10Terrestrial Fauna

10.1 EPA Objective

The EPA's objective for the environmental factor Terrestrial Fauna is:

> "To protect terrestrial fauna so that biological diversity and ecological integrity are maintained" (EPA 2016b).

10.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to the key environmental factor Terrestrial Fauna which have informed the planning for the Proposal, are listed in **Table 10-1**.

HPPL has specifically considered these guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and its significance;
- Identification of activities which may lead to impacts to terrestrial fauna; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 10-1: Terrestrial Fauna Policy and Guidance

Author	Title	How Policy has been considered
EPA 2016e	Environmental Factor Guideline – Terrestrial Fauna	Considered in design (methods and approach) of the terrestrial fauna surveys or previous guidance (if survey undertaken before current guidelines).
EPA 2020a	Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment	
EPA 2016f	Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna	
EPA 2016g	Technical guidance – sampling of short-range endemic invertebrate fauna	
EPA 2021g	Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans	
Government of Western Australia (GoWA), 2011	WA Environmental Offsets Policy	The offset policy and guidelines have been considered in relation to the definition of significant residual impacts and the proposed offset strategy.
GoWA 2014	WA Environmental Offsets Guidelines	

Specific additional work required for assessment of the Proposal, relating to Terrestrial Fauna, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

10.3 Receiving Environment

10.3.1 Relevant Studies

A summary of the terrestrial fauna surveys undertaken for the Proposal and surrounding area is provided in **Table 10-2**. Terrestrial fauna survey coverage is shown in **Figure 10-2** to **Figure 10-5**. The survey effort for Short Range Endemic (SRE) is shown in **Figure 10-6**.

Surveys for the Development Envelope and the surrounding Mulga Downs area date back to 2013; however, for this assessment only contemporary surveys from 2018 to 2024 have been included. Historic and recent fauna surveys and assessments have been undertaken at various survey levels including desktop, basic, detailed and targeted within the Development Envelope and surrounds (**Table 10-2**).

All surveys were undertaken in accordance with the *Technical Guidance - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2020a) and the *Technical Guidance – Sampling of Short-range Endemic Invertebrate Fauna* (EPA 2016g) or earlier technical guidance.

The entire Development Envelope has been surveyed (**Figure 10-1**). The areas which were surveyed are referred to as the Survey Area for the purpose of this assessment and are more extensive than the Development Envelope of the Proposal.

The terrestrial fauna surveys undertaken from 2019 to 2022 were consolidated into one report - Attexo (2023) *Consolidated Terrestrial Fauna Report* which is provided as **Appendix 11c**.

Surveys post 2022 have been collated into the final data set and are included in this ERD.

There are two proposed exclusion areas – the Fauna Habitat Exclusion Zone (FHEZ) which is not within the Development Envelope, however it is referred to and discussed as a mitigation measure and to confirm areas of occupancy for significant fauna. The second area is the FHEZ Corridor which is an exclusion area within the Development Envelope. These are discussed in the context of mitigation for terrestrial fauna and have been included in survey data.

The FHEZ will not support any proposed mining related activities with the exception of proposed monitoring. The FHEZ Corridor will remain within the Development Envelope and will accommodate minor, low impact activities such as a communications tower and light vehicle access road, and monitoring activities. An infrastructure corridor is also proposed within the FHEZ Corridor however this will only be developed if the related Mulga Downs Hub and Rail Spur Proposal is approved. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub and Spur Proposal.

Table 10-2: Terrestrial Fauna Surveys and Studies

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Terrestrial fauna survey effort - overview					
ecologia 2020 **Appendix 11d**	Baseline Terrestrial Invertebrate Fauna (SRE) Level 2 Assessment.	March 2020	• Level 2 SRE Invertebrate Survey	• 18 dry pitfall sites over 1,376 trap nights. • 31 active foraging sites over 104 hours of foraging. • 18 Leaf litter and soil sampling sites.	• Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g). • Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
ecologia 2021a **Appendix 11a.1**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019 (Wet Season)	• Detailed Phase 1 Vertebrate Fauna Survey • Mulga East - (R47/0012) • Malay Wells - (E47/2117) • Proposed Rail Corridor - (E45/380, L45/381, L45/382, L45/447, E47/2044, E45/3593)	• 18 Systematic Trap Sites, 5,652 trap nights. • 22 Avifauna survey sites. 23.3 hrs surveyed. • 21 Acoustic recording sites and 42 recording nights. • 12 hrs nocturnal surveyed sites.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	**Survey Effort**	
		April 2020 (Dry Season)	• Detailed Phase 2 Vertebrate Fauna Survey • Mulga East - (R47/0012) • Malay Wells - (E47/2117) • Proposed Rail Corridor - (E45/380, L45/381, L45/382, L45/447, E47/2044, E45/3593)	• 18 Systematic Trap Sites, 6,160 trap nights. • 15 Avifauna survey sites. 12.3 hrs surveyed. • 25 Acoustic recording sites and 60 recording nights. • 36 hrs nocturnal surveyed sites.	• Survey Guidelines for Australia's Threatened Bats (DEWHaH 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
Biologic 2022a **Appendix 11b.1**	Mulga East Iron Ore Project: Mulga West Borefield and Mulga East Corridors Terrestrial Fauna Survey.	November 2021 (Dry Season)	• Dry Season Basic Survey and targeted fauna survey • Mulga West Borefield – (E47/1315) • Mulga East Southern Corridor – (L45/316)	• 6 Avifauna survey sites. 2.3 hrs surveyed. • 2 Acoustic recording sites and 8 recording nights. • 2 hrs active foraging, 0.8 hrs surveyed.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	**Survey Effort**	
		March 2022 (Wet Season)	• Wet Season Detailed Survey, including targeted surveys • Mulga West Borefield – (E47/1315) • Mulga East Southern Corridor – (L45/316)	• 5 Systematic Trap Sites, 1,820 trap nights. • 6 Avifauna survey sites. 9.1 hrs surveyed. • 12 Acoustic recording sites and 65 recording nights. • 7 hrs nocturnal surveyed sites. • 12 hrs active foraging, 11.3 hrs surveyed.	• Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017) • Survey Guidelines for Australia's Threatened Bats (DEWHaA 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
Biologic 2022b **Appendix 11b.2**	Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey	November 2021 (Dry Season)	• Dry Season Basic Survey and targeted fauna survey	• 6 Avifauna survey sites. 2.3 hrs surveyed. • 2 Acoustic recording sites and 8 recording nights. • 2 hrs active foraging, 0.8 hrs surveyed.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
		March 2022 (Wet Season)	• Wet Season Detailed Survey, including targeted surveys	• 5 Systematic Trap Sites, 1,820 trap nights. • 6 Avifauna survey sites. 9.1 hrs surveyed. • 12 Acoustic recording sites and 65 recording nights. • 7 hrs nocturnal surveyed sites. • 12 hrs active foraging, 11.3 hrs surveyed.	• Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017) • Survey Guidelines for Australia's Threatened Bats (DEWHaA 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline (ASA)	March 2023	• Area referred to as ASA. • Level 1 –Basic and targeted terrestrial vertebrate and SRE assessment • Mulga East - (E47/2044, L45/0687) • Pipeline – (E47/1729, E47/1315, R47/0014)	• 2 Systematic Trap Sites, 30 trap nights. • 5 Acoustic recording sites and 19 recording nights. • 9 Targeted survey and active forages over 9 hours searched.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia (DBCA, 2017); • Survey Guidelines for Australia's Threatened Bats (DEWHaA 2010) • Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
Attexo 2023 **Appendix 11c**	Consolidated Terrestrial Fauna Report	2023	Consolidated Report: consolidates reports completed up to 2021 for the MDIOM		• Statement of Environmental Principles, Factors, Objectives and Aims of EIA • Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g).
Spectrum 2024a **Appendix 11e**	Targeted Bilby & Night Parrot Survey	March 2024 May 2024	Targeted Bilby and Night Parrot surveys at the MDIOM Development Envelope and surrounding tenements (Malay Well E47/2117-1, Mine Area M47/1621 and Murrays Hill L45/316 (the Survey Area)) within potential habitat.		

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2024b **Appendix 11f**	Supplementary Targeted Fauna Survey	June 2024	The scope of this study was to undertake a single-phase, targeted terrestrial fauna survey, focusing on the potential occurrence of threatened species within the Survey Area (MDIOM 25,588.1 ha; FHEZ 793.6 ha) and where the MDIOM intersects with the Rail 8B Alignment		• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
Northern Quoll and Pilbara Olive Python Survey Effort					
ecologia 2021a **Appendix 11a.1**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• Motion sensor sites for 48 nights. • 20 hrs targeted searches	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
		July 2019	Phase 1 – Targeted significant fauna survey	• 42 motion sensor sites for 207 nights. • 45 cage traps over 315 trap nights • 20 hrs targeted searches, 12 hrs nocturnal searches.	
		April 2020	Detailed Phase 1 Vertebrate Fauna Survey	• 39 motion sensor sites. • 60 hrs targeted searches.	
		July 2020	Phase 2 – Targeted Significant Fauna Survey	• 39 motion sensor sites for 3,982 nights. • 100 hrs targeted searches, 36 hrs nocturnal searches. • 107 kms of UAV flight pathways.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Biologic 2022b **Appendix 11b.2**	Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey	November 2021	Basic Survey	• 3 motion sensor sites for 10 nights. • 1.25 hrs targeted searches.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
		March 2022	Detailed Phase 1 Fauna Survey	• 13 motion sensor sites for 88 nights. • 5 cage trap sites for 70 nights • 9.6 hrs targeted searches, 7 hrs nocturnal searches.	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Level 1 –Basic and targeted terrestrial vertebrate and SRE assessment	• 2 motion sensor sites for 30 nights. • 11.25 hrs targeted searches.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2024b **Appendix 11f**	Supplementary Targeted Fauna Survey	June 2024	Supplementary Targeted fauna Survey	• 25 motion sensor cameras at 14 sites – total of 989 trap nights (Northern Quoll) • 14 unbounded targeted searches • 34.8km was traversed	• Environmental Factor Guidelines – Terrestrial Fauna (EPA, 2016a). • Environmental Protection Authority (EPA) Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2020). • Survey guidelines for Australia's threatened mammals (DSEWPaC 2011a). • Survey guidelines for Australia's threatened bats (DEWHaA 2010). • Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b). • EPBC Act Significant impact guidelines 1.1 - Matters of National Environmental Significance (DotE 2013). • EPBC Act referral guideline for the endangered Northern Quoll Dasyurus hallucatus (DotE, 2016). •
Ghost Bat and Pilbara Leaf-nosed Bat Survey Effort					
ecologia 2021a **Appendix 11a.1**	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• 31 acoustic recording sites over 59 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
		July 2019	Phase 1 – Targeted Significant Fauna Survey	• 57 acoustic recording sites over 75 recording nights.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
		December 2019	Targeted Pilbara Leaf-nosed Bat Survey	• 70 acoustic recording sites over 70 recording nights.	• Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)
		March 2020	Long-term Pilbara Leaf-nosed Bat Survey	• 6 acoustic recording sites over 212 recording nights.	
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	• 18 acoustic recording sites over 18 recording nights. • 107km of UAV flight pathways.	
		July 2020	Phase 2 – Targeted Significant Fauna Survey	• 42 acoustic recording sites over 42 recording nights. • 81 Cave habitat assessments.	
		October 2020	Targeted Pilbara Leaf-nosed Bat Survey	• 28 acoustic recording sites over 28 recording nights. • 1 cave habitat assessment.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
ecologia 2021b **Appendix 11a.2**	Letter: Targeted Pilbara Leaf-nosed Bat Gap Analysis	March 2021	Targeted Pilbara Leaf-nosed Bat Gap Survey	• 16 acoustic recording sites over 16 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)
Biologic 2022b **Appendix 11b.2**	Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey	November 2021	Basic Survey	• 2 acoustic recording sites over 8 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)
		March 2022	Detailed Survey	• 12 acoustic recording sites over 65 recording nights.	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment	• 5 acoustic recording sites over 19 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) • Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g)

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
ecologia 2023a. **Appendix 11h**	Desktop Risk Assessment for the Pilbara Leaf-nosed Bat and Ghost Bat.	NA	A desktop review of the Pilbara Leaf-nosed Bat and Ghost Bat surveys undertaken as part of this assessment was completed by *ecologia* (2023a). The review consolidated all relevant survey work and was commissioned based on concerns surrounding the habitat usage by the two species. The review included an additional peer review by a specialist bat consultant on the work completed to date, in particular with respect to bat cave categories. This study is discussed in Section 13.3.5.		• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)
Specialised Zoological 2021 (in *ecologia* 2021a)	Review of Pilbara leaf-nosed bat activity Mulga East Project.	NA	Peer review by a specialist bat consultant on the bat work completed to date, in particular with respect to bat cave categories. Included a comprehensive peer review of the long-term data collected at MEC016. This study is discussed in **Section 9.3.2.5**		
LGA, 2024 **Appendix 27**	Environmental Noise Assessment – Mulga Downs Mining Operations	N/A	An assessment of the potential noise and vibration impacts from the proposed Mulga Downs Iron Ore Mine (MDIOM, the Proposal) on surrounding noise sensitive receptors including the Youngaleena and Wirrilimarra communities, heritage sites and bat caves.		• Environmental Protection (Noise) Regulations 1997 (the Regulations) • Australian Standard AS2021 Acoustics – Aircraft Noise Intrusion - Building Siting and Construction • AS 2187.2-2006 Explosives – Storage and use – Use of explosives • State Planning Policy 5.4 Road and Rail Noise
PSM, 2024 **Appendix 28**	Geotechnical Assessment of Bat Caves, Mulga Downs Iron Ore Project	November 2023; January 2024	Geotechnical assessments of bat caves in the vicinity of the MDIOP. The primary objective of the assessments was to qualitatively assess geotechnical stability of the caves, with regards to the potential vibrations from the Proposal.		Not applicable
Night Parrot Survey Effort					
ecologia 2021a	Mulga East Baseline Terrestrial	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	3 acoustic recording sites over 24 recording nights.	• Technical Guidance - Terrestrial vertebrate fauna surveys for

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
(Appendix 11a.1)	Vertebrate Fauna Assessment	April 2020	Detailed Phase 2 Vertebrate Fauna Survey	• 7 acoustic recording sites over 42 recording nights. • 33km of UAV flight pathways.	environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f)
Biologic 2022a **(Appendix 11b.1)**	Mulga East Iron Ore Project: Mulga West Borefield and Mulga East Corridors Terrestrial Fauna Survey.	March 2022	Detailed Survey	• 7 acoustic recording sites over 40 recording nights.	
Spectrum 2023a **(Appendix 11g)**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment	2 acoustic recording sites over 12 recording nights.	• Technical guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017)
Spectrum 2024a **Appendix 11e**	MDIOM Night Parrot and Bilby Targeted Survey	18-24 March 2024 (following heavy rain) May 2024	Targeted Night Parrot Survey in habitats identified as potential habitat.	• 12 Night Parrot recorders installed in areas of long unburnt spinifex, clay pans and near drainage lines • 30 Habitat assessments completed	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporous occidentalis*) in Western Australia (DPaW 2017)
Greater Bilby Survey Effort					

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Terrestrial Ecosystems 2013	Mulga East Baseline Terrestrial Vertebrate Fauna Assessment	2013	Level 2 Fauna Assessment	• 702 Habitat assessments and targeted searches • 500 camera trap nights at 100 sites	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Technical Guidance – Sampling methods for Terrestrial Vertebrate Fauna (EPA, 2016f) •
ecologia 2021a **(Appendix 11a.1)**		April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• 42 targeted habitat assessments undertaken. The targeted surveys involved surveying habitat known to support populations of the Bilby in Western Australia, including Acacia aneura (mulga) woodland/shrubland growing on ridges and rises which was surveyed extensively with a UAV during the survey.	
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	228 km of UAV flight pathways.	
Spectrum 2023a **(Appendix 11g)**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment ASA – solar farm, northern haul road and pipeline route to Mulga West	• 9 targeted searches within a total of 9 hours. Mulga Woodland habitat was targeted along the proposed pipeline route.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2024a **(Appendix 11e)**	MDIOM Night Parrot and Bilby Targeted Survey 2024	18-24 March 2024 May 2024	Targeted Bilby Survey Mulga Woodland and Drainage Line / Floodplains habitat	• 14 targeted Bilby searches • 30 habitat assessments	• Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) • Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
SRE Survey Effort					
ecologia 2020 **Appendix 11d**	Mulga East Short-range Endemic Invertebrate Fauna Assessment.	March 2020	Level 2 SRE Invertebrate Fauna Survey	• 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights) • 22 active foraging sites; 44 hours of active foraging. • 10 Leaf litter and soil sampling sites.	• Technical guidance – sampling of short-range endemic invertebrate fauna (EPA, 2016g)
Biologic 2022a **Appendix 11b.1**	Mulga East Iron Ore Project: Mulga West Borefield and Mulga East Corridors Terrestrial Fauna Survey.	April 2019	Detailed Phase 1 Vertebrate Fauna Survey	• 6 active foraging sites over 9 hours of foraging. • 6 Leaf litter and soil sampling sites.	
		April 2020	Detailed Phase 2 Vertebrate Fauna Survey	• 18 active foraging sites over 27 hours of foraging. • 18 Leaf litter and soil sampling sites.	

