief nature of blasting associated with the Proposed Action means that blasting related vibrations are not expected to interfere with the Pilbara Olive Python's ability to detect prey and avoid predators and is not expected to result in a significant impact to the species.

Lighting in the mining area will be directed into the pit, away from Pilbara Olive Python habitat in the Breakaway, Gorge/Gully and Riverine habitats present in the Development Envelope. Light emissions from the Proposed Action are not expected to significantly alter nocturnal hunting activities as light emissions are already present in the operational mining area. Lighting will only be installed where required, that is, mainly in-pit and operational areas. Additional light emissions from the Proposed Action are not expected to significantly impact Pilbara Olive Python sheltering or hunting behaviour.

No significant impacts on Pilbara Olive Python are expected from the risk of disturbance from light, noise and/or vibration.

Significance of direct and indirect impacts to the Pilbara Olive Python

An assessment of the Proposed Action on Pilbara Olive Python is detailed in Table 10-9, with reference to the Significant Impact Guidelines (DoE 2013).

Table 10-9: Assessment of the significance of impacts to Pilbara Olive Python

Significant impact criteria	Assessment of impacts to Pilbara Olive Python
Potential to cause a long-term decrease in the size of a population	No persistent pools are being removed as part of the Proposed Action, and 79.2% of high and moderate value habitat will remain in the Development Envelope, the loss of 299 ha of high value habitat for the species is not expected to result in a long-term decrease in the size of an important population within the Development Envelope.
Potential to reduce the area of occupancy of the species	The species is expected to continue to exist within the Development Envelope. Approximately 79.2% of suitable mapped habitat will remain in the Development Envelope and surrounding areas. The Proposed Action is therefore, not expected to reduce the area of occupancy of the species.
Potential for fragmentation of an existing population into two or more populations	The Pilbara Olive Python is a mobile species and is likely to move through the retained major creeklines within the Development Envelope. Consequently, the Proposed Action is not expected to impede the movement of individuals within the Proposed Action area and is not expected to fragment an existing important population into two or more populations.
Potential to adversely affect habitat critical to the survival of a species	The Pilbara Olive Python is known only from the Pilbara region of Western Australia and suitable habitat within its modelled distribution is likely to be critical habitat for the species. The Proposed Action has the potential to adversely affect habitat critical to the survival of the species due to the clearing of 299 ha of high value potential denning and foraging habitat. The loss of this high value habitat is considered a potentially significant impact and is proposed to be offset. A total of 71.6% of high value potential shelter and foraging habitat (comprising 753 ha) will remain in the

Significant impact criteria	Assessment of impacts to Pilbara Olive Python
	Development Envelope and support the individuals that may be present.
Potential to disrupt the breeding cycle of a population	A total of 753 ha (71.6%) of potential shelter and hunting habitat will remain in the Development Envelope. Given the small numbers of records of this species in the Development Envelope, and that approximately 71.6% of potential breeding habitat will remain in the Development Envelope, the Proposed Action is not expected to disrupt the breeding cycle of an important population
Potential to modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Proposed Action will result in the loss of up to 299 ha of potential shelter and denning habitat associated with Breakaway, Gorge/Gully and Riverine areas. However, this habitat clearing will not be at an extent at which the species is likely to decline. The balance of clearing will occur in moderate value Drainage Line and Rocky Hill habitat, and Low Hill and Stony Plain habitats of low value to Pilbara Olive Python. Removal of areas of these habitats are not expected to be at an extent at which the species is likely to decline.
Potential for the establishment of invasive species in the endangered species' habitat that are harmful to the endangered species	Predation by feral cats and foxes is an identified key threat to Pilbara Olive Python. The Proposed Action is unlikely to increase the numbers of feral predators in the Development Envelope. The Proponent will undertake feral fauna control within the Development Envelope. The Proposed Action is not expected to increase the risk of impacts of these invasive species.
Potential for the introduction of disease that may cause the species to decline	There is no evidence to suggest that the Proposed Action would introduce disease that may cause the species to decline.
Potential interference with the recovery of the species	Regional and local priority actions identified for Pilbara Olive Python including ensuring that development in areas where the species occurs does not impact known populations; managing changes to hydrology, and implementing Threat Abatement Plans for the control and eradication of foxes and cats. The Proposed Action will result in the clearing of up to 299 ha of high value potential shelter and foraging habitat; and 1,011 ha of moderate foraging and dispersal habitat . The removal of high value habitat is considered to be a significant residual impact and proposed to be offset. Approximately 79.2% of total potential and suitable habitat will remain locally within the Development Envelope. In addition, the Proponent will undertake feral fauna control within the Development Envelope. On this basis, the Proposed Action is not expected to interfere with the recovery of the species.

10.8.3. Ghost Bat

Direct impacts

Loss of potential habitat

The most important habitat types for Ghost Bats in the Development Envelope are Gorge/Gully and Breakaway habitats, which provide suitable roost habitat. In addition, Riverine, Drainage Line and Breakaway habitats provide foraging and dispersal habitat.

The Development Envelope supports 18 known Ghost Bat roosts, all within the Western Range area. This area includes habitat which can be characterised as critical habitat, including one confirmed

maternity roost (Cave 6), three potential maternity roosts (Cave 11, 15 and 18) and four confirmed diurnal roosts, all located in Gorge/Gully habitat areas.

Although the VHF study (Biologic 2020b) provided evidence that the resident Ghost Bats do not regularly forage within the Development Envelope, the precautionary principle has been applied and all fauna habitats within 5 km of known roosts are assessed as foraging habitat.

A total of 3,927 ha of high and moderate value foraging habitat occurs in the Development Envelope within 5 km of Ghost Bat roosts. Of this, 907 ha moderate value foraging habitat and 280 ha of high value habitat (within 5 km of Ghost Bat roosts) occurs within the current conceptual footprint, the latter locally important habitat for the species with its removal representing a significant residual impact requiring offsetting. Therefore, approximately 30.2% of the foraging habitats within the Development Envelope will be removed as part of the Proposed Action. The balance of clearing will occur in moderate value foraging habitat more than 5 km from Ghost Bat roosts and low value common and widespread Low Hill and Stony Plain habitat areas. This clearing of low or moderate value habitat will be subject to State EP Act offsets (refer to Section 12 of the ERD).

In the context of land systems, the Newman land system is considered by Astron (2019) to be of the highest value to Ghost Bat as this land system coincided with the majority of the high quality habitat (97%), and the location of all roost caves for, including the significant diurnal roosts and potential maternal roosts. Only 0.12% of the total extent of the Newman land system mapped in the Pilbara bioregion is present within the conceptual footprint.

The direct loss of up 280 ha of high value, or critical, Gorge/Gully and Breakaway potential roosting and/or foraging habitat located in the conceptual footprint within 5km of Ghost Bat roosts and the removal of two confirmed diurnal, two potential diurnal and one feed cave represents a significant impact and will be required to be offset (refer to Section 12 of the ERD).

Of the 18 caves identified, a total of five caves will be removed for the Proposed Action. Bat Call (2020b) identified the four potential maternity roosts (Caves 6, 11, 15 and 18) and a further four caves that are significant as they support the use of these important caves which occur in three groups. None of the eight caves considered significant by Bat Call (2020b) will be removed.

In early surveys with limited survey effort, any diurnal record was considered as an indication that the cave could be significant. However, the detailed work over nineteen months of echolocation monitoring by Bat Call (2020b) supersedes some of the early conclusions about potential significance.

The caves that will be removed for the Proposed Action are as follows:

- two confirmed diurnal caves with low levels of use (Cave 1 and 4);
- two potential diurnal caves (Cave 3 and 13) with occasional diurnal use; and
- one nocturnal foraging cave (Cave 5) with no evidence of diurnal use.

Any removal of roost caves is considered significant under the Conservation Advice, however these caves were identified of lesser importance by Bat Call (2020b) as each is judged to be either nearby a primary grouping or midway between two primary cave groupings that are separated by less than 5 km and are judged to be of more importance for the local population. The cave groupings each include a combination of at least one confirmed (Cave 6) or potential maternity cave (Caves 11, 15 and 18) and at least one confirmed (Cave 16) or potential diurnal roost (Caves 2, 12 and 17). With the existence of these cave groups providing a range of roosting habitats the removal of the relatively separate caves of lower importance, Caves 1, 4, 3, 13 and 5, is not expected to result in a decline in the local population.

Targeted echolocation investigations by Bat Call (2020b) demonstrate that Cave 1 and 4 presented limited usage and activity by the Ghost Bat despite their location close to Cave 6. These caves had inconsistent ultrasonic call recordings and had no large middens present (Bat Call 2020b). As such, the removal of these two confirmed diurnal caves are not expected to significantly impact the Ghost Bat at a local or regional scale. The patterns, types and frequency of usage suggests the caves in the

important groupings as combined systems represent better habitat and suitable alternatives to the only occasionally used individual caves of lower importance.