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Spectrum 2023a **Appendix 11g**	Mulga Downs Iron Ore Project (MDIOP) Solar Farm, Haul Road and Pipeline.	March 2023	Basic and targeted terrestrial vertebrate and SRE assessment	• 20 active foraging sites (10 hours of foraging). • 8 Leaf litter and soil sampling sites.	
Grey Falcon Survey Effort					
ecologia 2023b **Appendix 11i.1**	Mulga Downs Iron Ore Project – Desktop Risk Assessment for the Grey Falcon	NA	An additional desktop risk assessment was competed for the Grey Falcon (*Falco hypoleucos*) listed as Vulnerable (BC Act, EPBC Act) for the Proposal. The desktop reviewed the surveys undertaken for the Proposal and identified potential nesting habitat for the Grey Falcon.		EPA Environmental Factor Guideline: Terrestrial fauna (EPA 2016a) Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a) Survey Guidelines for Australia's Threatened birds (DEWHA 2010) Conservation Advice – *Falco hypoleucos* Grey Falcon (TSSC, 2020)
Spectrum 2023b **Appendix 11i.2**	Memo: Mulga Downs Iron Ore Mine, Targeted Grey Falcon Survey	August 2023	A targeted Grey Falcon (*Falco hypoleucos*) survey including induvial searches and suitable nests within potential nesting habitat during the nesting/breeding season (June to November). Survey area across the MDIOM tenements E47/1315, E47/2117-1, M47/1621 and L45/316.		
Aquatic Fauna					

Reference	Report	Survey year and month	Description		Guidance (Specific to target species)
			Survey Type and Area	Survey Effort	
Biologic 2023 **Appendix 24**	Mulga Downs Iron Ore Mine, Freshwater Claypans Desktop Assessment	N/A	A desktop assessment of the aquatic ecosystems of freshwater claypans in the vicinity of the Mulga Downs Iron Ore Mine. The assessment included database searches and a literature review to summarise the aquatic biota assemblages of the freshwater claypans in the vicinity of the Development Envelope, including taxa of significance. The search area for the Desktop Assessment comprised a 40 km radius from the central point of the Development Envelope (the Desktop Assessment Search Area). Tolerance of sensitive receptors to salinity and turbidity was reviewed in the literature and threats to the claypans assessed.		• This Desktop Assessment was carried out in a manner consistent with the following, where applicable: • Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) • Assessing and Managing Water Quality in Temporary Waters (Smith et al., 2020) • Environmental Factor Guideline, Inland Waters. • Statement of Environmental Principles, Factors, Objectives and Aims of EIA • Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016g). • Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020a)

Figure 10-1: Terrestrial Survey Extent

605000 610000 615000 620000 625000 630000 635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000

7590000 7585000 7580000 7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000 7525000

NANUTARRA RD

MUNJINA RD

GREAT NORTHERN HWY

Legend

- Development Envelope

Fauna survey

- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).
- Biologic Environmental Survey (2022).
- ecologia Environment (2020 and 2021)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 06-Nov-2024
Drawn By: dmills	Checked By: VC

Scale 1:250,000 at A3

0 4 8
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EXTENT

FIGURE 10.1

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EPBC\02_MapProjects\67751_MDIOM_EPBC_s156a_PER_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-2: Terrestrial Fauna Survey area for the Proposal

Fauna Habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Legend

- Development Envelope
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor
- Indicative Footprint

Sample site

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).
- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Roads (LGATE-195)

- Highway
- Minor Road

GREAT NORTHERN HWY

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

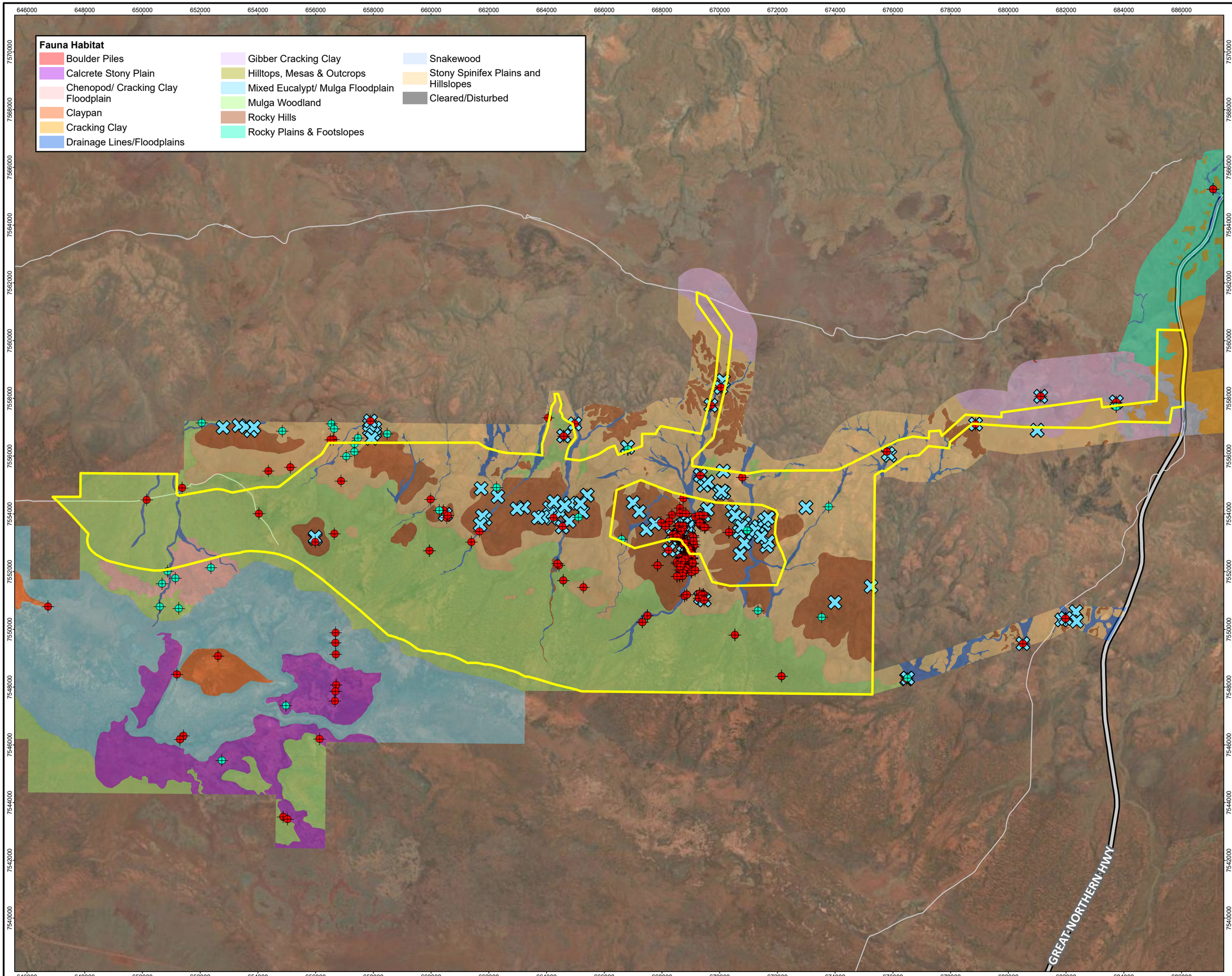
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT

FIGURE 10.2

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Figure 10-3: Terrestrial Fauna Survey Area for the Proposal (Acoustic, Avifauna and Nocturnal Survey Sites)



Legend

- Development Envelope
- Ultrasonic recording site
- Audio recording site
- Motion camera recording site

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

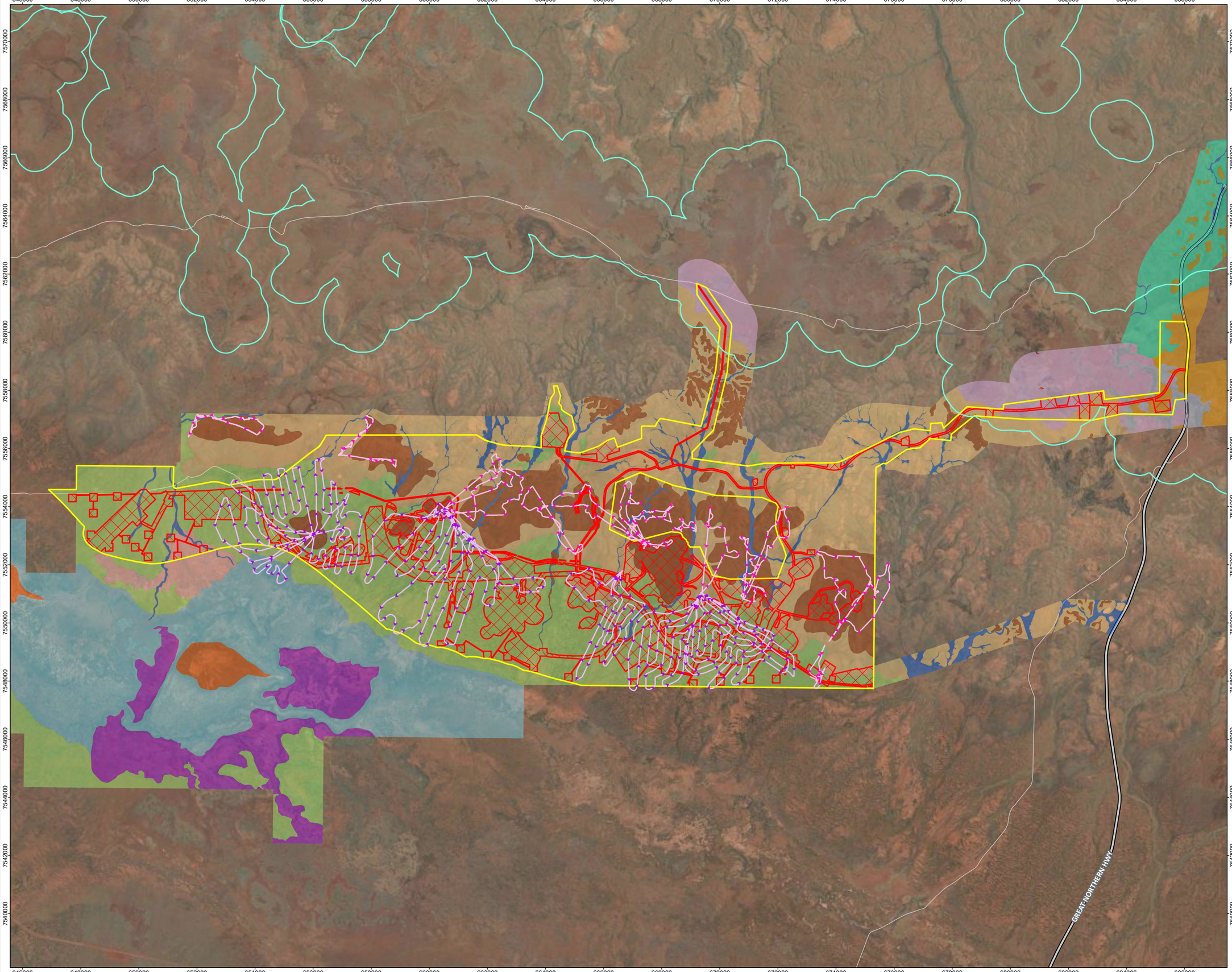
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY AREA FOR THE PROPOSAL (ACOUSTIC, AVIFAUNA AND NOCTURNAL SURVEY SITES).

FIGURE 10.3

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Figure 10-4: Terrestrial Fauna Survey area for the Proposal (UAV Survey Sites)



Legend

- Development Envelope
- Indicative Footprint

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Night Parrot flight path UAV effort
- Bilby flight path UAV effort

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 27-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

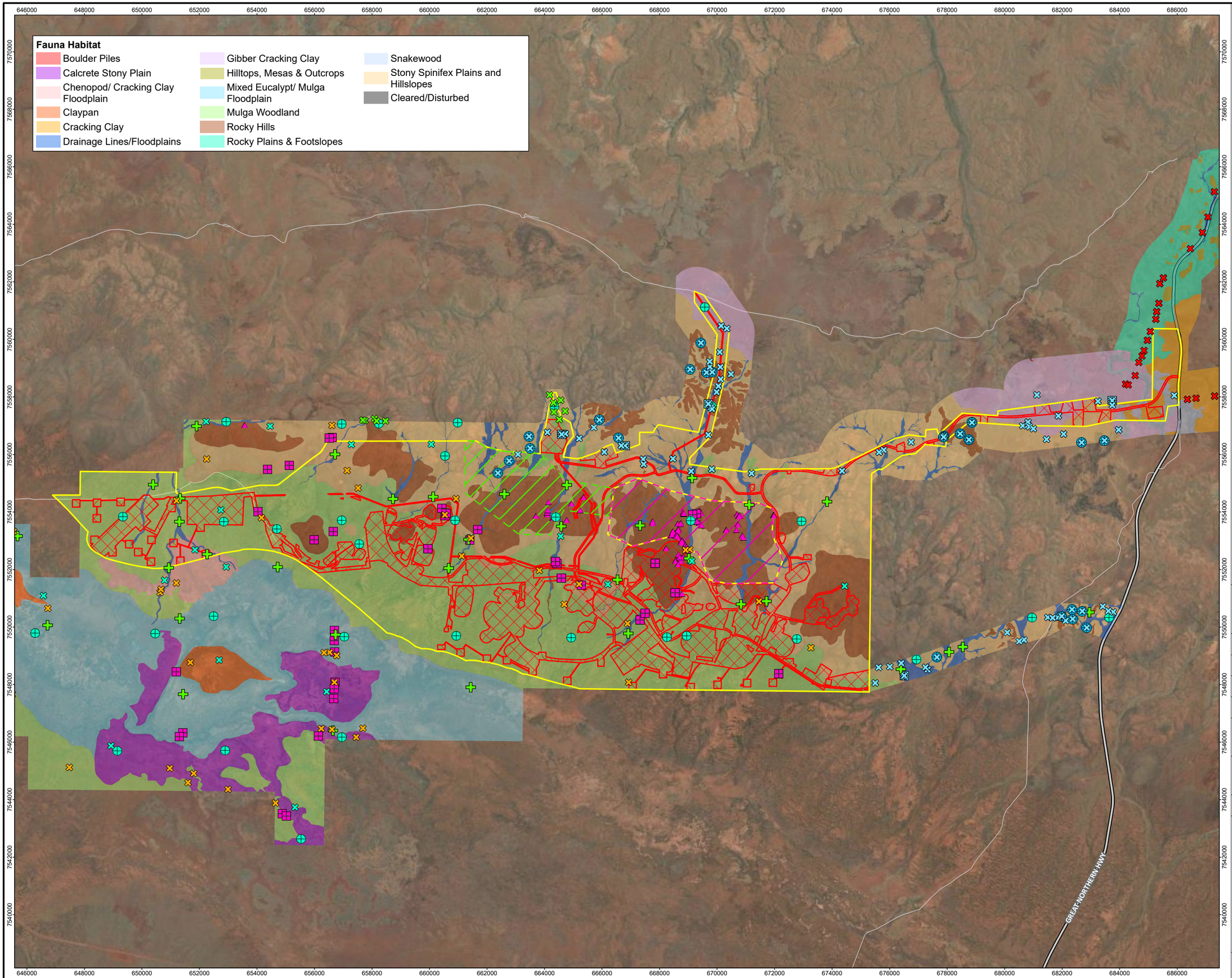
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT FOR THE PROPOSAL (UAV SURVEY SITES)

FIGURE 10.4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-5: Terrestrial Fauna Survey Effort (Habitat assessment, Cave assessment, Systematic Trapping and Targeted Survey)



Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor
- Fauna Habitat Exclusion Zone (FHEZ)

Habitat Assessment

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Targeted Survey

- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)

- Spectrum Ecology & Spatial (2023).

Systematic Trapping

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment

- ecologia Environment (2020).
- ecologia Environment (2021).

Roads (LGATE-195)

- Highway

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 1 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Habitat Assessment

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Targeted Survey

- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)

- Spectrum Ecology & Spatial (2023).

Systematic Trapping

- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment

- ecologia Environment (2021).

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 01-Apr-2025

Drawn By: dmills | Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

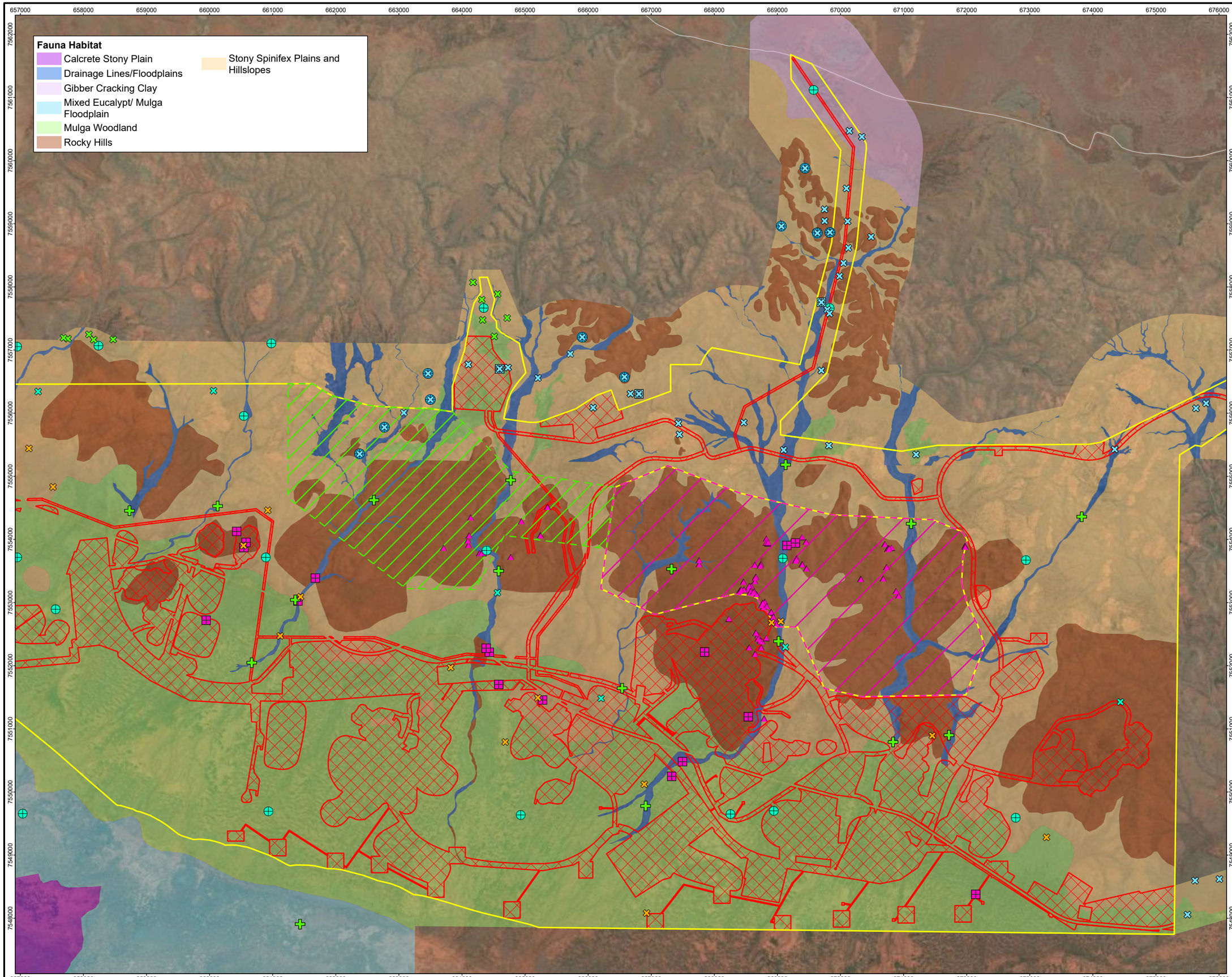
Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 2 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor
- Fauna Habitat Exclusion Zone (FHEZ)

Habitat Assessment

- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2023).
- Spectrum Ecology & Spatial (2024).

Targeted Survey

- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)

- Spectrum Ecology & Spatial (2023).

Systematic Trapping

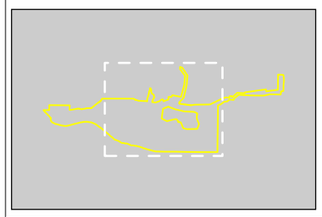
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment

- ecologia Environment (2020).
- ecologia Environment (2021).

Roads (LGATE-195)

- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 3 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Habitat Assessment
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- Spectrum Ecology & Spatial (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey
- Biologic Environmental Survey (2022).
- Spectrum Ecology & Spatial (2024).

Targeted Survey (Grey Falcon)
- Spectrum Ecology & Spatial (2023).

Systematic Trapping
- Biologic Environmental Survey (2022).
- ecologia Environment (2020).
- ecologia Environment (2021).

Cave Assessment
- ecologia Environment (2020).
- ecologia Environment (2021).

Roads (LGATE-195)
- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC
Scale 1:55,000 at A3	

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TERRESTRIAL FAUNA SURVEY EFFORT (HABITAT ASSESSMENT, CAVE ASSESSMENT, SYSTEMATIC TRAPPING AND TARGETED SURVEY)

FIGURE 10.05 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-6: Short Range Endemic Survey Effort for the Proposal

SRE Sample Sites

Biologic Environmental

- Phase 1 - 6 active foraging sites over 9 hours of foraging, 6 Leaf litter and soil sampling sites.
  Phase 2 - 18 active foraging sites over 27 hours of foraging, 18 Leaf litter and soil sampling sites.

ecologia Environment

- 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights), 22 active foraging sites; 44 hours of active foraging, 10 Leaf litter and soil sampling sites.

SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 1 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

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ecologia Environment

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SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

Legend

- Development Envelope
- Indicative Footprint

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 26-Mar-2025

Drawn By: dmills | Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 2 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

SRE Sample Sites

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  Phase 2 - 18 active foraging sites over 27 hours of foraging, 18 Leaf litter and soil sampling sites.

ecologia Environment

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SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2 Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 3 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

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ecologia Environment

- 10 dry pitfall sites within prospective habitat types at 10 locations for a minimum of seven nights (700 trap nights), 22 active foraging sites; 44 hours of active foraging, 10 Leaf litter and soil sampling sites.

SRE Sample Site

- 20 active foraging sites (10 hours of foraging), 8 Leaf litter and soil sampling sites.

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

SHORT RANGE ENDEMIC SURVEY EFFORT FOR THE PROPOSAL

FIGURE 10.6 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.2 Vertebrate Fauna

10.3.2.1 Desktop Assessment

Each terrestrial fauna survey included comprehensive database searches (all surveys provided results within 40 km of the Proposal) and literature reviews consistent with EPA guidance (EPA 2020). As part of the Attexo (2023) consolidated report, contemporary searches (using a 40 km buffer) of mapping resources and databases were completed to identify any changes to records of conservation significant fauna (desktop study area).

Previously completed assessments within the desktop study area were reviewed for conservation significant fauna and SREs which may occur. From this desktop review, the following information was collated for each fauna species of known conservation significance with potential to occur:

- Conservation status (EPBC Act, BC Act, DBCA listing);
- Description of habitat requirements;
- Description of previous records; and
- Distance of record to the Proposal.

Conservation significant fauna with the potential to occur in the Development Envelope were assigned a likelihood of occurrence rating according to the criteria set (**Table 10-3**). While there was some variation between assessments, the criteria for the rating were similar and comparable. Criteria included assessing the distance of the record from the Proposal (historical database records considered not accurate were excluded if required), presence of appropriate habitats within the Survey Area (using geology, vegetation mapping, and/or aerial imagery), and time passed since a fauna record.

Table 10-3: Likelihood of Occurrence

Likelihood	Criteria
Recorded	The species has been recorded within the Development Envelope previously or during the current survey.
Likely	The species may occur within the Development Envelope as suitable habitat is known to be present and there are existing records within 10 km of the Development Envelope.
Possible	The species may occur within the Development Envelope as there are existing records in the vicinity of the Development Envelope, and suitable habitat is likely to be present, OR the species may occur within the Development Envelope as there is insufficient information available to exclude the possibility of occurrence.
Unlikely	The species is unlikely to occur within the Development Envelope as suitable habitat is not present or is not likely to be present, OR suitable habitat is present within the Development Envelope, but the taxon/community has not been recorded despite reasonable survey effort.

The consolidated desktop and literature assessments undertaken as part of the *ecologia* (2021), Biologic (2022a, b) and Spectrum (2023a) fauna assessments identified 384 species of vertebrate fauna, which have previously been recorded in, or have potential to occur within, the desktop study area. This comprised:

- 49 mammals (43 native species and six introduced species);f
- 188 birds;
- 134 reptiles; and
- 13 amphibians.

Of these, 36 were considered conservation significant fauna and are listed in **Table 10-4**

Table 10-4: Conservation Significant Species Identified from Desktop and Literature Assessments

Scientific Name	Common Name	BC Act Status[1]	DBCA Status[1]
Mammals			
Dasycercus blythi	Brush-tailed Mulgara	-	P4
Dasyurus hallucatus	Northern Quoll	EN	-
Leggadina lakedownensis	Northern Short-tailed Mouse	-	P4
Pseudomys chapmani	Western Pebble-mound Mouse	-	P4
Macrotis lagotis	Greater Bilby	VU	-
Macroderma gigas	Ghost Bat	VU	-
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	VU	-
Birds			
Apus pacificus	Fork-tailed Swift	MI	-
Calidris acuminata	Sharp-tailed Sandpiper	MI	-
Calidris ferruginea	Curlew Sandpiper	CR	-
Calidris melanotos	Pectoral Sandpiper	MI	-
Calidris ruficollis	Red-necked Stint	MI	-
Charadrius veredus	Oriental Plover	MI	-
Elanus scriptus	Letter-winged Kite	-	P4
Falco hypoleucos	Grey Falcon	VU	-
Falco peregrinus	Peregrine Falcon	OS	-
Gelochelidon nilotica	Gull-billed Tern	MI	-
Glareola maldivarum	Oriental Pratincole	MI	-
Hirundo rustica	Barn Swallow	MI	-
Hydroprogne caspia	Caspian Tern	MI	-
Motacilla cinerea	Grey Wagtail	MI	-
Motacilla flava	Yellow Wagtail	MI	-

Scientific Name	Common Name	BC Act Status[1]	DBCA Status[1]
Pandion haliaetus cristatus	Eastern Osprey	MI	-
Pezoporus occidentalis	Night Parrot	CR	-
Plegadis falcinellus	Glossy Ibis	MI	-
Rostratula australis	Australian Painted Snipe	EN	-
Sternula albifrons	Little Tern	MI	-
Tringa glareola	Wood Sandpiper	MI	-
Tringa nebularia	Common Greenshank	MI	-
Actitis hypoleucos	Common Sandpiper	MI	
Reptiles			
Anilios ganei	Gane's Blind Snake	-	P1
Liasis olivaceus barroni	Pilbara Olive Python	VU	-
Ctenotus nigrilineatus	Pin-striped Finesnout Ctenotus	-	P1
Ctenotus uber johnstonei	Spotted Ctenotus	-	P2
Notoscincus butleri	Lined Soil-crevice Skink	-	P4
Underwoodisaurus seorsus	Pilbara Barking Gecko	-	P2

[1] Biodiversity Conservation Act: P1: Priority One, P2: Priority Two, P3: Priority Three, P4: Priority Four, OS: Other specially protected species, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory.

10.3.2.2 Field Surveys

A total of 236 terrestrial fauna species were recorded cumulatively from surveys undertaken by *ecologia* (2021a), Biologic (2022a, b), Spectrum (2023a) and Spectrum (2024 a, b). Records included 28 mammals, 121birds, 84reptiles and two amphibians (Attexo, 2023; Spectrum, 2023a). Native taxa recorded account for 79% of the species identified during the desktop assessment as occurring within the vicinity of the Proposal.

The 28 mammal species recorded within the survey area included 13 species of native ground dwelling mammals, nine species of bat and five eightfive introduced mammals. Ground dwelling mammal species recorded account for 57% of regional mammal species identified in database searches. Bat species recorded account for 75% of regional bat species identified in database searches.

The 121 bird species recorded from the surveys represent 63% of the regional bird species identified from database searches as having the potential to occur. A total of 63 species were predominantly woodland/shrubland canopy species, 18 species were ground dwelling, 17 species were nocturnal birds of prey, and 22 species were wading birds. One species was introduced – Zebra Dove (*Geopelia striata*) (Attexo, 2023; Spectrum 2023a).

The 84 species of reptile recorded during the surveys represent 63% of regional reptile species identified from database searches as having the potential to occur.

Two amphibian species, Little Red Treefrog (*Litoria rubella*) and Sheep Frog (*Cyclrana maini*) were recorded from the surveys representing 15% of regional amphibian species identified in the database searches as having the potential to occur.

Five introduced terrestrial fauna species were recorded during the surveys. This includes the domestic mouse (*Mus musculus*), feral cat (*Felis catus*), feral dog/dingo (*Canis lupus*), domestic cattle (*Bos taurus*) and the European red fox (*Vulpes vulpes*). Introduced species occur broadly across the Pilbara region and are not restricted to specific habitat types. Cats and foxes are classed as declared pests under the *Biosecurity Agriculture Management Act 2007* (BAM Act). As the Development Envelope is located around active pastoral leases, cattle were regularly observed during surveys.

10.3.3 Conservation Significant Fauna

A total of 11 conservation significant fauna (as categorised by the BC Act and under DBCA classification) have been recorded within the Development Envelope (Attexo 2023; Spectrum 2023a). This includes four migratory birds, which were recorded within the Gnalka Gnoona and Koodjeepindarranna claypans. These claypans are part of the Freshwater Claypans of the Fortescue Valley P1 PEC. They are not located within the Development Envelope; however, the Proposal has the potential to alter to hydrological regimes of the claypans and therefore the fauna species associated with these features have been considered in the assessment. A Glossy Ibis was recorded within the previously proposed Mulga West Borefield area which is also now outside of the Development Envelope (refer to **Section 2.3.3**).

A further six species are considered likely to occur based on historical records, although two species were considered to have a low likelihood based on habitat type – the Night Parrot and the Greater Bilby (**Table 10-5**).

Table 10-5: Conservation Significant Fauna within the Development Envelope (recorded and likely to occur)

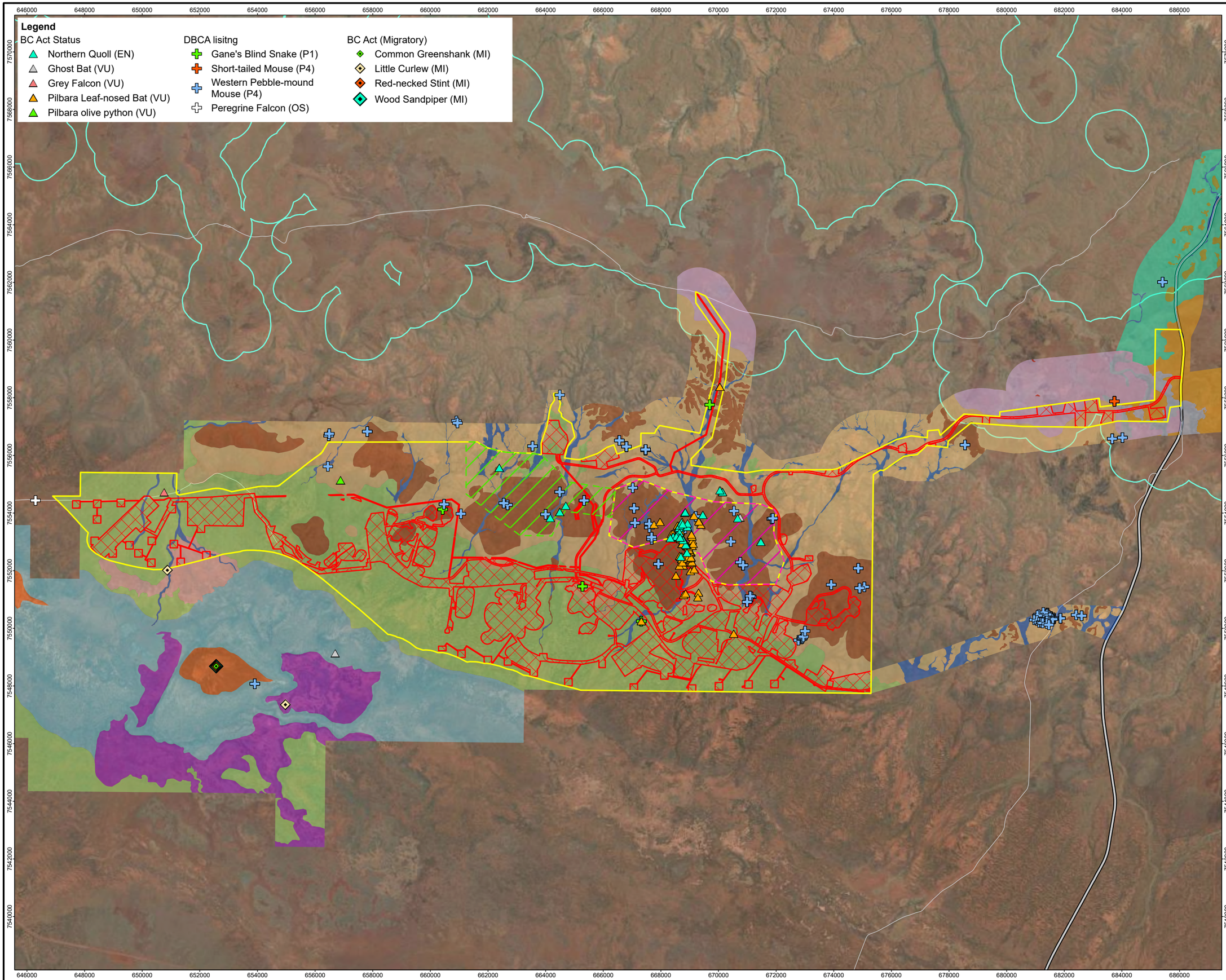
Species		**Conservation Status[1]**		**Occurrence**
Scientific Name	**Common Name**	**BC Act Status**	**DBCA Status**	
Mammals				
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	VU	-	Recorded
Macroderma gigas	Ghost Bat	VU	-	Recorded
Dasyurus hallucatus	Northern Quoll	EN	-	Recorded
Pseudomys chapmani	Western Pebble-mound Mouse	-	P4	Recorded
Dasycercus blythi	Brush-tailed Mulgara	-	P4	Likely
Leggandina lakedowensis	Northern Short-tailed Mouse	-	P4	Likely
Macrotis lagotis	Greater Bilby	VU	-	Likely (Low)
Birds				
Falco hypoleucos	Grey Falcon	VU	-	Recorded
Falco peregrinus	Peregrine Falcon	OS	-	Recorded
Calidris ruficollis	Red-necked Stint	MI	-	Recorded

Species		Conservation Status[1]		Occurrence
Scientific Name	**Common Name**	**BC Act Status**	**DBCA Status**	
Tringa glareola	Wood Sandpiper	MI	-	Recorded
Tringa nebularia	Common Greenshank	MI	-	Recorded
Plegadis falcinellus	Glossy Ibis	MI	-	Likely
Pezoporus occidentalis	Night Parrot	CR	-	Likely (Low)
Reptiles				
Anilios ganei	Gane's Blind Snake	-	P1	Recorded
Liasis olivaceus barroni	Pilbara Olive Python	VU	-	Recorded
Ctenotus uber johnstonei	Spotted Ctenotus	-	P2	Likely

[1] Biodiversity Conservation Act: P1: Priority One, P2: Priority Two, P3: Priority Three, P4: Priority Four, OS: Other specially protected species, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, MI = Migratory.

The species of conservation significance which have been confirmed within the Development Envelope, are discussed in detail in the following sections.