The Proposed Action will avoid direct impacts to the remaining 13 Ghost Bat caves/roosts in the Development Envelope comprising:

- one confirmed maternal roost (Cave 6), which is considered significant;
- three potential maternity roosts with regular use (Caves 11, 15 and 18), which are considered significant;
- two confirmed diurnal roosts with regular use (Caves 14 and 16), which are considered significant; and
- seven potential diurnal roosts with appropriate cave properties or signs of occasional use (Caves 2, 7, 8, 9, 10, 12 and 17).

Mining restriction zones providing a 100 m buffer around the internal roost dimensions will be established around Caves 6, 16, 17 & 18, as these caves occur in proximity to the conceptual pit footprints (Figure 10-5). Caves 12 and 15 occur within the proposed Mining Exclusion Zone for *Aluta quadrata,* and therefore will also be protected from direct disturbance*.* The remaining caves are located greater than 300 m from the conceptual pit footprints, which is beyond the distance for which blast management is proposed, therefore mining restriction zones are not proposed for the remaining caves. The mining restriction zones will ensure direct impacts to these roosts are avoided and will minimise the potential for indirect impacts on bats and caves from vibration, noise and light. Some limited ground disturbance may occur within the mining restriction zones from the development of adjacent pits (i.e. unavoidable spillage and rilling from drill and blast activities occurring upslope from protected roosts).

Ghost Bat monitoring at West Angelas (approximately 213 km northwest of the Development Envelope) has demonstrated evidence of Ghost Bat activity in a cave located 70 m from an active mine pit every year between 2012–2014. Sporadic use of another cave located 90 m from the mine pit has also been recorded. The data suggest there has been no impact on the use of caves adjacent to mining activities from the species (Rio Tinto 2018a), and that mining restriction zones are expected to effectively avoid physical impacts to roosts.

Furthermore, the three persistent surface water fed pools at Western Range will remain post mining and no impacts are predicted to groundwater fed Gardagarli (Ratty Springs) and Gurungu (Doggers Gorge), as a result of the Proposal; therefore, these features will continue to support the habitat value surrounding retained roosts.

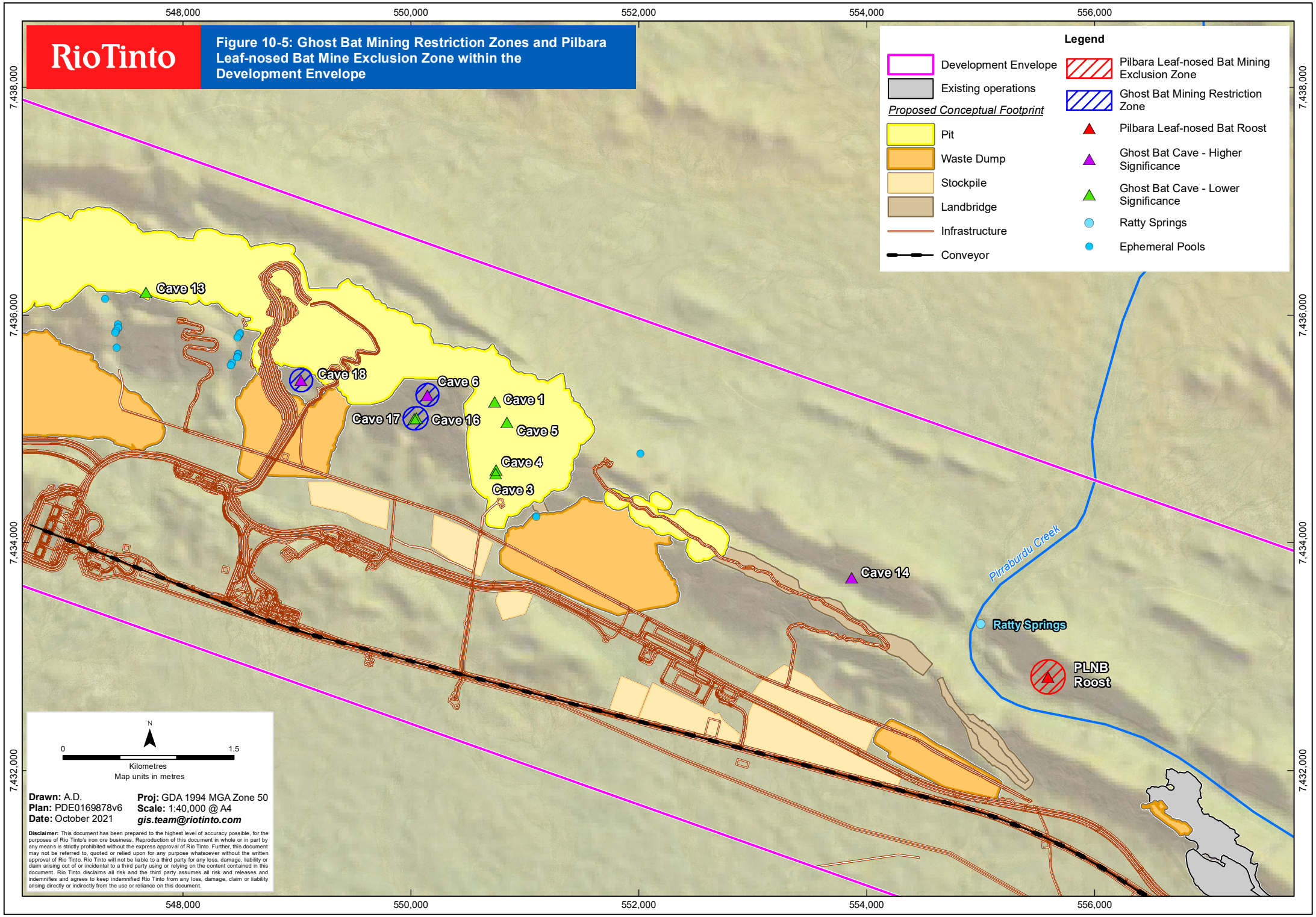
Loss of fauna individuals

Ghost Bats are known to be able to fly low and the use of vehicles and machinery for construction has the potential to result in collision with bats that may be present in the Development Envelope. This may result in injury or mortality to individuals, particularly at night when active foraging occurs. Construction activities will occur predominantly during daylight hours, and will therefore minimise the potential for interaction with bats. Vehicle movements at night (when Ghost Bats are foraging) are much less than during the day and are generally limited to in-pit operations. Vehicle movements within the disturbance footprint of the Proposed Action are not expected to result in a long-term decrease in the Ghost Bat population.

Ghost Bats are known to become entangled in barbed wire fencing due to their low elevation flying pattern. The use of barbed wire fencing within the Development Envelope will be avoided as far as practicable, noting the requirements of pastoralists, whose leases intersect the Development Envelope, to use barbed wire in their stock fences for the effective containment of cattle. Where the use of barbed wire fencing is legislated, the top strand will be replaced with single strand wire and reflectors will be installed to deter bay interaction. The potential impacts from infrastructure are expected to be low.

In addition to the avoidance measures, the Proponent will implement measures to be undertaken during clearing activities to ensure that impacts to Ghost Bats are not greater than predicted. The following measures to address impacts from clearing of habitat include:

- progressive clearing and progressive rehabilitation of disturbed areas to allow fauna to migrate away from clearing activities or machinery movements; and
- awareness training to identify conservation significant fauna and habitat, relevant management measures, personnel/contractor responsibilities, and incident reporting requirements (i.e. reporting of fauna observations and/or incidents).



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Indirect impacts

Degradation/alteration of habitat as a result of altered hydrological regimes

Groundwater drawdown in the alluvial aquifer in Seven Mile Creek as a result of dewatering activities at Paraburdoo 4EE pit has the potential to impact approximately 25 ha of riparian vegetation within Riverine habitat areas. However, none of the known Ghost Bat roost caves are located within 5 km of this potential adverse impact to riparian vegetation.

Discharge of surplus water to surface water systems may temporarily increase vegetative cover and insect activity within the discharge zone. However, as surplus water discharge volumes will be relatively small (up to 1.7 GL/a) and intermittent, these changes are not expected to have a significant impact on foraging patterns in the Development Envelope.

Ghost Bat caves are elevated in the landscape and humidity levels in the caves are not related to groundwater.

There are numerous small ephemeral rock pools that occur within the highly dissected landscapes of the Development Envelope, particularly Western Range and Eastern Range. These pools occur following rainfall in deeply incised rocky areas and would be expected to overflow in high rainfall events. There are three persistent surface water fed pools at Western Range; these will remain post mining. No impacts are predicted to groundwater fed Gardagarli (Ratty Springs) and Gurungu (Doggers Gorge), as a result of the Proposal. The Proposed Action will result in the removal of some ephemeral surface water fed pools and a reduction in the catchment of many remaining pools. Sediment loadings to remaining pools will also increase to varying degrees due to mining activities in the upper catchments. However, surface water modelling predicts pools will continue to receive run-off following significant rainfall events. Therefore, a significant impact to the ephemeral nature of the pools or their hydroperiod is not expected. The Proposed Action is therefore not expected to have a significant impact on the availability of these pools for Ghost Bat.