Figure 10-7: Conservation Significant Fauna Recorded in Relation to the Proposal



Legend

Development Envelope

Indicative Footprint

Fauna Habitat Exclusion Zone (FHEZ)

FHEZ Corridor

Priority Ecological Communties (DBCA)

Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

Boulder Piles

Calcrete Stony Plain

Chenopod/ Cracking Clay Floodplain

Claypan

Cracking Clay

Drainage Lines/Floodplains

Gibber Cracking Clay

Hilltops, Mesas & Outcrops

Mixed Eucalypt/ Mulga Floodplain

Mulga Woodland

Rocky Hills

Rocky Plains & Footslopes

Snakewood

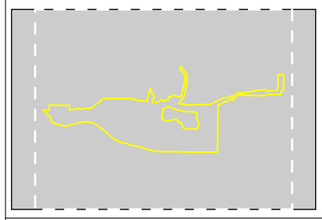
Stony Spinifex Plains and Hillslopes

Cleared/Disturbed

Roads (LGATE-195)

Highway

Minor Road



JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 1 2

Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

BC Act Status
- Northern Quoll (EN)
- Ghost Bat (VU)
- Grey Falcon (VU)
- Pilbara olive python (VU)

DBCA lisitng
- Gane's Blind Snake (P1)
- Western Pebble-mound Mouse (P4)
- Peregrine Falcon (OS)

BC Act (Migratory)
- Common Greenshank (MI)
- Little Curlew (MI)
- Red-necked Stint (MI)
- Wood Sandpiper (MI)

Legend
- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communties (DBCA)
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 2 of 4

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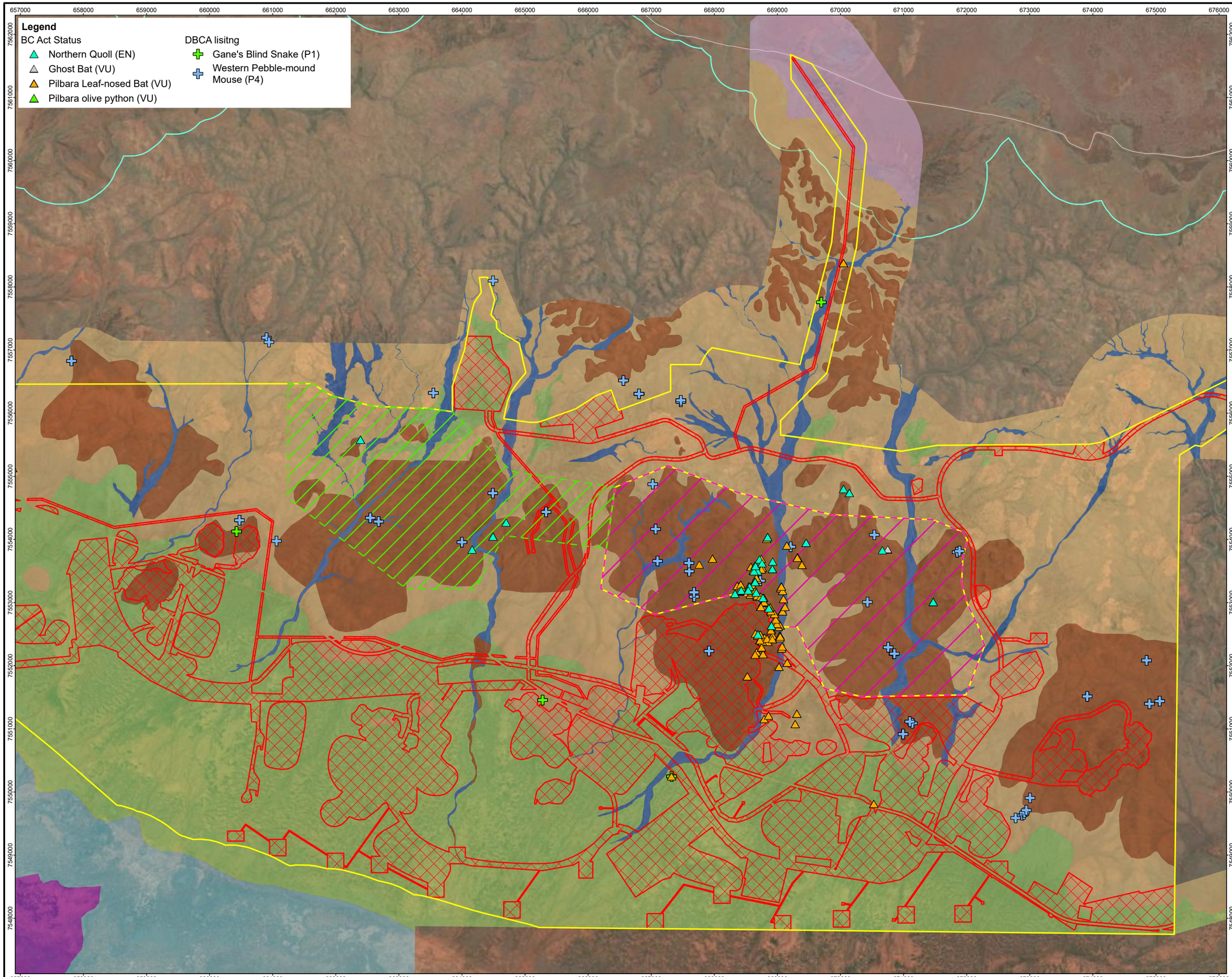


Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

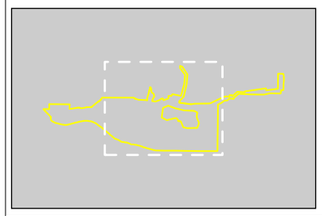
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road



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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 3 of 4

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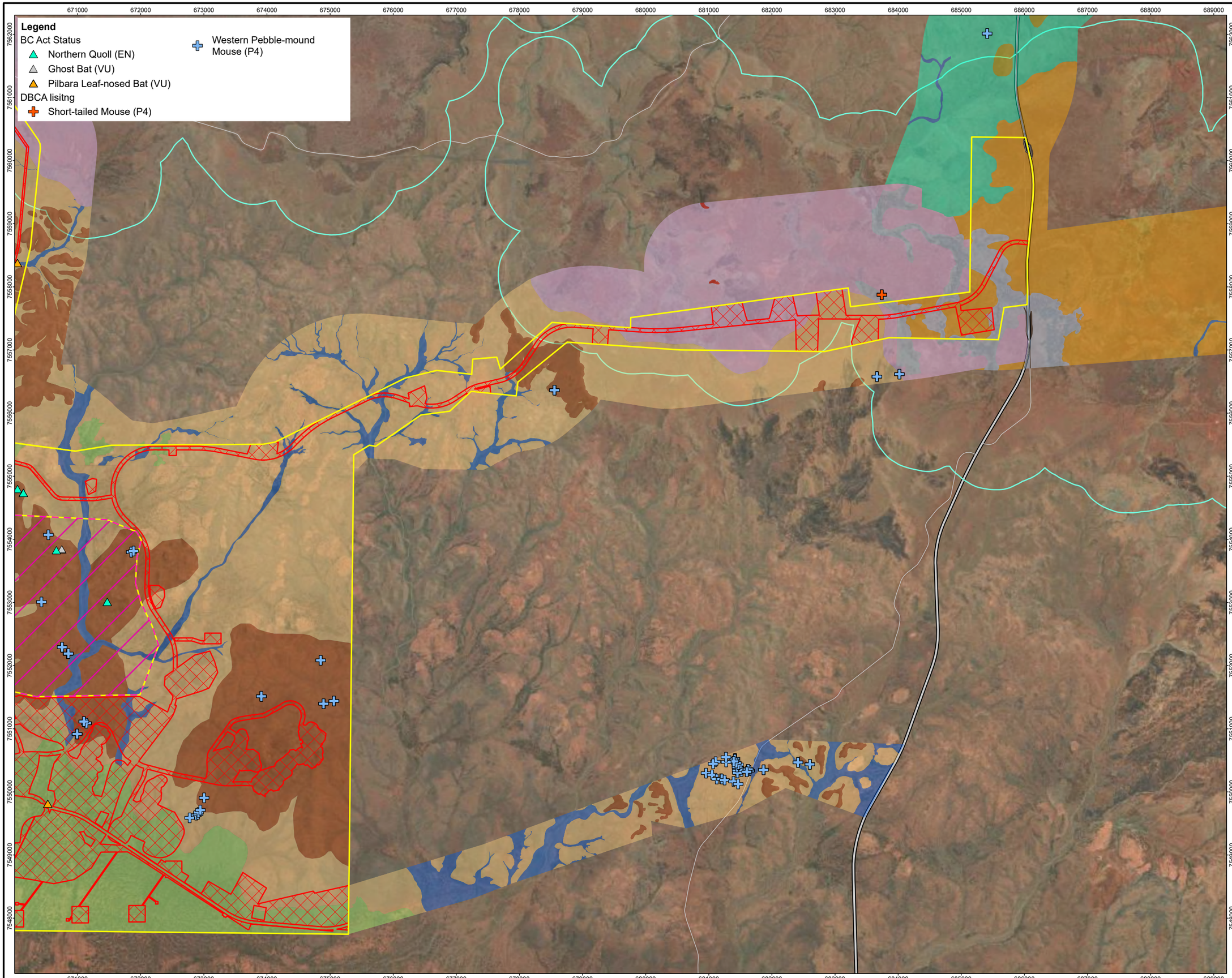


Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

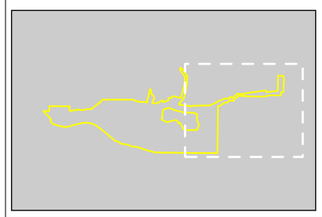
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road



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Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

CONSERVATION SIGNIFICANT FAUNA RECORDED IN RELATION TO THE PROPOSAL

FIGURE 10.7 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

10.3.3.1 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form))

Conservation Status: BC Act, Vulnerable

Distribution, Habitat and Ecology

The Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form*)* is the Pilbara form of the orange leaf-nosed bat and is listed as Vulnerable under the EPBC Act and BC Act. While it is considered a separate form, formal reclassification has been hampered by the small size of the Pilbara population which appear morphologically similar to the northern form (Armstrong 2008).

This small, insectivorous bat occurs throughout the Pilbara and adjacent upper Gascoyne regions of Western Australia (Threatened Species Scientific Committee 2016a). The species was listed as Vulnerable in Western Australia in April 2001 as it had undergone a substantial reduction in numbers, its geographic distribution is precarious for its survival (being limited to the Pilbara), the estimated total number of mature individuals is limited, and this number is likely to continue to decline (Threatened Species Scientific Committee 2016a).

The Pilbara leaf-nosed bat has specific and very restrictive roost requirements including caves, adits and disused mines with hot to very hot (28-32˚C) and humid (96-100%) microclimates (Armstrong 2001); (Churchill et al. 2008). Individuals rapidly dehydrate and die within a short period of time if removed from their roost (Bat Call 2016). During the dry season, prior to the heavy summer rains, Pilbara leaf-nosed bat colonies are believed to contract to the deepest mines and caves that maintain microclimates suitable for roosting (Armstrong 2001; Van Dyck and Strahan 2008; Bullen and McKenzie 2011).

At dusk, Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies, and large watercourses for insects (Van Dyck & Strahan 2008). The Pilbara Leaf-nosed Bat is a highly acrobatic flyer which is capable of intercepting prey in the air (McKenzie & Bullen 2009) and are commonly encountered over small pools of water in rocky gullies and gorges (*ecologia* 2023a).

Mating occurs in July and females give birth to a single pup in late December/early January, and young are weaned and independent by late February/March (Churchill, 1995; Armstrong, 2001). The Pilbara leaf-nosed bat is known to travel large distances (e.g., up to 45 km from diurnal roosts to forage; Bullen, 2023) with one male travelling more than 170 km over 12 months (Bullen and Reiffer, 2020). Genetic studies have identified some evidence of female philopatry (Armstrong, 2006; Umbrello *et al*., 2022). The Pilbara Leaf-nosed Bat is relatively long-lived, with an estimated life span of eight to ten years (Umbrello *et al*., 2022).

Permanent diurnal roosts have been detected throughout most of the Chichester and Hamersley subregions of the Pilbara, with a small number also found in the nearby Ashburton (south) and Little Sandy Desert (east) bioregions (Bat Call WA, 2021b). Colony members begin to depart their roosts (cave or mine adits) at, or soon after, dusk civil twilight and, except for the coldest winter months, the last individuals arrive back to the roost just prior to the dawn civil twilight (Bullen and Reiffer 2021).

Foraging in a variety of habitats including the characteristic *Triodia* hummock grasslands of the Pilbara, the Pilbara Leaf-nosed Bat favours the highly productive and structurally complex riparian zones where water is permanently available and insect biomass is sufficiently high (Armstrong, 2001; McKenzie and Bullen, 2013). Females are highly dependent on foraging habitat within close proximity to maternal roosts, especially during

lactation (Woinarski *et al*., 2014). As such, diurnal roost sites (deep caves within banded ironstone strata and disused underground copper/gold mines; McKenzie and Bullen, 2013) are typically located within flying range (i.e., 5-7 km) of permanent water (Bullen 2023). Seasonal variation in intra-regional presence, corresponding with lower temperatures and higher humidity (i.e., April/May), has also been documented with bats travelling > 20 km from permanent diurnal roosts to occupy non-permanent roost caves (Bat Call WA, 2021b).

At least 10 caves and underground mine sites in the Pilbara have been confirmed as permanent diurnal roost locations (Category 1) and in some cases these roosts also function as breeding sites (DCCEEW 2016b).

Bat Call (2021b) has since modified the 2016 conservation advice for this species, and underground refuges used by Pilbara Leaf-nosed Bat can be placed into the below categories:

- Permanent diurnal (categories 1 and 2) roosts

Category 1 permanent roosts are maternity roosts where seasonal presence of young is proven. These often have large colonies present. Category 2 permanent roosts are occupied year-round but without the proven presence of young. Based on wet season presence, these must also be classed as maternal sites, and these often have smaller colonies present. Both categories are considered as critical habitat that is essential for the daily and long-term survival of the Pilbara Leaf-nosed Bat.

- Semi-permanent diurnal (category 3) roosts

These are used diurnally during some part of the year, but not occupied year-round. They may be used during the breeding cycle and may facilitate long distance dispersal in the region, particularly in the autumn. They are often associated with a nearby Category 1 or 2 permanent roost as a ‘satellite’ roost, that together make up a colony. They are considered as critical habitat that is essential for the long-term survival of the Pilbara Leaf-nosed Bat.

- Nocturnal refuge (category 4) roost

These are occupied or entered at night for resting, feeding, or other purposes, with perching not a requirement. These are not considered critical habitat but are important for persistence in a local area. Most moderately deep caves and shallow abandoned mines fall into this category.

The nearest known Pilbara Leaf-nosed Bat roost locations to Proposal is at Rio Tinto Iron Ore’s Koodaideri mine, approximately 70 km to the south-east. The Mt Webber roost is approximately 80 km to the north-east of the Proposal. There is a Category 1 or 2 roost in the vicinity of Wittenoom (as shown in Figure 1, Bat Call (2021b)) approximately 25 km -35 km to the southwest of the Development Envelope (*ecologia* 2023a).

- Foraging habitats

The Pilbara Leaf-nosed Bat has been observed foraging in a variety of habitats such as *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (DCCEEW 2023b).

Seasonal variation in intra-regional presence, corresponding with lower temperatures and higher humidity (i.e., April/May), has also been documented with bats travelling > 20 km from permanent diurnal roosts to occupy non-permanent roost caves (Bat Call WA, 2021b). Given the lack of understanding around which habitats are

necessary to sustain a roosting colony, it is difficult to define the specific critical foraging habitat for the species (DCCEEW 2016b). According to the Conservation Advice for the Pilbara Leaf-nosed Bat, foraging habitats are categorised as follows:

- Gorges with pools (Priority 1)—watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months, sites of relatively large biomass production, sometimes containing caves.
- Gullies (Priority 2)—primary drainage with limited riparian development in upland rocky habitats, sometimes containing small pools that may last for weeks, with less biomass production than Priority 1 gorge habitat.
- Rocky outcrop (Priority 3)—areas of exposed rock at the top of rocky outcrop and mesa hills that contain caves and overhangs, and boulder piles in the granite terrains.
- Major watercourses (Priority 4)—riparian vegetation on flat land plus the main gravelly or sandy channel of the riverbed, sometimes containing pools that persist for weeks or months, and generally supporting higher productivity of biomass than the surrounding habitats.
- Open grassland and woodland (Priority 5)—dominated by *Triodia,* on lowland plains, colluvial slopes and hilltops.
- This species is most commonly encountered over small pools of water in rocky gullies and gorges (refer to Attexo 2023).

Surveys

Surveys completed for the Proposal targeting the Pilbara Leaf-nosed Bat included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- *ecologia* (2021b) Mulga East Pilbara Leaf-nosed Bat Assessment (**Appendix 11a. 2**);
- Biologic (2022a) Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey (**Appendix 11f**).

Additionally, a desktop risk assessment was prepared by *ecologia* (2023a) (**Appendix 11h**) to confirm the classification of bat caves - confirming the presence or absence of any Category 1, 2, or 3 caves within or immediately adjacent to the Development Envelope.

Prior to this several additional surveys were undertaken by *ecologia* with peer reviews and advice provided by Bat Call and Specialized Zoological after analysis of the acoustic recordings to address the possibility of a Category 1 roost in the Development Envelope. The surveys included multiple basic, detailed, and targeted survey events conducted between April 2019 and March 2022. These surveys were undertaken according to State and Commonwealth guidelines and best practice methods. The detailed surveys were conducted following

the period of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken for the first year of the *ecologia* (2021b) survey program were prior to the release of the currently accepted Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA, 2020), and were therefore undertaken in accordance with EPA (2016a). All other surveys by *ecologia* (2021b), and the Biologic (2022a) survey program were conducted using methodologies from the latest Guidance.

SongMeters (SM2) ultrasonic bat recorders were deployed at each systematic trapping site and at prospective foraging and or roosting locations (caves) potentially utilised by bat species throughout the Development Envelope. These Autonomous Recording Units (ARUs) have a high sampling frequency, enabling the full spectrum of bat calls to be recorded without being transformed, allowing greater accuracy and sensitivity. Omnidirectional microphones were used on all devices and placed 1m off the ground in open habitats and pointing at cave entrances or inside caves (*ecologia* 2023a). Bat calls were provided to R. Bullen of Bat Call for analysis and reporting (Bat Call reports #1, #2 and #3 in *ecologia* 2021a). The data was also reviewed by Dr Kyle Armstrong and a report prepared (Appendix K in *ecologia* 2021a).

Cave habitat assessments were completed and any potential Pilbara Leaf-nosed Bat roost caves within the Mulga East portion of the Development Envelope were evaluated. These assessments included a review of the cave morphology, geology, and the condition of the caves to identify which were potentially suitable for ghost bats as maternity and/or roost caves (*ecologia* 2021b). These surveys were undertaken prior to the publication of Bat Call (2021) however the methods align with those outlined in the survey requirements recommended in this guidance document. All surveys were undertaken according to the survey guidelines for Australia's threatened bats (DEWHA 2010a) and were peer reviewed by Dr Kyle Armstrong (Appendix K in *ecologia* 2021a).

An Unmanned Aerial Vehicle (UAV) was used to identify potential cave habitat within Rocky Hills over the extent of the Development Envelope, and subsequently traversed on foot to undertake cave habitat assessments with the aim of outlining potentially suitable roosting caves for the Pilbara leaf-nosed bat (*ecologia* 2023a).

Long-term bat detectors (deployed for between 76-79 consecutive recording nights) were established at one cave (MEC016) and five sites (not cave entrances) to determine continued presence of this species (*ecologia* 2023a).

The total survey effort undertaken for the Pilbara Leaf-nosed Bat (*ecologia* 2021b) and Biologic (2022a) included:

- recording echolocation calls using ARUs at 268 sites over 577 recording nights;
- 107 kms of UAV flights;
- 82 cave habitat assessments; and
- long-term bat detectors at six sites.

The survey effort is considered adequate as the Development Envelope has been surveyed over multiple seasons six months apart and the detector nights far exceeded the minimum requirements.

Occurrence in the Development Envelope

Pilbara Leaf-nosed Bats calls were recorded consistently across all surveys and seasons. The consensus of these studies was that Pilbara Leaf-nosed Bats were likely present in the Development Envelope year-round, but that there were likely no permanent roosts (Category 1, 2 or 3 roosts). All echolocation recordings were analysed by bat specialists Dr Kyle Armstrong and Bob Bullen. A review of surveys, interpretations of presence, and the use of caves by Pilbara Leaf-nosed bats was undertaken by Dr Kyle Armstrong (Specialised Zoological 2023).

During extensive searches for a potential permanent roost (Category 1 or 2 caves), 82 structures were found and 51 considered to be potential Category 4 roosts (occupied or entered at night for resting, feeding or other purposes). Pilbara Leaf-nosed Bats were recorded at 22 of them (**Figure 10-8**). Of the 51 caves, 36 Category 4 Nocturnal Roosts which have been identified as suitable for the Pilbara Leaf-nosed Bat are located within the FHEZ, and a further six are located in the FHEZ corridor. All caves with the potential to be used as a diurnal roost have been surveyed and there is no evidence to suggest a Category 1, 2 or 3 diurnal roost is present within the Development Envelope (*ecologia* 2023a). Several additional targeted surveys were completed by *ecologia* (2021b) to assess if a Category 1 roost existed close to the cave MEC016 (refer to *ecologia* 2023b). The source of the Pilbara Leaf-nosed Bats within the MDIOM remains nebulous, with the likelihood that there is a roost within approximately 40 km that foraging bats may fly from the home roost (Bat Call WA 2021). Without a permanent roost, the bats that are year-round but infrequent visitors are likely using the MDIOM as a foraging area or transiting through the MDIOM to or from the (assumed) nearby roost.

Habitat considered critical for this species includes Category 1, 2 or 3 roosts, as defined in Bat Call WA (2021b). Foraging habitat within 10 km radius of Category 1, 2 or 3 caves is also considered critical as is any permanent water source within 5 km – 7 km (according to literature, refer to Northover et al 2023).

Considerable survey effort undertaken within the Development Envelope has failed to locate permanent water sources within the area (Priority 1 habitat). Semi-permanent water sources within creek lines (small pools) may be found within the area following rain that may persist for weeks or months (*ecologia* 2023a).

No habitat considered to be critical for the survival of the Pilbara Leaf-nosed Bat was identified in the Development Envelope. Gorges bounded by sheer rock walls containing water lasting weeks or months typical of the Wittenoom and Karijini gorges are considered to be Priority 1 foraging habitat (TSSC 2016) are absent from the Development Envelope. Rocky Hills within the Development Envelope support Priority 2 and Priority 3 foraging habitat, while Drainage Lines/ Floodplains support Priority 4 foraging habitat and Stony Spinifex Plains and Hillslopes and Mulga Woodlands support Priority 5 foraging habitat. A semi-permanent channel pool (water lasting up to 3 months) was noted during the Biologic 2022 survey and is shown in **Figure 10-8**. It lies outside of the Development Envelope within Drainage Lines/Floodplain habitat.

These habitat types are considered widespread in the Development Envelope and in a regional context (in Attexo 2023; Spectrum 2023a). Regular detections in all seasons within the target valley indicate that the Drainage Line/Floodplains are a preferred commuting and foraging area and considered high priority foraging habitat (*ecologia* 2021b), though no Category 1, 2 or 3 roosts were detected and therefore they are not considered critical. This is consistent with other studies in the Pilbara (Northover et al. 2023).

10.3.3.2 Ghost Bat (*Macroderma gigas*)

Conservation Status: BC Act, Vulnerable

Distribution, Habitat and Ecology

The Ghost Bat is the largest Microchiroptera bat in Australia, is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (Van Dyck and Strahan 2008). It has a patchy but widespread distribution across northern Australia.

In the past decade, surveys for environmental impact assessments (Bullen 2021) have indicated a Pilbara Ghost Bat population of approximately 1,850 (350 across the Hamersley Range and 1,500 across the eastern Pilbara) (Bat Call 2021a).

Armstrong and Anstee (2000) suggested that Ghost Bats occur in small groups within the Hamersley Ranges and may move about in a local area, possibly in response to disturbance, microclimate, or social factors. Most shallow caves, shelters, and deep overhangs in the Pilbara are used in at least an opportunistic manner by itinerant Ghost Bats and are considered as Category 4 refuges (*ecologia* 2023a).

Preferred roosting habitat in the Pilbara includes caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles (Woinarski et al. 2014). Ghost Bats have also been known to roost in large colonies within sandstone caves, under boulder piles and in abandoned mines (Churchill 1998). They disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop 1985, JBS&G 2022). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong & Anstee 2000).

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; however, the conservation advice for the species indicates that persistence of the species in the Pilbara depends on the physiologically benign day roosts found deep underground in humid, temperature stable caves (TSSC 2016a).

Suitable roosts are rare and the presence of active roosts in an area is considered by DCCEEW to be the most important indicator of habitat for Ghost Bats. These roosts are generally the primary focus of conservation and/or monitoring (DoE 2015b). Ghost Bats utilise and require a group of caves/shelters including maternity, day and night roosts that open onto a plain or riparian line that provides good foraging opportunities. Night roosts (or feed caves) are used 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 night roosts to consume prey it has captured in the surrounding area. These caves often contain Ghost Bat scats and/or feeding remnants (typically feathers and small animal bones). Day roosts are caves and disused mines that contain domed ceilings and are deeper and more complex than night roosts. They typically have one or more large chambers with additional fissures or chambers at the rear in the fully dark regions. They have a minimum roof height in the chambers of 2 m to 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. Day roosts can vary in importance from almost continued use to occasional use by small numbers of Ghost Bats (DoE 2015b).

Maternal roosts are day roosts that usually include an interior chamber that rises toward the rear trapping warmer, more humid air at the top. Maternal roosts generally have a stable temperature of 23°C to 28°C and moderate to high relative humidity.

The Ghost Bat has previously been recorded on 13 occasions in the vicinity of the Proposal according to DBCA data. There is anecdotal evidence of a known roost occurring approximately 30 km south of the Development Envelope across the Fortescue Valley, near Wittenoom in the Hamersley Ranges (Bob Bullen pers. comm in *ecologia* 2023a).

In some parts of its range, the Ghost Bat shares roosts with the Pilbara leaf-nosed Bat, Finlayson's Cave Bat (*Vespadelus finlayson*), Common Heath-tailed Bat (*Taphozous georgianus*), and possibly Hill's Sheath-tailed Bat (*Taphozous hilli*) (DCCEEW 2023e). Ghost Bats are known to move between several caves seasonally or as dictated by weather conditions (Hutson et al. 2001) and disperse widely when not breeding but concentrate in a relatively few roost sites when breeding (DCCEEW 2016a).

The Ghost Bat is strictly carnivorous and captures its prey mainly on the ground before returning to an established feeding site to devour its catch (van Dyck and Strahan 2008). Ghost Bats are surface foragers ambushing prey either on the ground or in the air (Woinarski et al. 2014). Hunting behaviour within foraging areas consists of observing and locating prey from stationary vantage points with brief flights to catch prey before intermittently changing vantage point (Tidemann et al. 1985).

There is currently little confirmed data on foraging habitat. Bat Call (2021a) notes research that indicates Ghost Bats can forage up to 12 km from their diurnal roosts. Bats transiting to distant sites have been recorded between 20 and 30 km from their diurnal roost in a night. The available GPS/satellite data (Bullen unpublished data in Bat Call 2021a) suggest that the bats prefer to forage on productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground. Isolated trees and trees on the edge of thin thickets on the plains, or trees along the edges of watercourse woodlands, appear to be preferred vantage points.

Extensive survey activity in the last decade has led to four proposed categories of roosting habitat used by Ghost Bats in the Pilbara region which are defined in the Bat Call (2021a) *A review of ghost bat ecology, threats and survey requirements*. These categories are:

- Category 1 maternity/diurnal roost sites with permanent Ghost Bat occupancy

There are several documented permanent roost caves and underground mines in northern Australia. These tend to have large but fluctuating populations (Bat Call 2021a). In the Pilbara, other than the large colonies (>100 individuals) in a number of historical underground mines for example, Klondyke Queen, Lalla Rookh and Bamboo Creek, very few such roosts in natural caves are documented. Usually, these caves are deep and dark, with one or more elevated roosting chambers that provide a stable microhabitat. Caves with proven permanent presence must all be assumed to be maternity caves, a source population for the surrounding district. They are therefore critical habitat for the ongoing presence of Ghost Bats in the area (Bat Call 2021a).

- Category 2 maternity/diurnal roost caves with regular occupancy

There are a number of Pilbara caves and adits where Ghost Bats have regular, but not continuous, presence over long periods. These caves have similar features as Category 1 caves but are often less complex with only a single inner chamber and are often in less productive areas that the bats only utilise periodically. These caves typically have several other caves, shelters, and overhangs within a few hundred meters. Together they make up an 'apartment block' grouping that supports the ongoing presence of the bats (Bat Call 2021a).

- Category 3 diurnal roost caves with occasional occupancy

There are many caves and adits where one to a few Ghost Bats roost occasionally, or rarely. Normally less well-developed structures, such places are often used as feeding sites (as evidenced by middens with food scraps) or temporary refuges. Surveys in recent years have identified numerous caves that have Ghost Bat scats or small food middens present but either no evidence of roosting bats or with rarely repeated presence observations (Bat Call 2021a).

When adjacent to Category 2 caves, these are considered to be a part of an 'apartment block' and are therefore critical habitat important for the ongoing presence of the species in the area. In contrast, isolated Category 3 caves are not considered critical habitat. However, these caves may enable the long-distance movement of individuals across a landscape, and therefore contribute to genetic exchange between neighbouring colonies (Bat Call 2021a).

- Category 4 nocturnal roost caves with opportunistic usage

Numerous observations suggest that the majority of shallow caves, shelters and deep overhangs in the Pilbara are used in at least an opportunistic manner by itinerant Ghost Bats. This may be anything from a single foraging visit to a longer visit, with a resting period or possibly a feeding session. Evidence of such visits is the widespread presence of small numbers of scats and/or food scraps found, or occasional echolocation calls recorded during surveys. These visits may or may not be repeated, depending on whether the bat is passing through a district or is a more permanent resident nearby. These are not considered critical habitat (Bat Call 2021a).

Surveys

Surveys completed for the Proposal targeting the Ghost Bat include:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a**); this assessment includes:
  - Phase 1 - Level 2 vertebrate fauna survey: 4- 16 April 2019
  - Phase 1 - Targeted conservation significant fauna survey: 22 - 30 July 2019
  - Targeted Pilbara leaf-nosed bat survey: 25 November to 2 December 2019
  - Long-term Pilbara leaf-nosed bat survey December 2019- March 2020
  - Phase 2 – Level 2 vertebrate fauna assessment: 14 – 27 April 2020
  - Phase 2 - Targeted conservation significant fauna survey: 29 June - 6 July 2020
  - Targeted Pilbara leaf-nosed bat Survey: 5 - 9 October 2020
  - *ecologia* (2021b) Targeted Pilbara leaf-nosed bat Gap Survey: 5 - 9 March 2021;

- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Spectrum (2023a) MDIOM Solar Farm, Haul Road & Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

The surveys included multiple basic, detailed, and targeted survey events between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken for the first year of the *ecologia* (2021b) survey program were conducted prior to the release of the currently accepted '*Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment*' (EPA, 2020), and were therefore undertaken in accordance with EPA (2016a). All other surveys by *ecologia* (in 2021a), and the Biologic (2022a) survey program were conducted using methodologies from the latest Guidance.

SM2 ultrasonic bat recorders were deployed at each systematic trapping site and at prospective foraging and or roosting locations (caves) potentially utilised by bat species throughout the Development Envelope. These ARUs have a high sampling frequency, enabling the full spectrum of bat calls to be recorded without being transformed, allowing greater accuracy and sensitivity. Bat calls were analysed by suitability qualified ecologists to determine which species were present within the Development Envelope (Attexo 2023).

A UAV was used to identify potential cave habitat within the Rocky Hills habitat type over the extent of the Development Envelope, and these areas were subsequently traversed on foot to assess cave habitat with the aim of outlining potentially suitable roosting caves for the Ghost Bat. These assessments included a review of cave morphology, geology, and cave conditions to narrow down the list of potential Ghost Bat maternity and/or roost caves (*ecologia* 2021b; 2023a).

Long-term bat detectors (deployed for between 76 to 79 consecutive recording nights) were established at one cave (MEC016) and five sites (not cave entrances) to determine continued presence of this species (*ecologia* 2023a). All caves with the potential to be used as roost sites have been surveyed using ARUs. The total survey effort undertaken for the Ghost Bat by *ecologia* (2021b), Biologic (2022a,b) and Spectrum (2023a; 2024b) included:

- Recording echolocation calls using Acoustic Recording Units (ARUs) at 299 sites over 831 recording nights;
- 107 km of UAV flights;
- 82 cave habitat assessments; and
- Long-term bat detectors at six sites.

A further desktop assessment was prepared by *ecologia* (2023a) and addressed the requirement to categorise all the caves within the Development Envelope (**Appendix 11h**). A comprehensive review of the long-term data collected at MEC016 was conducted by Specialised Zoological (2021b, 2023) and included in *ecologia* (2023a).

The survey effort is considered adequate as the Development Envelope has been surveyed over multiple seasons, six months apart.

Occurrence in the Development Envelope

Ghost Bat calls were recorded at one site (MDARU27) within the Mixed Eucalypt/Mulga Floodplain habitat type located in the Fortescue Valley (**Figure 10-9**). This area is not in the Development Envelope. Secondary evidence (such as feeding debris, scats) of the Ghost Bat was found at two sites (MEC001 and MEC030) (**Figure 10-9**). Both caves are located within the FHEZ, which is outside of the Development Envelope. MEC001 is considered a Category 4 nocturnal roost with occasional visitation from Ghost Bats. Cave MEC030 is a small cave with no diurnal roosting potential because there were open cracks in the cave ceiling and therefore cave humidity could not be maintained. Cave MEC030 was considered a nocturnal refuge and visitation only occasional. The majority of shallow caves, shelters and deep overhangs in the Pilbara are used in at least an opportunistic manner by itinerant Ghost Bats and are considered to be Category 4 nocturnal roosts (Bat Call WA 2021a). Within the Development Envelope, 51 caves were identified that possessed Category 4 cave attributes and considered to have opportunistic usage.

No known or potential Category 1, 2 or 3 (associated with "apartment blocks") caves exist within the Development Envelope, nor are documented within a 30 km radius. There is anecdotal evidence of roost caves south of the Fortescue Valley within the Hamersley ranges (Bob Bullen pers. comm in *ecologia* 2023a). Ghost Bat occurrence and habitation within the Development Envelope is low with only a few records of this species. A lack of deep caves limits the suitability for diurnal roosting for this species within the Development Envelope (*ecologia* 2023a).

After extensive survey effort, it is considered unlikely that a permanent Ghost Bat roost occurs within the Development Envelope. Previous acoustic surveys conducted to target the Pilbara Leaf-nosed Bat were also analysed for Ghost Bat calls and the absence of calls indicates that a Ghost Bat maternity roost is unlikely to occur within the Development Envelope (*ecologia* 2023a; Attexo 2023). Within the Development Envelope Rocky Hills habitat type is considered potential roosting habitat for the Ghost Bat. Drainage Lines/Floodplain, Stony Spinifex Plains and Hillslopes, Gibber Cracking Clay and Mixed Eucalypt/Mulga Floodplain (now excluded from the Development Envelope) are considered foraging habitat (open grassland and woodland). The record of the Ghost Bat within the Mixed Eucalypt/Mulga Floodplain indicates this species traverses the area (**Figure 10-9**).

Of the 82 cave assessments undertaken, 51 cave structures within the Development Envelope are considered as Category 4 (nocturnal refuges). It is unlikely a permanent Ghost Bat roost site exists.

A temporary water body (identified as a persistent channel pool in AQ2 2024b) was noted within the Development Envelope during a biological survey (Biologic, 2022a) (**Figure 10-9**). Two pools were located immediately adjacent to one another spanning a total length of approximately 40 m with a maximum depth of approximately 0.5 m. These pools are located within the northern infrastructure corridor. Camera traps were placed at this site in 2022 (Biologic, 2022a). A Pilbara Leaf-nosed Bat was recorded visiting the pool on an ARU. No taxa were recorded on any motion cameras. This pool does not fall within the Indicative Footprint and will be retained given the importance of this habitat. The Ghost Bat has the potential to forage in Rocky Hills, Stony Spinifex Plains and Hillslopes, Drainage Lines/Floodplain and Gibber Cracking Clay habitat types within the

Development Envelope (**Table 10-6**). However, given the absence of critical roosting habitat and permanent water sources in the Development Envelope, habitats present are considered to be of low value to Ghost Bats.