Habitat fragmentation and barriers to fauna movement

The Proponent has modified the conceptual footprint of the Proposed Action to ensure a suitable separation distance from recorded roosts. Mining restriction zones will be implemented, providing a 100 m buffer around the internal roost dimensions at Caves 6, 16, 17 and 18 as these roosts are in close proximity to the conceptual footprint. Caves 12 and 15 are located within the Mining Exclusion Zone established for *Aluta quadrata,* and therefore will also be protected from direct disturbance. All other roosts that are proposed to be retained are located greater than 300 m from conceptual pit footprints and therefore mining restriction zones are not proposed for these roosts.

Three important groupings of caves with recorded Ghost Bat activity have been identified at Western Range (Bat Call 2020b). These include Caves 6, 16, 17 and 18 which are located within 1 km of each other. Cave 12 and Cave 15 are located approximately 550 m apart in unfragmented habitat. Caves 2, 7, 8, 9, 10 and 11 are located within 1.5 km of each other, also in unfragmented habitat (Figure 10-5) These important cave complexes will continue to provide roosting habitat for Ghost Bats and will provide the species with opportunities to move to other caves within the species' range in the event that disturbance from the Proposed Action causes individuals to vacate a cave.

No significant impacts are expected from the Proposed Action from habitat fragmentation or barriers to Ghost Bat movement from the Proposed Action based on:

- the application of the mining restriction and exclusion zones providing unimpeded pathways to and from cave sites;
- intact high value habitat within 100 m of cave roosts;
- availability of 13 known cave roosts within the Western Range area of the Development Envelope;
- high mobility and natural movement of Ghost Bats between cave roosts; and

- the known use of caves in historical mine areas.

Habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust, and increased abundance of introduced fauna species

Dust emissions from mining activities have the potential to impact the quality of foraging habitat but are not expected to significantly impact roosts as they are located on the south side of the range and are generally orientated towards the south, away from mine pits. Cave 18 is at increased risk of impacts from dust emission as it is close to Waste dump 2, which was modified to allow for Cave 18 to be retained. However, the designated mining restriction zone will ensure the toe of the waste dump does not encroach within 100 m of Cave 18.

Based on dust monitoring to date and a study by Matsuki *et al.* (2016), any decline in the quality of Ghost Bat foraging habitat is likely to be limited to the area immediately adjacent to the Proposed Action.

The following measures to ensure habitat degradation associated with construction activity and/or increased human activity is managed for Ghost Bat include:

- dust emissions to be controlled using conventional dust suppression techniques;
- implementation of approved fauna control methods in consultation with the DBCA and pastoralists, where required; and
- education and awareness training will inform employees of their requirement to report sightings of feral animals, that no domestic pets are allowed onsite and that no feeding of native and or feral animals is permitted.

Cane toads are a recognised threat to Ghost Bat; however, the cane toad is not currently present in the Pilbara and the Proposed Action will not increase the potential for cane toad to become established in the Paraburdoo area. The Proponent will undertake feral animal control within the Development Envelope.

The Proponent considers that this impact can be appropriately managed and; therefore, no significant impacts to Ghost Bat is expected in relation to habitat degradation associated with construction activities.

Disturbance from light, noise and/or vibration and displacement of fauna

The Proponent will implement a Blast Management Plan for all roosts within 300 m of the conceptual pit footprints (being Caves 6, 16, 17 & 18) and mining restriction zones around the same caves which is expected to be effective in minimising impacts from vibration and noise on Ghost Bat roosts. Fauna monitoring at Process Minerals' Poondano project near Port Hedland, and at the West Angelas mine reported the continued presence of a colony of Ghost Bats despite mining. Studies on sound and vibration transmissivity through Robe Pisolite as a result of blasting have also been undertaken at Mesa A Operations and focussed on vibration propagation through the pit walls. Although the Mesa A operations have different geology compared to that present in the Development Envelope, the studies indicate that blast vibrations were attenuated over a distance of less than 50 m from the blast site, without any specific blast management or trim shots being employed to reduce vibration (Rio Tinto 2019b).

Geotechnical assessments have been completed for Caves 6, 16, 17 & 18 and the results will be used to determine appropriate vibration thresholds and stand-offs from mining activities to ensure the structural integrity of caves is maintained throughout the life of mining operations. The implementation of mining restriction zones, providing a 100 m buffer around the internal roost dimensions, represents a minimum stand-off between roosts and direct disturbance from mining operations.

Impacts to roosting Ghost Bats from noise from mining activities is not expected to be significant as caves are located on the south side of the range and generally face southwards, away from in-pit mining activities to the north.

Temporary night time construction lighting and increased night time light emissions around the active mining areas may alter nocturnal foraging behaviour. The Proponent will implement the following actions to address impacts from light, noise and/or vibration and displacement of fauna:

- lighting in the mining area will be directed into the pit, away from roosts in Breakaway and Gorge/Gully; and
- lighting to be installed only where required, that is, mainly in-pit and operational areas.

The Blast Management Plan will be implemented to minimise vibration from blasting. The Blast Management Plan takes a risk-based approach in relation to diurnal/potential maternal roost sites. This approach assumes all diurnal / potential maternal roost sites are sensitive receptors requiring a high level of protection. As such, a conservative blast threshold (peak particle velocity (PPV)) trigger criterion will be set to ensure no structural damage to the caves occurs. Based on the Proponent's experience and monitoring from mining operations at mesa formations throughout the Robe Valley, and successfully applied vibration control to blasting near sensitive sites such as culturally sensitive sites, sensitive infrastructure (e.g. high pressure gas pipeline, communications tower) and environmentally sensitive sites (e.g. troglofauna habitat and Ghost Bat roosts), the Proponent can demonstrate the effectiveness of current blast management techniques and the Blast Management Plan is expected to also be effective in its application to the Greater Paraburdoo Hub.

Calculation of the likelihood that the blast will reach or exceed the set trigger PPV is based on a conservative generic set of ground condition parameters.

If the trigger is likely to be reached:

- conducting site specific tests to establish site specific ground condition parameters and re-calculation of the vibration levels; and
- revision of the blast design.

The design of the blast can be altered in a number of ways to reduce the PPV. For example, distance from the blast to the sensitive site may be increased, drill hole sizes and charge weights may be reduced, blast timing (the layout and delays between firing successive holes) may be modified or high frequency blasting techniques may be used.

The Proponent considers the proposed mining restriction zones at Caves 6, 16, 17 and 18, which will provide for a 100 m buffer around the internal roost dimensions, and the inclusion of Caves 12 and 15 in the proposed mining exclusion zone for *Aluta quadrata* will be appropriate to ensure disturbance to the caves is avoided and the integrity of the caves is not compromised by the Proposed Action. The application of mining exclusion and restriction zones coupled with proposed blast management controls is expected to provide protection to Caves 6, 12, 14, 15, 16, 17 and 18 and will be effective in preventing damage these caves. All other retained caves are greater than 300 m from the conceptual footprint and as such are not expected to be impacted by blasting activities.

No significant impacts on Ghost Bat are expected from the disturbance from light, noise and/or vibration.

Significance of direct and indirect impacts to Ghost Bat

An assessment of the Proposed Action on Ghost Bat is detailed in Table 10-14, with reference to the Significant Impact Guidelines (DoE 2013).

Table 10-10: Assessment of the significance of impacts to Ghost Bat

Significant impact criteria	Assessment of impacts to Ghost Bat
Potential to cause a long-term decrease in the size of a population	The Proposed Action will result in the loss of 1,186.84 ha of high and moderate value Ghost Bat habitat within 5km of Ghost Bat roosts, of which 280 ha comprises high value habitat (Gorge/Gully and Breakaway habitat), which provides potential roosting habitat and foraging opportunities. This high value habitat aligns with the definition for critical habitat for the species. A total of 18 roost caves was identified within the Development Envelope for Ghost Bat of which the following five caves will be removed as part of the Proposed Action: • two confirmed diurnal caves with low levels of use (Cave 1 and 4) • two potential diurnal caves (Cave 3 and 13) with occasional diurnal use; and • one nocturnal foraging cave (Cave 5) with no evidence of diurnal use. The remaining 13 caves will be retained within the Development Envelope. There is evidence of persistence of Ghost Bat population in the Pilbara region alongside existing mining operations so caves and habitat that are retained in the Development Envelope are expected to continue to be utilised. Given approximately 68.3% of high value habitat will remain in the Development Envelope, the widespread availability of foraging and dispersal habitat beyond, and the retention of all confirmed (Cave 6) and potential (Cave 11, 15 & 18) maternity roosts within the Development Envelope and the additional four caves that were identified by Bat Call (2020b) as likely to support the use of these roosts; the removal of 280 ha of high value habitat within 5km of Ghost Bat roosts is not expected to cause a long-term decrease in the size of a population that may occur within the Development Envelope.
Potential to reduce the area of occupancy of the species	The Proposed Action and Development Envelope are located toward the southern extent of the modelled distribution of the Pilbara population of the species extent of occupancy. The species would continue to occupy the Development Envelope and wider Pilbara region. The Proposed Action may reduce the area of occupancy of an important population.
Potential for fragmentation of an existing population into two or more populations	The Proposed Action will result in the clearing of 292 ha of potential roosting and foraging habitat, of which 280 ha occurs within 5km of Ghost Bat roosts. The species is highly mobile, and 68.3% of high value, and 81.1% of moderate value intact habitat for the species will remain in the Development Envelope post-disturbance, as well as habitat in the wider Pilbara region. The species is known to disperse up to 10 km from known roosts during nocturnal foraging activities. A total of 3,927 ha of foraging habitat occurs within 5 km of identified caves with the Development Envelope. Of this, 1,186.84 ha (30.2%) occurs within the conceptual footprint. The Proposed Action is not expected to fragment the existing Ghost Bat population given extensive foraging habitat will remain within the species' predicted nocturnal foraging range; the retention of 13 caves including one confirmed maternity cave (Cave 6), three potential maternity (Caves 11, 15 and 18), two confirmed diurnal roosts (Caves 14 and 16) and seven potential diurnal roosts (Caves 2, 7, 8, 9, 10, 12 and 17); the high mobility of the species; and the persistence of the population outside of the Development Envelope.

Significant impact criteria	Assessment of impacts to Ghost Bat
Potential to adversely affect habitat critical to the survival of the species	The Development Envelope supports habitat that satisfies the definition of critical habitat for Ghost Bat including the known occurrences of roosts, in particular, maternity roosts in the Development Envelopment. The focus on retention of these roosts is required for the persistence of the species in the Pilbara and active roosts are the most important indicator of habitat suitability. The local population in the Development Envelope is an important population and the removal of two confirmed diurnal roosts (Caves 1 and 4); therefore, represents disturbance of critical habitat. Ghost Bats have been recorded within the Development Envelope and the Proposed Action will result in the clearing of 292 ha of potential roosting and foraging (i.e. critical) habitat in the Development Envelope, of which 280 ha occurs within 5km of Ghost Bat roosts. Consequently, the Proposed Action has the potential to adversely affect habitat critical to the survival of the species.
Potential to disrupt the breeding cycle of a population	There is one confirmed maternity roost (Cave 6) and two potential maternity roosts (Cave 15 and 18) within the Development Envelope; however, these locations will not be directly impacted by the Proposed Action. Mining restriction zones will be implemented around Cave 6 and 18, and the design of Waste Dump 2 was modified so that Cave 18 could be retained. Cave 15 is located within the Mine Exclusion Zone for the Threatened *Aluta quadrata*. As such, it is not expected that there will be a potential disruption to the breeding cycle of the local population.
Potential to modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Proposed Action will result in the loss of up to 292 ha of potential high value habitat in the Development Envelope associated with Breakaway and Gorge/Gully areas. The Proposed Action has the potential to modify, destroy, remove or isolate or decrease the availability or quality of Ghost Bat habitat due to the clearing of shelter, foraging and dispersal habitat. However, for the Proposed Action this will not be at an extent at which the species is likely to decline. A further 907 ha of moderate value foraging habitat from Riverine, Drainage and Rocky Hill areas within 5 km of Ghost Bat roosts will also be disturbed. The balance of clearing will occur in moderate value Riverine, Drainage and Rocky Hill habitat more than 5 km from roosts, and Low Hill and Stony Plain habitats of low value to Ghost Bats. Removal of these areas of habitat, all of which are common and widespread in the Pilbara region, are not expected to be at an extent at which the species is likely to decline.
Potential for the establishment of invasive species in the endangered species' habitat that are harmful to the endangered species	The Proponent will undertake feral animal control within the Development Envelope. Cane toads are a recognised threat to Ghost Bat; however, the cane toad is not currently present in the Pilbara and the Proposed Action will not increase the potential for cane toad to become established in the Paraburdoo area.
Potential for the introduction of disease that may cause the species to decline	A possible herpes-type virus is reported to be affecting a population at Mt Etna in Queensland; however, this has not been identified in the Paraburdoo region of Western Australia and the Proposed Action will not increase the potential for this disease to be introduced to the local population.
Potential interference with the recovery of the species	The conservation advice for the species identifies active mitigation of threats as a key management action, including protection of land with significant colonies, replacing and avoiding the use of barbed wire fencing, protecting roost sites and surrounding foraging areas and preventing collapse of roost sites. The Proponent commits to avoid the use of barbed wire fencing as far as practicable, noting the requirement for pastoralists, whose leases intersect the Development Envelope, to use barbed wire in stock fences for the effective containment of cattle. Where barbed wire is required by legislation, reflectors will be installed to prevent Ghost Bat interaction.

Significant impact criteria	Assessment of impacts to Ghost Bat
	The Proposed Action has also been modified to limit disturbance within highest value denning and foraging habitat. Key mitigation measures include: • modification of the 36W pit crest to provide an adequate stand-off for the protection of Cave 6 (potential Ghost Bat maternity roost); and • modification of Waste Dump 2 to allow for the retention of Cave 18 (potential Ghost Bat maternity roost). On this basis, the Proposed Action is not expected to interfere with the recovery of the species.

10.8.4. Pilbara Leaf-nosed Bat

Direct impacts

Removal of habitat

Critical habitat for the Pilbara Leaf-nosed Bat is present within the Development Envelope as a confirmed permanent diurnal/maternal roost was identified at Ratty Springs which is classified as Priority 1 habitat (TSSC 2016b). The Proposed Action will not impact the known Ratty Springs roost in the Development Envelope. The conceptual footprint (14-16W pit) is approximately 540 m from the Ratty Springs roost on the opposite side of Pirraburdu Creek.

Additional threats to the Pilbara Leaf-nosed Bat habitat includes disturbance to foraging habitat and water sources within 10 km of the known roosts (TSSC 2016b).

The total extent of potential foraging habitat within the 10 km foraging range of the roost is approximately 2,611 ha. Of this, approximately 550 ha moderate value foraging habitat (excluding low value habitat) and 133 ha of high value habitat (Gorge/Gully and Breakaway) occurs within the Proposed Action within 10 km of Ratty Springs roost based on the current conceptual footprint.

The direct loss of up to 292 ha of high value foraging habitat located within the conceptual footprint, of which 133 ha occurs within 10km of the Ratty Springs roost, represents a significant local impact to critical habitat and will be required to be offset (refer to Section 12 of the ERD). The loss of this foraging habitat is not expected to significantly affect the viability of the Ratty Springs roost as approximately 74% of the foraging habitat within 10 km of the roost will remain. The balance of clearing will occur in moderate value Riverine, Drainage Line and Rocky Hill foraging habitat and low value and widespread Low Hill and Stony Plain habitat areas. None of the high value Riverine or Drainage Line foraging habitat at Ratty Springs and in Pirraburdu Creek will be impacted by the Proposal. Alluvial Plain habitat, of moderate value for Pilbara Leaf-nosed Bat, is not located within the conceptual footprint.

Semi-permanent pools exist at Ratty Springs in Pirraburdu Creek in proximity to the Ratty Springs roost. These pools will not be impacted by the Proposed Action. Additionally, there are several ephemeral pools that exist within a 10 km radius of the Ratty Springs roost and extensive riparian habitat north and south in Pirraburdu Creek that will not be impacted by the Proposed Action.

Loss of fauna individuals

The use of vehicles and machinery for construction has the potential to result in collision with bats that may be present in the Development Envelope. This may result in injury or mortality to individuals, particularly at night when active foraging occurs. Pilbara Leaf-nosed Bats are known to be attracted to light and fly low, resulting in the potential for collisions with vehicles. However, vehicle movements at night (when Pilbara Leaf-nosed Bats are foraging) are much less than during the day and are generally limited to in-pit operations.

The species may also collide with fences, resulting in injury or death of individuals. The use of barbed wire will be avoided as far as practicable, noting the requirement for pastoralists, whose leases intersect

the Development Envelope, to use barbed wire in stock fences. Where there is a statutory requirement for barbed wire, reflectors will be installed to minimise bat entanglement. In addition to the avoidance measures, the Proponent will implement measures to be undertaken during clearing activities to ensure there are no adverse impacts outside of predictions to Pilbara Leaf-nosed Bats. The following measures to address impacts from clearing of habitat include:

- progressive clearing and progressive rehabilitation of disturbed areas to allow fauna to migrate away from clearing activities or machinery movements; and
- awareness training to identify conservation significant fauna and habitat, relevant management measures, personnel/contractor responsibilities, and incident reporting requirements (i.e. reporting of fauna observations and/or incidents).