Figure 10-8: Pilbara Leaf-nosed Bat records and Category 4 nocturnal refuges

659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000

7559000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

MEC016

MEC012

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Fauna habitat

- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Pilbara Leaf-nosed Bat records [ARU]
- Category 4 nocturnal refuges
- MEC012 and MEC016
- Water feature

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:40,000 at A3

0 250 500
Meters

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PILBARA LEAF-NOSED BAT RECORDS AND CATEGORY 4 NOCTURNAL REFUGES

FIGURE 10.8

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Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar

Figure 10-9: Ghost Bat records and Category 4 Nocturnal Refuges

659000 660000 661000 662000 663000 664000 665000 666000 667000 668000 669000 670000 671000 672000

7559000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

MEC030

MEC001

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Fauna habitat

- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Ghost Bat (VU) records
- Category 4 nocturnal refuges
- MEC001 and MEC030
- Water feature

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 17-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:40,000 at A3

0 250 500
Meters

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GHOST BAT RECORDS AND CATEGORY 4 NOCTURNAL REFUGES

FIGURE 10.9

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Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar

10.3.3.3 Northern Quoll (*Dasyurus hallucatus*)

Conservation Status: BC Act, Endangered

Distribution, Habitat and Ecology

The Northern Quoll (*Dasyurus hallucatus* Gould, 1842) is listed as Endangered under the BC Act. The Northern Quoll range once extended continuously across northern Australia from Western Australia to south-east Queensland. The Northern Quoll has been in gradual decline in population density and distribution for the last 50 years. Studies have shown a rapid decline in populations soon after colonisation of an area by cane toads (*Rhinella marina*), deaths attributable to poisoning from consumption of the cane toad (CoA 2016). The Northern Quoll populations are now restricted to five separate land units across the Pilbara, the Kimberley, parts of the Northern Territory and near-coastal Queensland (DCCEEW 2023c). The Pilbara is regarded as the stronghold population for the species as, at present, the desert forms a barrier to the movement of the cane toad into parts of the Pilbara (Woinarski et al. 2014). However, given the progression of the cane toad, strategies are being developed to address their invasion of the Pilbara.

This species is predominantly nocturnal, however can be sighted in daylight hours during their breeding season as well as on overcast days (Oakwood 2008). Mating season is from June to August. At the end of the breeding season, the Northern Quoll population is comprised almost entirely of mature females and their young. Males do not survive to breed a second year, primarily the result of excessive energy expended during roving. Females may live for two or three years (Hill & Ward 2010), though rarely survive to produce a litter in the third year. Females usually raise a litter of up to eight young. Male die-off, in combination with the fact females usually breed only once, makes local populations highly vulnerable to extinction. The most common cause of adult mortality (excluding post-reproduction die-off) is predation by dingoes, foxes, feral cats as well as native predators (snakes, owls, and kites) (Maxwell et al. 1996; Oakwood 2008). In areas infested with cane toads, mortality from cane toad ingestion is now considered as a main cause.

While Northern Quolls do not have highly specific habitat requirements (Hill & Ward 2010), rocky habitats with rock crevices and caves support higher densities of Northern Quoll (van Dyck & Strahan 2008). Predominantly inhabiting dissected rocky escarpments, a male quoll can have a home range of more than 100 ha while a female occupies territories of up to 35 ha (van Dyck & Strahan 2008).

Surveys

A number of surveys to assess the presence of the Northern Quoll were undertaken;

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm, Haul Road & Pipeline: Vertebrate & Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and

- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Additional information on the presence of Northern Quolls within drainage lines which have been identified as their preferred habitat for foraging and dispersal is presented in Spectrum (2024a) Mulga Downs Iron Ore Mine (**Appendix 11f**).

Attexo (2023) *Mulga Downs Iron Ore Mine Consolidated Terrestrial Fauna Report* is a consolidation of the terrestrial fauna surveys undertaken prior to 2023 and included surveys for short-range endemic invertebrates (**Appendix 11c**).

Surveys were scheduled following the season when maximum rainfall typically occurs in the Eremaean September to April as per the EPA *Technical Guidance: Terrestrial Fauna Surveys* (EPA, 2016a). Surveys for the first year of the *ecologia* (2021b) survey program were conducted prior to the release of the currently accepted *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA, 2020), and were therefore completed in accordance with EPA (2016). All other surveys by *ecologia* (2021b), and the Biologic (2022a) survey program were conducted using methodologies from the latest guidance.

A combination of cage traps, motion sensor cameras, and opportunistic searches to detect dens and scats were employed to detect the presence/absence of Northern Quolls as well as to gather an understanding of habitat use and population dynamics (*ecologia* 2021a, Biologic 2022a,b; Spectrum 2024b). To comply with the referral guidelines (CoA 2016), trapping transects along linear rocky ridgelines in the Development Envelope were used to achieve optimal coverage of potential habitat (*ecologia* 2021a).

The *ecologia* (2021a) surveys deployed the use of a UAV to identify potential denning and shelter habitat within the Rocky Hills habitat. The drone covered approximately 107 km searching for prospective Northern Quoll habitat. Once suitable habitat was identified, motion sensor cameras (Reconyx HC500 HyperFire) were baited with sardines and placed in selected areas (*ecologia* 2021a). Survey effort and type are shown in **Figure 10-10.**

Cage traps, consisting of two larger wire-frame box traps were placed at each systematic trapping site and baited with sardines. Traps were cleared within three hours of sunrise each morning (*ecologia* 2021a). Cage traps were covered by hessian shades to reduce the likelihood of animals suffering from overheating, excess stress from being out in the open and protection from predators. All traps were removed following the completion of the systematic trapping program (as summarised Attexo 2023).

Surveys included targeted searches for secondary signs associated with Northern Quolls (tracks and scats etc.) within habitat considered suitable for this taxon. These searches were undertaken as part of the cave habitat assessment and included the placement of motion cameras. Searches were undertaken during each phase of the survey.

Nocturnal searches were undertaken within suitable habitat with the aid of a Pulser Helion XP28 thermal monocular. Thermal imaging scopes use infra-red light to detect heat signatures emitted by endothermic species such as the Northern Quoll. The surveys which included nocturnal searches are summarised in **Table 10-2**.

The total survey effort for the Northern Quoll included:

- Motion sensor camera traps at 132 sites over 5,429 trap nights;

- Cage traps at 50 sites over 385 trap nights;
- Targeted searches, including 229.73 hrs of targeted surveys and 55 hours of nocturnal searches, and 34.8 kms of transect;
- 34.8km of transect length; and
- 107 km of UAV flight pathways.

Occurrence in the Development Envelope:

The outcome of the earlier surveys (2019) recorded only two quolls, one male and one female, which were captured in cage traps on six occasions (*ecologia* 2021a). The motion cameras were triggered by three Northern Quolls on 58 occasions at six locations within the Rocky Hills habitat (**Figure 10-10**). The individuals were identified using spot patterns. The location of Northern Quoll scats is show in **Figure 10-10**.

The rainfall records prior to this survey (from 2017 to 2019) were considered to be below average for the survey area resulting in a low count. Low rainfall is known to impact the size of a Northern Quoll population. No Northern Quolls were detected during the Phase 2 survey despite camera traps being placed at 39 locations within habitat considered suitable for this species. Nocturnal spotlighting did not yield any records. Northern Quoll scats were noted at six locations within the Rocky Hills habitat, three of these locations are in the FHEZ (**Figure 10-10**) (*ecologia* 2021a).

Subsequent surveys in 2021 (Biologic 2022a, b) did not detect the presence of Northern Quolls. The two Phase surveys included targeted searches and camera traps at 25 sites spanning from the far west of the Development Envelope across to the Great Northern Highway.

Targeted searches for the Northern Quoll in March 2023 did not find evidence of Northern Quolls along the northern section of the Development Envelope (Spectrum 2023a). Motion cameras were placed in areas considered suitable; however, none were triggered by Northern Quolls. Targeted searches did not yield any results either (Spectrum 2023a). No Northern Quoll dens were found during any of the terrestrial fauna surveys. Targeted searches along drainage lines and spotlight searches were completed as part of the Bilby targeted survey and opportunistic sightings did not result in any evidence of quolls within the drainage lines (Spectrum, 2024a).

The FHEZ contains 1,320.82 ha of suitable habitat, 950.81 ha of which is Rocky Hills – habitat which is critical to the survival of the Northern Quoll. A targeted survey was commissioned in June 2024 to further assess the presence of the Northern Quoll in the FHEZ (Spectrum 2024b). Rainfall records prior to the survey stated above average which is optimal for the survey (Spectrum, 2024b) (**Appendix 11**).

Northern quolls were detected within the FHEZ on motion cameras and from secondary evidence (scat records) at 10 of the 14 sites. All were in the Rocky Hills and near the Drainage Lines/Floodplains habitat which intersected the Rocky Hills (**Figure 10-10**). According to the Northern Quoll referral guidelines (CoA 2016), a low-density population is characterised by infrequent captures of one or two individuals confined to one or two traps or where no trapping has identified a Northern Quoll, but latrine evidence remains. A high-density population may be characterised by numerous camera triggers by multiple individuals across multiple cameras and/or traps on the site (CoA 2016).

Initially, the population within this area was classified as low density given that only three quolls triggered 58 camera traps (*ecologia*, 2021a). The lack of any further records during subsequent surveys supported this understanding. In 2024, following better conditions, the outcome of a targeted survey was that a potential high-density Northern Quoll population was present. The area which was targeted for this survey was the FHEZ and therefore the Northern Quolls recorded, were concentrated in the area outside of the Development Envelope (refer to Spectrum 2024b). Northern Quolls have been recorded in Rocky Hills habitat within the Development Envelope, and within the Indicative Footprint (**Figure 10-10**). The presence of the Northern Quolls within the FHEZ and in the FHEZ Corridor support the exclusion of these areas for the purpose of mitigating impacts to this MNES. In particular, the FHEZ Corridor comprises habitat critical to the survival of this MNES and supporting habitat such as Drainage Lines/Floodplains and Stony Spinifex and Hillslopes. The FHEZ Corridor also has a number of caves and ridges which are considered critical habitat for the Northern Quoll (Hernandez-Santin et al., 2022).

Critical to the survival of the Northern Quoll is habitat for denning and foraging located within their home range (from 35 ha up to 100 ha during the breeding season). This includes habitat of low rocky hills – such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or tree lined creek lines (CoA, 2016). Within the Development Envelope, the Rocky Hills habitat is considered critical habitat for the Northern Quoll. Approximately 2,658.23 ha of Rocky Hills habitat is present within the Development Envelope. Multiple patches of suitable habitat for this species were identified in the Rocky Hills habitat area which would be considered habitat critical to the survival of this species. These micro-habitats provide shelter for breeding and refuge from fire/predation. Should the Cane Toad invade, this habitat is considered to provide protection to the Northern Quolls (CoA 2016). The Rocky Hills habitat is considered common and widespread throughout the Pilbara (Attexo 2023; Spectrum 2024a).

The Drainage Line/Floodplains habitat provides Northern Quoll populations dispersal habitat. Foraging habitat is recognized to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of shelter habitat, or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (CoA, 2016). Potential foraging/dispersal habitat for the species within the Development Envelope consists of:

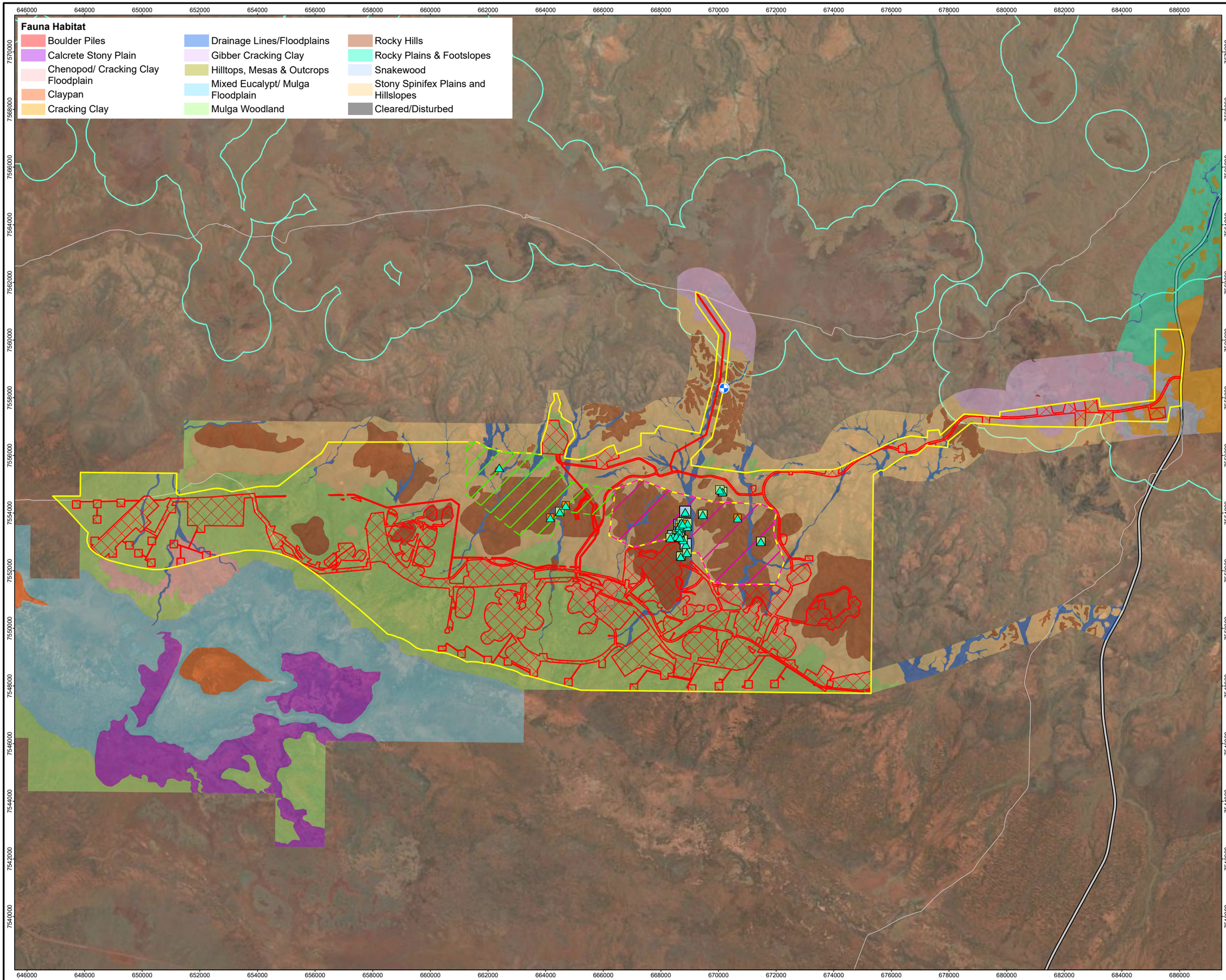
- Drainage Line/Floodplains;
- Rocky Hills; and
- Stony Spinifex Plains and Hillslopes.

The extent of these habitat types and the extent of impact of the Proposed Action on each is provided in (**Figure 10-10).** These habitats are in both the FHEZ and the connecting FHEZ Corridor and extend outside the Development Envelope (**Figure 10-10**). The FHEZ contains 1,320.82 ha of Northern Quoll habitat, 950.81 ha is Rocky Hills habitat intersected by 107.62 ha of Drainage Line/Floodplains and 262.39 ha of Stony Spinifex Plains and Hillslopes habitat.

To further protect the Northern Quoll and avoid fragmentation of the breeding population, the FHEZ Corridor provides a further 991.45 ha of habitat. Of this, 548.14 ha is Rocky Hills habitat. This corridor allows the Northen Quoll to safely disperse form the FHEZ to similar habitat within the Chichester Ranges to the north. In total, over 1,400 ha of Rocky Hills habitat will be preserved for the protection of the Northern Quolls and ensure the

population within the Development Envelope is not isolated from the population in the Chichester Ranges. There are several DBCA long term study sites for the Northern Quoll in the Chichester – one being at Mt Florance Station (Dunlop et al., 2018) which is the neighbouring pastoral station to Mulga Downs.