Indirect impacts

Degradation/alteration of habitat as a result of altered hydrological regimes

The semi-permanent pools near Ratty Springs that support the Ratty Springs roost are not within the area of groundwater drawdown for the Proposed Action. Therefore, the water levels in these pools will not be affected as a result of the Proposed Action.

Habitat fragmentation and barriers to fauna movement

The one known confirmed maternity roost at Ratty Springs for Pilbara Leaf-nosed Bat within the Development Envelope will be avoided by the Proposed Action. Habitat connectivity between roost and foraging areas such as Ratty Springs east and west pools (which have demonstrated high usage from the species) will also remain within the Development Envelope.

Given the high mobility of the species and retention of the majority of roost habitat within 10 km of the known roost location at Ratty Springs, the removal of 292 ha of high value Pilbara Leaf-nosed Bat foraging habitat in the conceptual footprint, of which 133 ha is within 10km of the Ratty Springs roost, is not expected to fragment the local population or habitat.

Habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust, and increased abundance of introduced fauna species

Any decline in the quality of Pilbara Leaf-nosed Bat foraging habitat is likely to be limited to the area immediately adjacent to the conceptual footprint. In addition, the known roost location for the species is located 540 m north of the Proposed Action. Dust will be managed in by the Proponent; any potential dust generation is expected to be of a short-duration and will not result in permanent impacts to Pilbara Leaf-nose Bat.

The following measures to ensure habitat degradation associated with construction activity and/or increased human activity is managed for Pilbara Leaf-nosed Bat include:

- dust emissions to be controlled using conventional dust suppression techniques
- implementation of approved feral predator control methods in consultation with the DBCA and pastoralists, where required.

The approved conservation advice for the species suggests that invasive species are not expected to have a significant impact overall on the Pilbara Leaf-nosed Bat (TSSC 2016b). The Proponent will undertake feral animal control within the Development Envelope. Cane toads are identified as a threat to the species; however, the cane toad is not currently present in the Pilbara and the Proposed Action will not increase the potential for cane toad to become established in the Paraburdoo area or Development Envelope.

No significant impacts on Pilbara Leaf-nosed Bat are expected from the risk of habitat degradation from introduction or spread of introduced fauna.

Disturbance from light, noise and/or vibration and displacement of fauna

This species is known to display a curiosity for light sources (DotEE 2019). Light emissions may alter nocturnal foraging activities, particularly if light enters potential night roosts or attracts invertebrates, which are a food source for the species. Temporary mobile lighting in areas of active excavation may result in temporal and localised areas of light spill on to habitat within the Development Envelope, and attraction to light sources may also give rise to collisions with vehicles. However, as light will be directed away from retained habitat and light emissions will affect only a small proportion of Pilbara Leaf-nosed Bat foraging habitat, light emissions are not expected to significantly impact this species.

Noise and vibration impact from mining operations are not expected to significantly impact the Pilbara Leaf-nosed Bat as the Ratty Springs roost is located approximately 540 m north from the proposed 14-16W pit.

Significance of direct and indirect impacts to Pilbara Leaf-nosed Bat

An assessment of the Proposed Action on Pilbara Leaf-nosed Bat is detailed in Table 10-11, with reference to the Significant Impact Guidelines (DoE 2013).

Table 10-11: Assessment of the significance of impacts to Pilbara Leaf-nosed Bat

Significant impact criteria	Assessment of impacts to Pilbara Leaf-nosed Bat
Potential to cause a long-term decrease in the size of a population	The confirmed diurnal/maternity roost at Ratty Springs will be avoided by the Proposed Action. The Proposed Action will result in clearing of 292 ha of high value habitat (Gorge/Gully and Breakaway habitat), which provides potential roosting and foraging habitat. Of this, approximately 133An additional 1,018 ha moderate value habitat (Riverine, Drainage Line and Rocky Hill habitat) will be removed as part of the Proposed Action, which provides foraging and dispersal opportunities. Moderate value Alluvial Plain habitat is not located within the conceptual footprint. Changes to the footprint may result in small amounts of clearing to this habitat type but this is not expected to result in clearing more than 5% of this habitat type and is unlikely to be significant. This moderate value habitat is not classified as critical habitat for the species. All habitats within the Proposed Action are common and widespread throughout the Pilbara region, with approximately 68.3% of high value habitat remaining undisturbed within the Development Envelope. The Proposed Action is not expected to result in the loss of, or unmitigated disturbance to, roosts constituting habitat critical to the survival of the Pilbara Leaf-nosed Bat (Priority 1 and 2 refuges, especially those with a known or suspected large colony size) and; therefore, will not lead to a long-term decrease in the size of the Pilbara Leaf-nosed Bat population.
Potential to reduce the area of occupancy of the species	The species will continue to exist within and surrounding the Development Envelope. Therefore, the Proposed Action is not expected to reduce the area of occupancy of an important population.
Potential for fragmentation of an existing population into two or more populations	The Proposed Action is not expected to fragment the existing Pilbara Leaf-nosed Bat population given extensive foraging habitat will remain within the species' predicted nocturnal foraging range; the proposed retention of the known roost site at Ratty Springs; the high mobility of the species; and the persistence of the population outside of the Development Envelope.
Potential to adversely affect habitat critical to the survival of the species	The Development Envelope supports habitats that satisfy the definition of critical habitat for the Pilbara Leaf-nosed Bat including in particular, the only confirmed diurnal/ maternity roost in the Development Envelope. The local population in the Development Envelope is an important population and the known roost is therefore critical habitat. Critical habitat for the Pilbara Leaf-nosed Bat is also classified as habitats identified as critical foraging habitat comprising Gorges with pools. Semi-permanent pools at Ratty Springs is located in the immediate proximity to the permanent diurnal/maternal roost in the Development Envelope. The Ratty Springs pools will not be directly or indirectly impacted by the Proposed Action.

Significant impact criteria	Assessment of impacts to Pilbara Leaf-nosed Bat
	Pilbara Leaf-nosed Bat have been recorded within the Development Envelope and the Proposed Action will result in the clearing of 292 ha of high value potential roosting and foraging habitat in the Development Envelope. Consequently, the Proposed Action has the potential to adversely affect habitat critical to the survival of the species.
Potential to disrupt the breeding cycle of a population	Development-related activities in proximity to diurnal roosts have the potential to disrupt the breeding cycle of the Pilbara Leaf-nosed Bat if they occur within any part of the breeding period (when aggregations may form to support mating, pregnancy, parturition and the raising of young), if they cause individuals to relocate elsewhere (TSSC 2016b). A confirmed diurnal/maternity roost occurs within the Development Envelope but will not be impacted by the Proposed Action. As the conceptual footprint is approximately 540 m south from the Ratty Springs roost, there is not expected to be any impact on the breeding cycle of the local population.
Potential to modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Proposed Action will retain the only known roost within the Development Envelope but will result in the clearing of 292 ha of potential roosting and foraging habitat. The approved conservation advice indicates that a reduction in habitat availability could result in a decline of the species in a region (TSSC 2016b). A total of 73.8% of intact high and moderate value habitat will remain within 10 km of the known roost site post-disturbance. As such, the Proposed Action is not expected to modify, destroy, remove or isolate or decrease the availability of habitat to the extent that Pilbara Leaf-nosed Bat population will decline.
Potential for the establishment of invasive species in the endangered species' habitat that are harmful to the endangered species	The approved conservation advice for the species suggests that invasive species are not expected to have a significant impact overall on the Pilbara Leaf-nosed Bat (TSSC 2016b). Cane toads are identified as a threat to the species; however, the cane toad is not currently present in the Pilbara and the Proposed Action will not increase the potential for cane toad to become established in the Paraburdoo area or Development Envelope.
Potential for the introduction of disease that may cause the species to decline	Currently there are no known diseases harmful to Pilbara Leaf-nosed Bat. There is no evidence to suggest that the Proposed Action would introduce disease that may cause the species to decline.
Potential interference with the recovery of the species	Key management actions for the recovery of the species include protection of land with significant colonies, replacement of barbed wire fencing, protection of roosts and protection of the structural integrity of roosts (TSSC 2016b). There will be no direct disturbance to the confirmed permanent diurnal/maternity roost at Ratty Springs and mitigation measures will be implemented to minimise and manage any potential indirect impacts. The Proponent will avoid the use of barbed wire fencing, as far as practicable, noting the requirement for pastoralists, whose leases intersect the Development Envelope, to use barbed wire in stock fences. Where barbed wire fencing is required, reflectors will be installed to deter interaction. On this basis, the Proposed Action will not interfere with the recovery of Pilbara Leaf-nosed Bat.

10.9. Proposed management

A summary of the Proposed management of MNES is provided in Table 10-12.