Figure 10-10: Northern Quoll records and Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature
- Northern Quoll (EN) records

Observation method

- Scat
- Cameras (motion)
- Cage traps

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 1 of 4

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Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Northern Quoll (EN) records

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 2 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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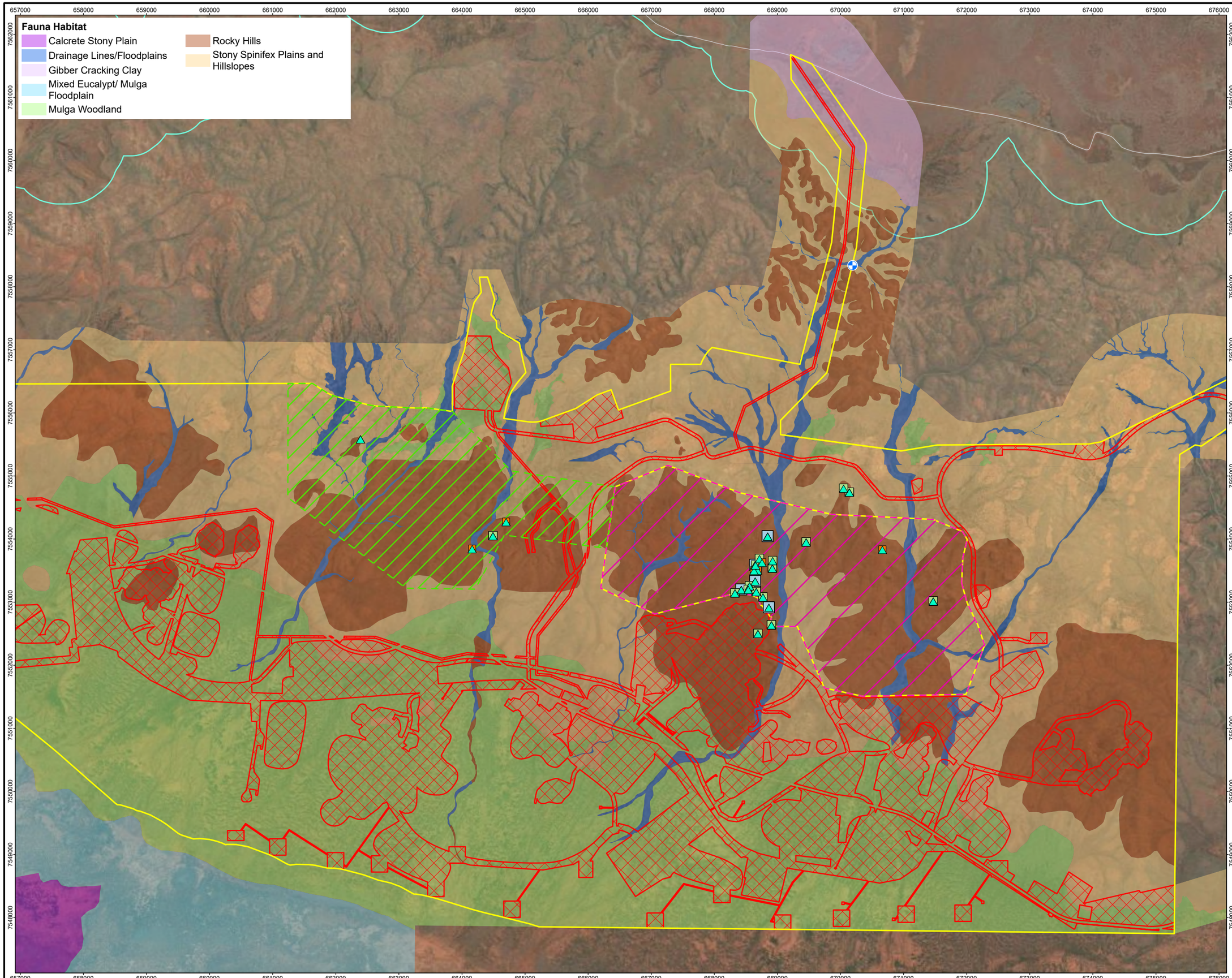

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature
- Northern Quoll (EN) records

Observation method

- Scat
- Cameras (motion)
- Cage traps

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature
- Northern Quoll (EN) records

Observation method

- Scat
- Cameras (motion)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 13-Dec-2024
Drawn By: droberts	Checked By: VC

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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NORTHERN QUOLL RECORDS AND HABITAT

FIGURE 10.10 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

10.3.3.4 Greater Bilby (*Macrotis lagotis*)

Conservation Status: Vulnerable, BC Act

Distribution, Habitat and Ecology

The Greater Bilby (*Macrotis lagotis*) is a medium-sized, omnivorous, nocturnal burrowing marsupial with a long tail and distinctive big ears. The species is distinguished by its large rabbit-like ears, silky blue-grey fur, and long black tail with a furred white tip (Johnson, 2008). Weighing between 0.8 kg to 2.5 kg and measuring up to 550 mm in length (head and body), Bilbies have strong forelimbs for digging and construct complex burrow systems for shelter (Johnson, 2008). The Bilby is considered an ecosystem engineer (Fleming *et al*., 2014), with their foraging enhancing soil health and plant productivity (Chapman, 2013) and their (used/disused) burrows providing important refuge sites for other fauna (Hofstede and Dziminski, 2017).

Throughout most of its range, the distribution of Bilby is patchy and often occurs in low abundance (Southgate et al. 2007). The Bilby will utilise multiple burrows throughout its range. Bilbies occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils which are typically sandy, for burrow excavation. The Bilby suffered a sudden and widespread population crash in the early 20th Century and is now confined to the driest and least fertile parts of its former range, and its distribution is negatively correlated with foxes (Southgate 1990). Population monitoring in the Pilbara, Kimberley and central desert regions indicates that wild Bilby populations are small, comprising roughly 2-15 individuals (DBCA, 2018; Dziminski *et al*., 2020a; DBCA, 2021b); wild populations in the Pilbara are isolated and distinct (Dziminski *et al*., 2020a) (DCCEEW 2018a).

Capable of breeding throughout the year, Bilbies typically raise no more than two young, which remain attached to the teat for approximately 80 days prior to deposition in a burrow. Young stay in the burrow for around two weeks before weaning (Johnson 2008). Bilbies are cryptic and generally solitary (Bradley *et al*., 2015), with reported low site fidelity (Southgate *et al*., 2007). In the wild, Bilbies are relatively short-lived, with a generation length of approximately four years (Woinarski et al., 2014). Bilbies can be highly mobile with variable home ranges, particularly males (Bradley et al., 2015).

Bilbies occupy a range of habitats including open tussock (*Triodia* spp.) grassland on uplands and hills; mulga (*Acacia aneura sens. lat.*) woodland/shrubland growing on ridges and rises; and hummock grassland on plains and in alluvial areas (Woinarski et al. 2014). Bilby distribution is limited by the availability of soils suitable for burrowing, such as sandy areas, where burrow excavation is easier (Southgate 1990; Moseby & O'Donnell 2003; Dziminski and Carpenter 2016).

In the north of Western Australia, suitable habitat for the Bilby includes woodlands (<10 m) with *Eucalyptus* and *Acacia* spp., Pindan woodlands with hummock and tussock grass, on coarse sand to light medium clay; low shrub cover of *Acacia* spp. over hummock and tussock grasses, on sandy soils, loams and red earth; spinifex grasslands with low shrub cover of *Acacia* and *Melaleuca* spp. on sandy and sandy loam soils (Cramer et al. 2016).

Using presence data, DBCA commenced habitat modelling in 2017 using physical habitat characteristics (i.e., topography, geology and soil properties). Preliminary results (Dziminski and Carpenter, 2017) identified elevation, and soil type and depth as key predictor variables contributing to habitat suitability for the Bilby.

Using publicly available species occurrence data, Cadenhead *et al*. (2015) mapped the habitat suitability and distribution of four Pilbara MNES species using MaxEnt (Phillips *et al*., 2006). For the Bilby (n = 46), '*mean diurnal temperature range, seasonal temperature variation, precipitation of the driest period, amounts of clay in the soil and the mean temperature of the driest quarter*' were the most important parameters predicting the distribution of Bilbies in the Pilbara. Predictive species habitat modelling has also been conducted by environmental consultants and mining proponents for environmental impact assessment processes (e.g., Eco Logical, 2015; for the BHP iron ore mining in the Pilbara strategic assessment); Bilbies were '*strongly associated with hotter regions of the eastern part of the Pilbara bioregion, with lower, flatter and sandier areas identified as higher potential habitat*' (BHP, 2016).

Adult males will commonly move up to two to three kilometres between burrows per night, whereas females often only move 500 m to 2 km between burrows (Moseby & O'Donnell 2003). An individual Bilby may have over a dozen regularly used burrows which are used as shelter during the day and rest at night (Attexo 2023).

The Bilby is often associated with three vegetation types, open tussock grassland on uplands and hills, hummock grassland in plains and alluvial areas, and occasionally mulga woodland/shrubland growing on ridges and rises (Southgate 1990). One of the three major vegetation types outlined in the national recovery plan for the Bilby is hummock grassland growing on sand plains and dunes, drainage systems, salt lake systems, and other alluvial areas.

Surveys

Surveys completed for the Proposal targeting the Bilby include:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment; (**Appendix 11a.1**)
- Spectrum (2023a) MDIOP Solar Farm. Haul Road, and Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment; (**Appendix 11g**)
- Spectrum (2024a) Mulga Downs Iron Ore Mine Targeted Bilby and Night Parrot Survey; (**Appendix 11e**) and
- Spectrum (2024b) Mulga Downs Iron Ore Mine Supplementary Targeted Fauna Survey. (**Appendix 11f**)

The surveys were undertaken between April 2019 to May 2024. All surveys included an initial desktop assessment followed by on-ground habitat assessment to determine if suitable burrow or foraging habitat was present.

The results of soil assessments undertaken within the Development Envelope (Mine Earth 2019) were interrogated for suitable substrates for Bilby burrows. To identify habitat which was likely to be used by the Bilby a UAV was deployed. Preferred habitat was initially selected from habitat sampling and the UAV allowed for assessment of areas which were difficult to access. UAV flights were completed in a linear pattern, with transects separated by no more than 500 m (usually between 200 m and 400 m) within Mulga Woodland habitat type to identify potentially suitable habitat and secondary signs (diggings and burrows) (*ecologia* 2021a). The UAV path is shown in **Figure 10-11.**

The Drainage Line/Floodplain habitat was also identified from the desktop assessments as likely to support the Bilby and these were also targeted for on ground searches. Habitat which may be considered critical for the survival of the Bilby has also been defined as habitat along palaeo drainages near salt lake systems such as the Fortescue Valley (Northover et al 2023).

Targeted searches were also undertaken in March 2023 by Spectrum within six locations along the proposed pipeline route from the Mine to the Mulga West Borefield (Spectrum 2023a). Earlier Level 2 (detailed) terrestrial fauna surveys in 2012 and 2013 undertaken across the Mulga Downs Development Envelope did not find any evidence of the Bilby in the area. The information from these surveys is included in each of the desktop assessments completed as part of the terrestrial fauna assessment by *ecologia* and Spectrum (refer to *ecologia* 2021a for details on the earlier surveys by Terrestrial Ecosystems).

The targeted surveys involved surveying habitat known to support populations of the Bilby in Western Australia, including *Acacia aneura* (mulga) woodland/shrubland growing on ridges and rises which was surveyed extensively with a UAV during the survey (*ecologia* 2021a). Mulga Woodland habitat was targeted by Spectrum during the March 2023 survey along the proposed pipeline route (Spectrum 2023a).

In 2024, a targeted Bilby and Night Parrot survey was completed across a broader area for the Proposal. Thirty habitat assessments and 49 targeted Bilby searches were conducted across the Survey Area over a two phase sampling program, totalling 80 person-hours of effort and 132.2 km traversed (Refer to Map 2.2 in Spectrum, 2024a). Targeted searches were completed using the 2 ha plot technique as defined in the Bilby survey guidelines (DBCA, 2017). Due to the size of the Survey Area, plots were spaced at approximately 4 km (where possible) over the Survey Area to ensure sampling independence, with additional sites located in areas of preferred habitat.

The targeted searches included looking for Bilby evidence in the form of tracks, scats, diggings, and burrows for approximately one person hour at each site. Where plant species could be identified in the field, more focus was placed on specific *Acacia* species) known to contain root-dwelling larvae that the Bilby favours as a food source (Southgate et al., 2019). Bilbies can be surveyed any time of the year using non-invasive techniques (DBCA, 2017).

No secondary evidence of the Bilby was recorded during any of the surveys. These surveys included on ground targeted searches in the Mulga Woodlands and Drainage Line/Floodplain habitat, which is considered the preferred habitat for the Bilby as it contains vegetation associations considered preferred habitat. Each survey adopted the recommendations of Dziminski and Carpenter (2018) with on-ground searches to identify signs – tracks, scats and multiple diggings into the base of Acacia shrubs where grubs are accessed.

The total survey effort undertaken for the Greater Bilby by *ecologia* (2021b) and Spectrum (2023a; 2024a) included:

- 9 targeted searches, including 74 habitat assessments and 89 person hours; and
- 228 kms of UAV flights identifying the location of suitable habitat.

Occurrence in the Development Envelope

Seventy Bilby records were identified from desktop database searches within 40 km of the Development Envelope, and one anecdotal verbal record (2001) exists in proximity to the Development Envelope (Mulga Downs homestead). The verbal record lacks some credibility as the associated data indicates the record locality is 'Telfer' and the site is listed as 'Mulga Downs Station', which covers a relatively large range (*ecologia* 2021a).

Despite the targeted survey effort, no primary or secondary evidence of Bilbies was recorded in the Development Envelope from any of the surveys. The likelihood of Bilbies breeding and forming dens within the Development Envelope is considered low and this species is instead considered to be a visitor. The presence of cats, foxes and wild dogs, which are known predators of the Bilby (DCCEEW 2023j; Pavey 2006), further decreases the likelihood of Bilbies being residents within the Development Envelope (*ecologia* 2021a).

No Bilby evidence (scats, diggings, tracks or burrows) was recorded within the Survey Area during the 80 person-hours of targeted searches in 2024 (Spectrum, 2024a). No Bilby evidence was observed across these four habitat types identified in previous surveys and as characterised by DCCEEW (2022), with 41.98 km traversed over Stony Plains and Slopes, 3.31km over Chenopod/Cracking Clay, 38.77 km over Drainage Area/Floodplain, and 48.13 km traversed over Mulga Woodland. Sandy substrate required for burrow excavation occurred patchily in some drainage lines but was largely absent across the Survey Area (Spectrum, 2024a).

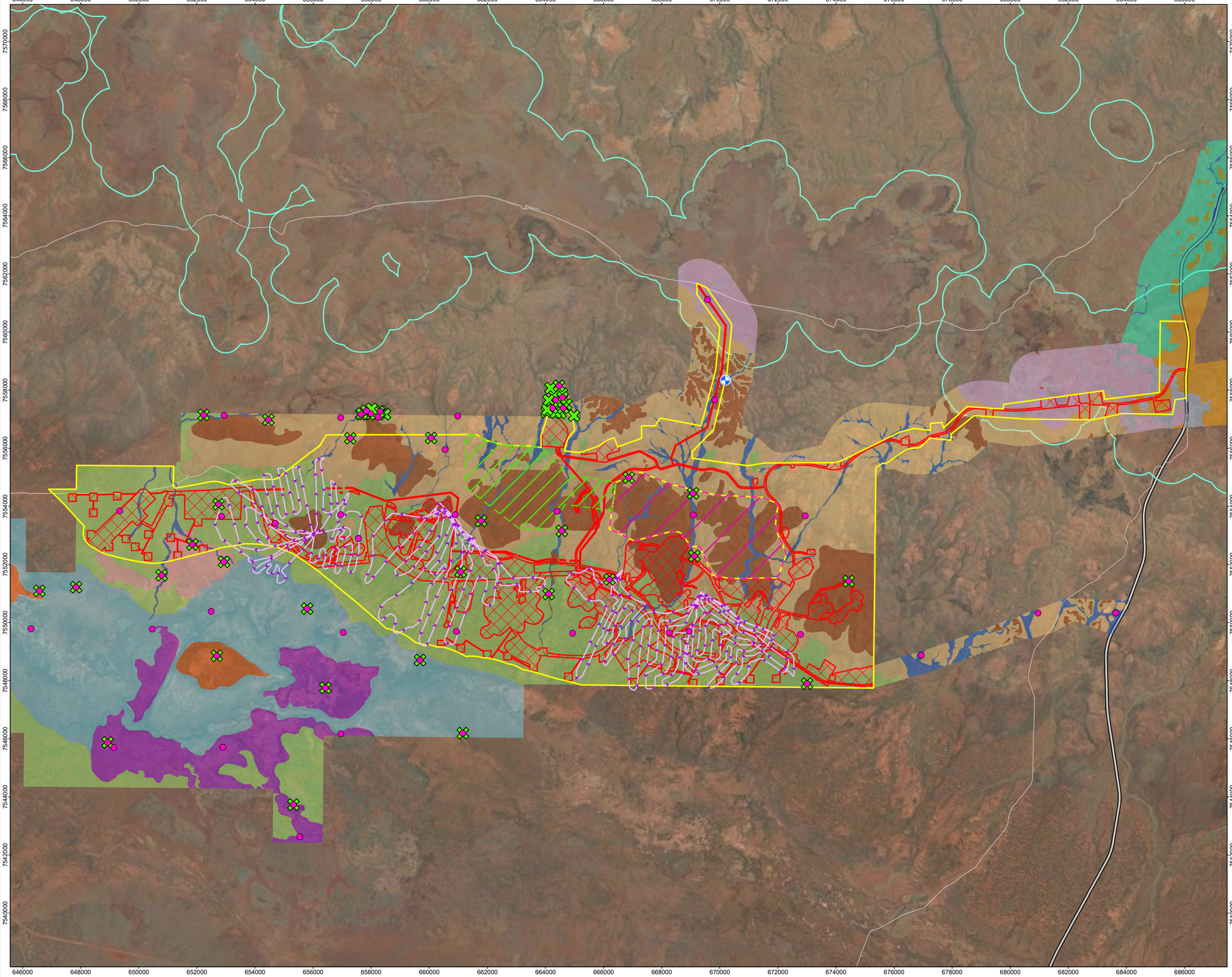
Habitat considered to be suitable for the Bilby was identified during the database searches for each of fauna surveys. Database search results indicated that Drainage Lines/Floodplain and Mulga Woodland habitats could provide suitable supporting habitat for Bilbies. Habitat which may be considered critical for the survival of the Bilby has also been defined as habitat along palaeo drainages near salt lake systems such as the Fortescue Valley (Northover et al 2023) which can be considered habitat within the home range of paleo drainage systems for the Bilby (DCCEEW, 2021).

Systematic fauna surveys were undertaken within the following habitats: Drainage Line/Floodplains, Mulga Woodland, and Chenopod/ Cracking Clay Floodplain. These all exist within the Fortescue Valley paleo drainage system and also includes habitat such as Mixed Eucalypt/Mulga Floodplain. Earlier targeted searches included the use of a UAV to allow for a greater area to be assessed for evidence of the Bilby.

No Bilby dens or burrows were identified in any targeted surveys or systematic surveys sites undertaken within the Fortescue Valley paleodrainage system within and south of the Development Envelope. The presence of soil substrate suitable for burrow construction is critical (Dziminski and Carpenter 2016). The Mulga Woodland was found to have compacted alluvial loamy clay soils with occasional surface stones, not suitable for burrowing.

Surveys to the east of the Proposed Action for the Mulga Downs Hub and Rail Project located active dens and captured the Bilby on motion cameras. This provides evidence that Bilbies appear to have a greater presence toward the drier sandier sections of the Fortescue region.