Table 10-12: Summary of residual impacts to MNES following implementation of management and mitigation measures

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Removal of habitat.	The conceptual footprint has been modified where practicable to avoid impacts to high value fauna habitat and cave systems. Including: • Modification of the 36W pit crest to provide an adequate stand-off for the protection of Cave 6 (potential Ghost Bat maternity roost); and • Modification of Waste Dump 1B to allow for the retention of Cave 18 (potential Ghost Bat maternity roost). The Proposal avoids direct and indirect impacts to Ratty Springs as well as high value Riverine and Drainage Line Pilbara Leaf-nosed Bat foraging habitat at Ratty Springs and in Pirraburdu Creek. The Proposed Action has avoided direct impacts to 13 recorded confirmed and potential diurnal/maternity roosts for the Ghost Bat and avoided the only known Pilbara Leaf-nosed Bat roost at Ratty Springs. The mine design incorporates mining restriction zones which will provide for a 100 m buffer around the internal roost dimensions at Ghost Bat caves 6, 16, 17 and 18 to avoid direct disturbance, minimise the impact of blasting and associated vibration on the structure and quality of roosts and protect the integrity of the habitat values of these caves. In addition, caves 12 and 15 occur within the proposed Mining Exclusion Zone for *Aluta quadrata*, and therefore will also be protected from direct disturbance.	Clearing of high value habitat will be restricted to the areas identified in the residual impact column. Mining restriction zones retain high and moderate value habitat within the Development Envelope. Mining restriction and exclusion zones have been delineated to minimise indirect disturbance (dust and noise) to significant caves for Ghost Bat and Pilbara Leaf-nosed Bat. A Blast Management Plan will be implemented to manage vibration from blasting to ensure the structural integrity of significant caves is maintained throughout the life of the mining operation. The Proponent proposes that the Proposed Action approval Decision Notice will include the requirement to prepare and implement an EMP (in accordance with the State approval) to mitigate impacts to listed threatened species.	The Closure Plans includes, amongst others, objectives to ensure that vegetation on rehabilitated land is self-sustaining and compatible with the post-closure land use, and final landforms are stable and consider ecological and hydrological factors. Habitat elements considered part of the rehabilitation design include, amongst others: • vegetation known to provide food or shelter; • retaining and replacing woody debris; • retention of leaf litter using small-scale topography; and • introducing in-situ rock features. Rehabilitation will be conducted in accordance with the *Rio Tinto Iron Ore Rehabilitation Handbook* and will include fauna and habitat monitoring.	Residual impacts from the Proposed Action include: • clearing up to 299 ha of high value and 1,011 ha of moderate value MNES habitat; • clearing of low value MNES Stony Plain and Low Hill habitats comprising 2,990 ha. Significant impacts that require offsets comprise of the following: • removal of up to 299 ha of high value Pilbara Olive Python habitat; • removal of up to 292 ha of high value habitat for Northern Quoll, Ghost Bat and Pilbara Leaf-nose Bat; • removal of two confirmed diurnal roosts (Caves 1 and 4), two potential diurnal caves (Caves 3 and 13) and one nocturnal cave (Cave 5). Low and moderate value habitat types in the Development Envelope are common and widespread; the local loss of these habitats is considered of low importance with regard to MNES ongoing viability in the Pilbara region. The proposed offset for the significant residual impact is discussed in Section 12 of the ERD.
Loss of, or injury to, individuals as a result of vehicle and machinery movement or interactions with infrastructure.	Mining restriction zones will provide for a 100 m buffer around the internal roost dimensions at Ghost Bat caves in proximity to the conceptual footprint (being Caves 6, 16, 17 and 18) to avoid direct impacts to the species. Caves 12 and 15 occur within the established Mine Exclusion Zone for *Aluta quadrata,* and therefore will also be protected from direct disturbance.	The Proponent will avoid the use of barbed wire fencing, as far as practicable, noting the requirement for pastoralists, whose leases intersect the Development Envelope, to use barbed wire in stock fences. Where barbed wire fencing is required for legislative compliance, reflectors will be attached to make fencing more visible and to reduce the risk of fauna injury or mortality due to entanglement with fencing. The Proponent will implement the following management measures: • progressive clearing and progressive rehabilitation of disturbed areas to allow fauna to migrate away from clearing activities or machinery movements; • implement vehicle speed limits on all access roads; • roadkill will be removed from trafficable areas; and • awareness training to identify conservation significant fauna and habitat, relevant management measures, personnel/contractor responsibilities, and incident reporting requirements (i.e. reporting of fauna observations and/or incidents). The Proponent proposes that the Proposed Action approval Decision Notice will include the requirement to prepare and implement an EMP (in accordance with the State approval) to mitigate impacts to listed threatened species.	The Proponent will implement Closure Plans which include a closure objective to ensure that the final landform is stable and considers ecological and hydrological factors.	Given high value habitat has been avoided as much as is practicable (most impact is in low or moderate value habitat), the potential for loss of individuals has been minimised and; therefore, the Proponent expects no significant residual impact.

Potential impact	Avoidance	Minimisation	Rehabilitation	Residual impact
Alteration of habitat as a result of groundwater drawdown and/or surplus water discharge.	Avoidance of dewatering and surplus water disposal is not possible for this Proposed Action.	Discharge of surplus dewatering water to surface water systems will be minimised as discharge to dis-used pits will be utilised where practicable.	No specific closure actions are proposed as altered hydrological regimes are expected to recover naturally.	Lowering of groundwater levels from groundwater abstraction, may impact the quality of up to 27 ha of GDEs that comprise a variety of habitats including Riverine foraging habitat for Ghost Bat, Pilbara Leaf-nosed Bat, Pilbara Olive Python and Northern Quoll in Seven Mile Creek. However, this is not considered a significant impact as the vegetation is located within a heavily modified landscape and is in Degraded condition. The Proponent considers the Proposal can be appropriately managed to address this impact and; therefore, no offsets are proposed.
Disturbance to, or degradation of, potential habitat as a result of noise and vibration.	No blasting will occur within the 100 m mining restriction zones around Caves 6, 16, 17 and 18.	Proponent will implement a Blast Management Plan for Ghost Bat Caves 6, 16, 17 and 18 to ensure blast vibration levels roosts remain below an agreed trigger level.	Not applicable.	The Proponent considers noise and vibration emissions which have the potential to disturb Ghost Bat individuals and roosts and may cause Pilbara Leaf-nosed Bat individuals to avoid foraging habitat can be managed to avoid any significant adverse effect on these species. The Proponent anticipates no significant residual impact on terrestrial fauna with respect to this potential impact.
Disturbance to, or degradation of, potential habitat as a result of dust and light emissions.	Lighting will be directed into the active pits to avoid light spill to adjacent areas of habitat.	The Proponent will undertake the following: • application of dust suppression methods including water sprays to minimise dust emissions; and • lighting will be installed only where required, mainly in-pit and operational areas.	Not applicable.	The Proponent considers the Proposal can be managed to address any potential disruption from light and dust on nocturnal foraging behaviour of the Northern Quoll, Ghost Bat and Pilbara Leaf-nosed Bat. The Proponent anticipates no significant residual impact on terrestrial fauna with respect to this potential impact.
Indirect impact: Habitat degradation associated with construction activity and/or increased human activity, including transmission of weeds, dust, and increased abundance of introduced fauna species	No avoidance measures.	The Proponent will implement hygiene procedures to prevent introduction of new or additional populations of weed species into the Development Envelope. The Proponent will undertake annual weed control to minimise infestation in the Development Envelope The Proponent will undertake feral animal control within the Development Envelope.	Not applicable.	The Proponent considers the Proposal can be managed to address any potential degradation of habitat from introduction or spread of weeds, dust and feral animals. No residual impacts are expected from the Proposal.

10.10. Consistency with relevant recovery plans and other guidance

A range of guidance exists to guide the protection and conservation of the MNES identified in Section 10.4. The available guidance varies but generally includes recovery plans, conservation advice and threat abatement plans. Guidance documents include measures for minimising further impacts as well as broader conservation initiatives.

To the extent the guidance is relevant to this impact assessment, this section describes how the Proposed Action has had regard to, and is not inconsistent with, relevant recovery plans, conservation advices and threat abatement plans. Broader conservation initiatives are typically the focus of organisations with those responsibilities and capabilities and are therefore not considered further in this section.

10.10.1. Northern Quoll

The relevant plans and guidance documents for Northern Quoll are:

- EPBC Act Referral Guideline for the Endangered Northern Quoll Dasyurus hallucatus (DoE 2016);
- Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*) (TSSC 2005);
- National Recovery Plan for the Northern Quoll *Dasyurus hallucatus* (Hill & Ward 2010);
- Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (DSEWPaC 2011c);
- Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (DSEWPaC 2012a); and
- Threat abatement plan for predation by feral cats (DoE 2015a).

There is no approved Conservation Advice for Northern Quoll. However, the Listed Advice *Commonwealth Listing Advice on Northern Quoll (Dasyurus hallucatus)* (TSSC 2005) lists priority recovery and threat abatement actions required for the Northern Quoll:

- minimise the impact of colonising cane toads on the species by:
    - investigating the use of physical barriers or other means, where feasible, to prevent the colonisation of key habitat areas;
    - undertaking translocation and management of Northern Quoll populations in safe havens where necessary;
    - identify areas of critical habitat (e.g. island populations);
    - investigate the need to establish a captive breeding program for the species; and
    - investigate the status of the species in Queensland, including the reasons for its survival following cane toad invasion.

The *EPBC Act Referral Guideline for the Endangered Northern Quoll* (DoE 2016) provides an outline of the requirements for Proponents on habitat quality, habitats critical to the survival of the species, populations important for the species long-term survival, survey expectations, standards for mitigating impacts and significant impacts. These referral guidelines were used to guide the assessment of the potential impacts from the Proposed Action to the Northern Quoll and development of appropriate mitigations. Consistent with the *EPBC Act Referral Guideline for the Endangered Northern Quoll* (DoE 2016), the Proponent has:

- assessed the Northern Quoll habitat values and potential for populations within the Development Envelope using survey's consistent with the use of the recommended detection technique (remote activated cameras and scat searches) in this guideline;

- used the information provided in the baseline and targeted investigations to identify and avoid clearing habitat critical to the Northern Quoll within the Development Envelope;
- maintained dispersal opportunities within the Development Envelope for populations important for the long-term survival of the Northern Quoll;
- developed measures to avoid and or minimise both direct and indirect mortality to the Northern Quoll population; and
- developed adaptive management measures to control impacts from fire, pastoralism, and invasive species, particularly feral cats and weeds.

The *National Recovery Plan for the Northern Quoll (Dasyurus hallucatus)* (Hill & Ward 2010). This recovery plan aims to minimise the rate of decline of the Northern Quoll in Australia and ensure that viable populations remain in each of the major regions of distribution into the future. The Proposed Action aligns with the objective of this Recovery Plan (refer to Table 10-13).

Table 10-13: National Recovery Plan actions for the Northern Quoll

Objective	Actions	Proposed Action assessment
Protect Northern Quoll populations on offshore islands from invasion and establishment of cane toads, cats and other potential invasive species	1.1 Maintain biosecurity of important offshore islands through quarantine measures on the mainland.	The Proposed Action does not involve transfers to offshore islands. As such, these actions do not apply to the Greater Paraburdoo Hub.
	1.2 Monitor offshore islands supporting quoll populations to detect the presence of cane toads, cats and any other potential invasive predator.	
	1.3 Develop and where required implement a strategy for rapid-response control of cane toad or cat outbreaks on offshore islands occupied by Northern Quolls.	
Foster the recovery of Northern Quoll subpopulations in areas where the species has survived alongside cane toads	2.1 Determine which factors affect survival and recovery of Northern Quolls in areas with cane toad.	The Proponent has completed baseline investigations, including a targeted survey for the Northern Quoll to identify potential refuge habitats within the Development Envelope.
	2.2 Use information from Action 2.1 to assist surviving populations to recover in sympatry with cane toads.	
	2.3 Identify potential refuge habitats in WA and NT where quolls might be most likely to persist in the long-term alongside cane toads.	
Halt Northern Quoll declines in areas not yet colonised by cane toads	3.1 Collect baseline data on population densities and monitor trends of quolls at a series of key sites not currently occupied by cane toads	The Proponent has completed baseline investigations, including a targeted survey for the Northern Quoll to identify possible resident populations of the Northern Quoll within the Development Envelope (an area not currently occupied by cane toads). The Proponent will also implement an EMP to minimise fauna mortalities, manage fire regimes within the Development Envelope to avoid declines of populations.
	3.2 Investigate factors causing declines in Northern Quoll populations not yet affected by cane toads	
	3.3 Manage key quoll populations in areas not currently affected by cane toads to halt population declines	
	3.4 Identify the effect of pastoral land management practices on Northern Quoll persistence	
	3.5 Interim fire management at potential key quoll populations in areas not currently affected by cane toads	
	3.6 Refine models of the current and expected distribution of cane toads and Northern Quolls, incorporating predictions of climate change	

Objective	Actions	Proposed Action assessment
Halt Northern Quoll declines in areas recently colonised by cane toads	4.1 Continue research into the susceptibility of quolls to cane toad poisoning	The Proponent will monitor the presence of invasive species during construction and operation of the Greater Paraburdoo Hub. The cane toad is not currently present in the Development Envelope.
	4.2 Test the efficacy of control measures for cane toads and whether they allow local persistence of quoll populations	
Maintain secure populations and source animals for future reintroductions/ introductions, if they become appropriate	5.1 Manage translocated populations of Northern Quolls on Astell and Pobassoo Islands	The Proposed Action will not be impacting areas of suitable Northern Quoll habitat protected in National Parks and Conservation Agreements.
	5.2 NT and WA to maintain captive breeding populations of Northern Quolls	
	5.3 Protection of key secure populations through protection of habitat in National Parks and Conservation Agreements	
	5.4 NT and WA to determine the status of Northern Quolls on islands with suitable habitat and assess the potential for future translocations to these islands	
Reduce the risk of Northern Quoll populations being decimated by disease	6.1 Increase knowledge and vigilance of disease in Northern Quoll populations	The Proponent has completed baseline studies and a targeted survey to understand the population within the Development Envelope. The Proponent will also implement hygiene measures during construction and operation of the Greater Paraburdoo Hub to ensure introduction of disease is minimised.
Reduce the impact of feral predators on Northern Quolls	7.1 Assess the impacts of feral predators on populations of Northern Quolls	The Proponent will document invasive species within the Development Envelope.
	7.2 Implement efforts to protect key Northern Quoll populations from the impacts of feral predators	
Raise public awareness of the plight of Northern Quolls and the need for biosecurity of islands and WA	8.1 Develop new and promote existing materials for educating the public on the need for quarantine measures at important island habitat for quolls and along major routes westward into Western Australia	The Proponent will implement measures that include site inductions for all onsite personnel to ensure environmental awareness is raised and to also identify onsite threats to Northern Quoll populations.
	8.2 Provide materials and support to Indigenous rangers and other groups responsible for habitat critical to survival for Northern Quolls to educate their communities on the importance of cane toad and cat control and quarantine measures	
	8.3 Implement a broader public education and awareness campaign on quolls and feral species (particularly cane toads and cats)	
	8.4 Develop and implement public education and awareness campaign on land management threats to quolls	

A number of factors are considered to be threatening the survival of the species:

- inappropriate fire regimes;
- predation following fire; and
- lethal toxic ingestion of cane toad toxin.

The Cane toad (*Bufo marinus*) is yet to establish in the Pilbara and is not expected to be introduced by the Proposed Action; as such the actions documented in the *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads* (DSEWPaC 2011c) are not relevant to the Proposed Action as they relate to research and identification of cane toad impacts.

The five listed grasses in the Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (DSEWPaC 2012a) are:

- gamba grass (*Andropogon gayanus*);
- para grass (*Urochloa mutica*);
- olive hymenachne (*Hymenachne amplexicaulis*);
- mission grass (*Pennisetum polystachion*); and
- annual mission grass (*Pennisetum pedicellatum*).

None of these introduced taxa were identified to occur within or in the vicinity of the Development Envelope during database searches or recorded during the flora and vegetation assessments (Astron 2018a, b). As such the actions documented within this threat abatement plan are not relevant to the Proposed Action, with the exception that the Proponent is committed to minimising/preventing the spread/introduction of weed species to the Development Envelope. The Proponent will implement ground disturbance, flora management, and weed hygiene procedures as part of the EMP during construction and operation of the Greater Paraburdoo Hub to ensure weeds are controlled as far as practicable. The flora management procedure will also include regular and targeted weed control (e.g. by spraying, physical removal) as appropriate.

Cats have been recorded within the Development Envelope. Mine sites have the potential to attract/increase the abundance of introduced fauna due to the provision of additional resources (food scraps, water, shelter), and as such, the Proponent will record all introduced fauna sightings and will undertake feral animal control within the Development Envelope. As such, the Proposed Action will align with the *Threat abatement plan for predation by feral cats* (DoE 2015a).

The proposed action is not expected to interfere with the recovery of the Northern Quoll given:

- the on-ground management within the Development Envelope; and
- the extensive areas of potential foraging and breeding habitat close to the Proposed Action area as illustrated in Figure 10-1.

The Proposed Action is expected to be consistent with the recovery plan, in particular the protection and management of suitable habitat within the Development Envelope.

10.10.2. Pilbara Olive Python (*Liasis olivaceus barroni*)

The relevant plans and guidance documents for Olive Python are:

- Approved Conservation Advice for *Liasis olivaceus barroni* (Olive Python - Pilbara subspecies) (DEWHA 2008a)
- Threat abatement plan for predation by feral cats (DoE 2015a).

There are no adopted or made recovery plans for this species.

The *Approved Conservation Advice for Liasis olivaceus barroni (Olive Python - Pilbara subspecies)* (Conservation Advice) (DEWHA 2008a) was used to guide the assessment of the Proposed Action's potential impacts to this species and assist in the development of appropriate mitigations. The conservation objective is to minimise the risk of extinction of this species and support the recovery of the Olive Python through the implementation of priority recovery actions. The Proposed Action aligns with the Conservation Advice (DEWHA 2008a) as outlined in Table 10-14.

Table 10-14: Regional and local priority actions in the Conservation Advice for the Olive Python

Aspect	Actions	Proposed Action assessment
Habitat loss, disturbance and modification	Identify populations of high conservation priority.	The Proponent will implement management measures to ensure changes in hydrology are managed.
	Ensure road widening, maintenance activities, and gas infrastructure development (or development activities) in areas where the Olive Python (Pilbara subspecies) occurs do not adversely impact on known populations.	
	Manage any changes to hydrology which may result in changes to the water table levels, increased run-off, sedimentation or pollution.	
	Investigate further formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.	
Animal predation or competition	Implement Threat Abatement Plan for the control and eradication of foxes and cats in the local region	The Proponent will undertake feral animal Within the Development Envelope.
Conservation information	Raise awareness of the Olive Python (Pilbara subspecies) within the local community.	A site induction will be implemented for all onsite personnel to ensure environmental awareness for the species is raised.
	Use road signage to raise awareness of the Olive Python (Pilbara subspecies) with road users on or near roads.	
Enable recovery of additional sites and/or populations	Investigate options for linking, enhancing or establishing additional populations.	Not applicable to the Proposed Action.

Proposed Action will align with the *Threat abatement plan for predation by feral cats* (DoE 2015a) by managing the provision of additional resources (food scraps, water, shelter), recording all introduced fauna sightings and implement a control program if required, as documented in the EMP, to ensure invasive species are managed as far as practicable.

10.10.3. Ghost Bat

The relevant plans and guidance documents for Ghost Bat are:

- Approved Conservation Advice *Macroderma gigas* Ghost bat (TSSC 2016a).
- Threat abatement plan for predation by the European red fox (DEWHA 2008b).

There is no Recovery Plan for this species. However, the Threatened Species Scientific Committee (TSSC) have recommended a Recovery Plan be developed.

The *Approved Conservation Advice Macroderma gigas Ghost bat* (TSSC 2016a) was used to guide the assessment of the Proposed Action's potential impacts to this species and assist in the development of appropriate mitigations. The Proposed Action aligns with the Conservation Advice as outlined in Table 10-15.

Table 10-15: Regional and local priority actions in the Conservation Advice for the Ghost Bat

Aspect	Actions	Proposed Action assessment
Protect roost sites from mining, human disturbance and collapse	Where there are known roosts in proximity to mining or other activities, ensure disturbance is minimised by undertaking environmental assessment, considering alternative locations for works and impact mitigation measures	Targeted Ghost Bat surveys have been undertaken and 100 m mining restriction and exclusion zones will be established around Cave 6, 16, 17 & 18. Caves 12 and 15 will be captured within a mining exclusion zone to be established for the protection of the Threatened flora speciea *Aluta quadrata*.
	Assess impacts of disturbance of breeding sites and identify appropriate buffer zones for specific activities around roost sites so mining and other activities do not lead to abandonment.	
Modification to foraging habitat	Protect areas from disturbance, including the loss of habitat quality due to changes to fire and grazing regimes.	The Proposal has been designed to minimise loss of high value habitat.
Collision with fences, especially those with barbed wire	Avoid the use of barbed wire fencing as far as practicable	No barbed wire fences will be installed near roost sites in the Development Envelope.
Survey to better define distribution	Collate and review all information on Pilbara roost sites and identify banded-ironstone areas in all parts of the region that are planned for future mining or may be quarantined from mining.	Targeted Ghost Bat surveys have been undertaken in the Development Envelope.
Establish or enhance monitoring program	Monitor populations at key sites and where impacts from mining are occurring or likely.	The Proponent will continue to undertake population monitoring at significant Ghost Bat roosts.

Loss of roost sites, in particular maternity roosts containing breeding females, and nearby areas is identified as having potentially severe consequences. No loss of maternity roosts is proposed and the three important cave groupings likely to support breeding in Western Range will all be retained.

Five caves with occasional use will be removed and any removal of roost caves is considered significant under the Conservation Advice; however these caves were not identified as priorities for protection by Bat Call (2020b) and therefore, their removal is not expected to result in a decline in the local population.

Human disturbance to roosts is considered to have moderate to severe consequences, and both modifications to foraging habitat and collision with barbed wire fences are considered to have moderate consequences (TSSC 2016a). The Proponent will avoid the use of barbed wire fencing within the Development Envelope as far as practicable, noting the requirement for pastoralists, whose leases intersect the Development Envelope, to use barbed wire in stock fences. Where the use of barbed wire fencing is legislated, the top strand will be replaced with single strand wire and reflectors will be installed to deter bat interaction. Disturbance to the remaining 13 Ghost Bat roost caves will also be avoided. Other threats are identified but are not considered relevant to the Proposal.

The *Threat abatement plan for predation by the European red fox* is outlined in Section 10.4.3, Ghost Bat are a species that could be adversely affected. Some population declines could be attributable to competition for prey with foxes and feral cats (TSSC 2016a). Red fox *(Vulpes vulpes*) have not been recorded in the Development Envelope, therefore are not relevant to the Proposed Action.

10.10.4. Pilbara Leaf-nosed Bat

The relevant plans and guidance documents for Pilbara Leaf-nosed Bat are:

- Approved *Conservation Advice Rhinonicteris aurantia* (Pilbara form) (Pilbara Leaf-nosed Bat) (TSSC 2016b).

There is no Recovery Plan and no Threat Abatement Plan has been identified as being relevant for this species.

The *Approved Conservation Advice Rhinonicteris aurantia (Pilbara form) (Pilbara Leaf-nosed Bat)* (TSSC 2016b) was used to guide the assessment of the Proposed Action's potential impacts to this species and assist in the development of appropriate mitigations. The Proposed Action aligns with the Conservation Advice as outlined in Table 10-16.

Table 10-16: Regional and local priority actions in the Conservation Advice for the Pilbara Leaf-nosed Bat

Aspect	Actions	Proposed Action assessment
Discover new occurrences	During the planning and design stages of a new mine or expansion, ensure that placement of mine infrastructure on or near critical habitat of the Pilbara Leaf-nosed Bat discovered during pre-construction surveys is avoided	Targeted Pilbara Leaf-nosed Bat surveys have been undertaken in the Development Envelope
Discover new roosts	Confirm diurnal occupancy of suspected roost sites with an appropriate method, and estimate the actual or relative size of colonies in such roost sites using a robust non-invasive method with a demonstrable error rate	Targeted Pilbara Leaf-nosed Bat surveys have been undertaken in the Development Envelope
Confirm diurnal roosts	Establish permanent buffers around suspected or confirmed diurnal roosts to exclude all anthropogenic activities with the potential to negatively affect the colony, with buffer width dependent on local context, colony size estimates and information on alternative sites nearby	250 m mining exclusion zone placed around the known roost site in the Development Envelope.
Monitor the population	Implement a standardised monitoring programme to confirm continued presence and levels of activity at diurnal roosts, night refuges or in open habitats such as over pools. Baseline information should be collected as early as possible before works commence, methods should be non-invasive such as making acoustic or video recordings, the design should be standardised to allow long term comparisons and the programme should include triggers and contingencies in the event that a negative influence of nearby development-related activity is detected	The Proponent will continue to monitor the population of Pilbara Leaf-nosed Bats at Ratty Springs
Assess and protect foraging habitat	Minimise the loss of high value foraging habitat by considering it in the design of development projects	The Proposed Action has been designed to minimise loss to high value foraging habitat (including avoiding Riverine and Drainage Line habitat at Ratty Springs and in Pirraburdu Creek).
Protect roosts	Consider the location of diurnal roosts when designing and constructing roads, tracks and light sources to avoid mortality and localised decline of the Pilbara Leaf-nosed Bat through roadkill	The Proponent will implement management measures to minimise impact of light.

Aspect	Actions	Proposed Action assessment
Maintain water pools	Maintain existing natural water pools to encourage long term persistence in a project area	No impacts to the semi-permanent water features around Ratty Springs are predicted.
General public access	Restrict general access and entry to known or suspected roost sites	Public access restricted to the Development Envelope.
Artificial roosts	Consider the replacement of existing natural roost sites with artificially created habitat as a solution of last resort only	Not applicable. No artificial roosts in the Development Envelope.

As per the approved conservation advice (TSSC 2016b) the population of Pilbara Leaf-nosed Bat in the Pilbara is identified as an important population. Consequently, individuals within the Development Envelope would be considered to be part of an important population.