Figure 10-11: Bilby Survey Effort



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Targeted surveys
- Habitat assessments
- Water feature
- Bilby flight path UAV effort

Roads (LGATE-195)

- Highway

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 26-Mar-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

BILBY SURVEY EFFORT

FIGURE 10.11 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Targeted surveys
- Habitat assessments
- Bilby flight path UAV effort

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

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Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

BILBY SURVEY EFFORT

FIGURE 10.11 Map 2 of 4

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Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes
- Targeted surveys
- Habitat assessments
- Water feature
- Bilby flight path UAV effort

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

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BILBY SURVEY EFFORT

FIGURE 10.11 Map 3 of 4

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Legend

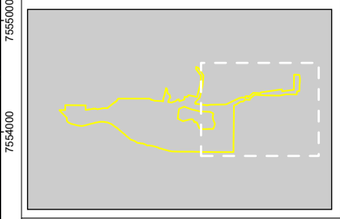
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Targeted surveys
- Habitat assessments
- Water feature
- Bilby flight path UAV effort

Roads (LGATE-195)

- Highway
- Minor Road



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BILBY SURVEY EFFORT

FIGURE 10.11 Map 4 of 4

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10.3.3.5 Pilbara Olive Python (*Liasis olivaceus barroni*)

Conservation Status: Vulnerable.

Distribution, Habitat and Ecology

The Pilbara Olive Python (*Liasis olivaceus barroni*) is a dull olive-brown to pale fawn or rich brown python with a white/cream belly, pale lips finely dotted with pale grey or brown, pitted anterial scales bordering the lips and smooth scales in 55–80 rows at mid-body. The Pilbara Olive Python is one of Australia's largest snakes and can grow to 4 m in length with an average size of 2.5 m (Cogger 2000). The Pilbara subspecies is larger and can grow up to 6.5 m in length (Wilson & Swan 2017) and females are slightly longer than males (Shine & Slip 1990). Pilbara Olive Pythons have been known to eat prey as large as rock wallabies (Wilson & Swan 2017).

The Pilbara Olive Python is restricted to ranges within the Pilbara region, north-western Western Australia, such as the Hamersley Range, and islands of the Dampier Archipelago (DCCEEW 2023d). Two distinct populations of the Pilbara Olive Python exist (not including the northern subspecies *L. olivaceus olivaceus*) with one isolated around Mt Augustus in the Gascoyne, and the other occurring across a vast area from the Burrup Peninsula, Ord Ranges and Meentheena, south to Nanutarra and Newman (Storr et al. 2002). Population size estimates are difficult due to the Pilbara Olive Python's cryptic nature and lack of reliable trapping or census techniques (DCCEEW 2008a).

The Pilbara Olive Python is restricted to gorges, rocky habitats, and escarpments of the Pilbara (Wilson & Swan 2017). Bush & Maryan (2011) noted that Pilbara Olive Pythons have been observed from locations some distance from water sources including granite outcrops, elevated mesas, and spinifex plains on stony ground, preferring to shelter in caves, crevices, and beneath large boulders.

At present, there are no species-specific policy guidelines on what constitutes habitat critical to the survival of the species or what represents an important population. This is likely due to the species' cryptic nature which makes conducting reliable surveys difficult (DEWHA 2008a). An accepted 'default' definition of critical habitat for this species is rocky gorges, gullies and permanent waterholes (Northover et al, 2023).

Surveys

Surveys completed for the Proposal targeting the Pilbara Olive Python included:

- *ecologia* (2021b) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment;
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey;
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment; and
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417).

The surveys included multiple basic, detailed, and targeted survey events between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA *Technical Guidance: Terrestrial Fauna Surveys* (EPA, 2016a). The surveys included multiple basic, detailed, and targeted surveys between April 2019 and June 2024. The detailed surveys were conducted following the period

of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken were compliant with the required guidance. For the Pilbara Olive Python these were:

- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b); and
- Threatened Species Scientific Committee: Conservation Advice for *Liasis olivaceus barroni* (Olive Python- Pilbara subspecies) Canberra: Department of the Environment, Water, Heritage and the Arts.

Targeted searches conducted in rocky hills habitats for secondary evidence (sloughs and scats) were conducted concurrently with cave habitat assessments, Northern Quoll targeted searches, and while deploying bat ARUs. Spotlighting through rocky habitat on foot and nocturnal road spotting for this cryptic nocturnal species was undertaken during the targeted surveys. Four zoologists conducted spotlighting on foot through suitable rocky habitat for a total of 480 minutes. Nocturnal road spotting was also undertaken on spotlighting for cryptic nocturnal species including the Pilbara Olive Python during each phase of the surveys for a total of 3840 minutes. Camera traps deployed in the Rocky Hills targeting Northern Quolls were also used to detect presence of Pilbara Olive Pythons resulting in greater survey effort for the species (*ecologia* 2021a).

A motion camera was placed near an ephemeral water hole in the Powerline Corridor which lies within Drainage Line/Floodplains habitat in the northern section of the Proposed Action (Biologic 2022b). The total survey effort undertaken for the Pilbara Olive Python by *ecologia* (2021a), Biologic (2022b) and Spectrum (2023a; 2024b) and included:

- Motion sensor camera traps at 140 sites over 7,067 trap nights;
- Cage traps at 50 sites over 385 trap nights;

Targeted searches, including 229.38 hours targeted surveys and 55 hours of nocturnal searches.

Occurrence in the Development Envelope

A single Pilbara Olive Python was opportunistically recorded from the Mulga East camp (*ecologia* 2021a) confirming the likely presence of this species within the Development Envelope (**Figure 10-12**). As the Pilbara Olive Python habitat requirements overlaps the Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat, active searches for the species were undertaken concurrently with the other targeted surveys. Despite considerable survey effort, no Pilbara Olive Pythons or secondary signs of this species were recorded during targeted searches. A motion camera was placed above an ephemeral water feature in the Powerline Corridor (**Figure 10-12**) and no Pilbara Olive Pythons were detected (Biologic 2022b).

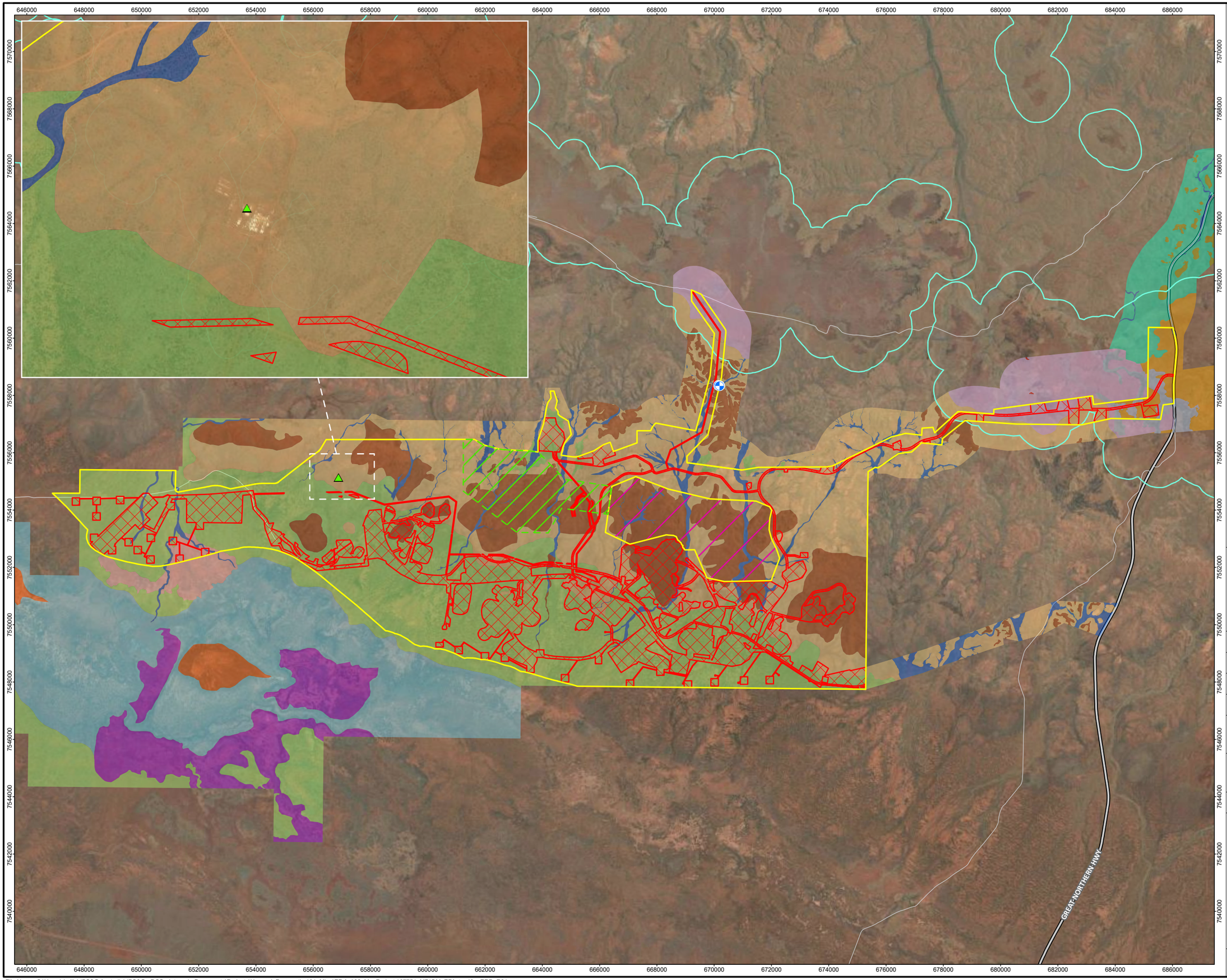
There are multiple records of the Pilbara Olive Python from the Fortescue's Solomon mine (40 km west), the most recent in March 2024 (FMG 2024). This species has also been recorded 13 km south of Malay Well in Wittenoom Gorge in 2013, 10 km north of Mulga East in 2013, and in the Chichester Ranges 7 km north-west of the proposed rail corridor in 2012. The distribution of this species to the south, west, north, and north-east of the Development Envelope indicates this species occurs widely across the broader landscape and is not restricted to specialised habitats within the Development Envelope (*ecologia* 2021a).

Within the Development Envelope, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills (rocky outcrops, breakaways and small gorges), however it has also been known to inhabit spinifex grasslands and travel large distances. Drainage Line/Floodplains habitat also provides suitable foraging habitat

Although one Pilbara Olive Python was found at the Mulga East camp within the Development Envelope, the habitat type present (Stony Spinifex Plains and Hillslopes) (**Figure 10-12**)is not consistent with defined habitat for the species in the most recent work by DBCA (*ecologia* 2021a).

Rocky Hills habitat is considered common and widespread throughout the Pilbara (*ecologia* 2021a). No deep gorges or permanent sources of water considered preferred habitat for this species have been recorded within the Development Envelope. While the Rocky Hills habitat may support the Pilbara Olive Python, it cannot be considered critical for the survival of this species given the absence of permanent water holes. The closest water source is the ephemeral water feature in the Powerline Corridor. This feature is outside the Indicative Footprint and will be clearly demarcated.

Figure 10-12: Pilbara Olive Python record



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Pilbara olive python (VU)
- Water feature
- Highway
- Minor Road

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Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PILBARA OLIVE PYTHON RECORD

FIGURE 10.12

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Image Reference: World Imagery: Earthstar Geographics
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10.3.3.6 Night Parrot (*Pezoporus occidentalis*)

Conservation Status: Critically Endangered

Distribution, Habitat and Ecology

The Night Parrot (Pezoporus occidentalis) is listed as Critically Endangered under the BC Act. The survey area occurs within the classified "high priority area" for occurrence of the Night Parrot (DPaW 2017).

The Night Parrot is one of Australia's rarest birds, with very few confirmed sightings in recent years (Pyke & Ehrlich 2014). It is a highly elusive nocturnal ground dwelling parrot found in the arid and semi-arid zones of Australia. The Night Parrot was thought to be extinct but, in 2013, was rediscovered in Queensland (Pullen Pullen Reserve) (DCCEEW 2023f). The Night Parrot is currently known from at least eight sites in northern WA and a single site in south-western Qld (Leseberg et al., 2021b; A.H. Burbidge, unpubl.).

This species is known to occur at the Fortescue Marsh (Davis and Metcalf 2008) approximately 60 km east of the Development Envelope. Calls were detected in 2005 however, no more calls were recorded until 2017 (Jackett et al. 2017) indicating the species is present in some areas, and more recently from Fortescue's Cloudbreak mine area (Fortescue Metals Group 2021). Only a few of these records are from long-term stable roost sites, with the remainder being records of birds that are foraging or moving between sites with central and norther WA now considered the stronghold for this species (Leseberg 2021).

There is one population recently recorded in the Diamantina National Park/Pullen Pullen Reserve area in western Queensland, and other recent records in the Wiluna district of central WA, and the Lake Gregory area of northern WA (Burbidge 2018). Night Parrot foraging calls were recently recorded at Lake Mackay (East Pilbara) (Stantec, 2021).

The species is relatively sedentary spending the day roosting in low, dense vegetation, usually as pairs or as small groups. The Night Parrot is predictably vocal and when emerging at dusk they engage in a brief period of calling before leaving their roost sites to feed. They then typically return for another brief period of calling just before dawn (Murphy et al. 2017b).

Night Parrots reportedly occur in spinifex grasslands in stony or sandy areas on floodplains or near creeks, shrubby samphire, and chenopod vegetation on claypans or at the edges of salt lakes, and in dense, low vegetation, around watercourses (Murphy et al. 2017a, Pyke & Ehrlich, 2014). Based on limited data, Night Parrots seem to prefer to nest in large spinifex hummocks (Murphy et al. 2017b), which is a common and widespread habitat type throughout much of the Pilbara region.

Critical habitat for the species is defined as:

- nesting and foraging in areas that can support multiple to many occurrences of dense roosting habitat such as old-growth dense hummock-forming spinifex (*Triodia* spp.), thickets of lignum, or dense shrubby samphire.
- Nesting and foraging in old-growth spinifex (*Triodia* spp.) in close proximity to ephemeral water sources, which may be associated with the following:
  - Hummock grasslands (unburnt) in stony or sandplain environments;

- Paleo-drainage features in a landscape mosaic with spinifex (*Astrebla* spp.) and *Acacia aneura* (Mulga) woodland; and
- Treeless areas and bare gibber.

The species has a home range of 10 ha to 100s of ha (depending on the size of either permanent or ephemeral food resource habitat in the landscape that is surrounding breeding habitat).

Supporting habitat includes:

- Areas that are likely to be of relatively high vegetative or seed productivity such as run-on areas, floodplains, salt or clay pans, salt-lake margins;
- Paleo-drainage systems, salt lakes and pans;
- Permanent or ephemeral sources of free water, or areas where high soil moisture ephemerally or permanently support vegetation that offers a source of water; and
- Flyways varying from river and creek drainage systems, surrounding dune-fields, forb–grasslands on mainly ironstone gravel-covered plains, low ranges and low dissected tablelands supporting sparse shrublands, undulating stony clay plains supporting Mitchell Grass, and Gidgee.

Surveys

Surveys completed for the Proposal targeting the Night Parrot included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm. Haul Road, and Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024a) Mulga Downs Iron Ore Mine Targeted Bilby and Night Parrot Survey (**Appendix 11e**).

The surveys were undertaken between April 2019 to May 2024. All surveys included an initial desktop assessment followed by on-ground habitat assessment to determine if suitable roosting or foraging habitat was present. The desktop assessment included previous surveys and imagery to assess Night Parrot habitat at a landscape scale.

Surveys were scheduled following the season when maximum rainfall typically occurs in the Eremaean September to April (EPA, 2020). All surveys listed above were compliant with State (Western Australian) and Commonwealth guidelines (refer to **Table 10-2**).

ecologia (2021a) also included the use of UAVs to investigate habitat which may be suitable for the Night parrot. ARUs were then deployed at small patches of sparsely distributed long unburnt spinifex. The location of where the ARUs were placed and the oath of the UAV flight to assess habitat suitability for the Night parrot is shown in **Figure 10-13**.

Habitat considered suitable for the Night Parrot in the Development Envelope includes:

- Unburnt spinifex. These areas were confined to the north-eastern portion of the Development Envelope (*ecologia* 2021a);
- Rocky Hills habitat includes vegetation complexes of sparse hummock grasslands of *Triodia* spp. and sparse chenopod – both which have been identified as suitable for the Night Parrot; and
- The Stony Spinifex Plains and Hillslopes occur interspersed between the Rocky Hills habitat may contain habitat which may be critical or supporting. Burbridge (2020) identifies breeding and roosting habitat which includes old dense spinifex surrounded by rocky ridges.

Acoustic monitoring has proven to be the most efficient technique for monitoring Night Parrots at known locations and detecting at new locations (Leseberg et al., 2020). SongMeter SM4 long term passive Acoustic Recording Units (ARUs) have a high sampling frequency and are appropriate to detect Night Parrot calls (DBCA, 2024). The use of SongMeter SM4 is discussed further below.

Many suitable habitat types for the species are extensive and the terrain difficult and therefore it is appropriate to use drones in such a landscape. *ecologia* (2021a) also included the use of UAVs to investigate habitat which may be suitable for the Night parrot. ARUs were then deployed at small patches of sparsely distributed, long unburnt spinifex. The location of where the ARUs were placed and the oath of the UAV flight to assess habitat suitability for the Night Parrot is shown in **Figure 10-13**.

The total survey effort undertaken for the Night Parrot by *ecologia* (2021b), Biologic (2022a) and Spectrum (2023a; 2024a) included:

- Recording calls using ARUs at 39 sites over 260 recording nights; and
- 33 kms of UAV flights.

In March 2023, additional surveying was conducted for the Night Parrot by Spectrum (2023a) (**Appendix 11e**) which covered the Solar Farm (in addition to the pipeline route and revised haul road which are now outside the Development Envelope). The survey effort for the Night Parrot included a habitat assessment, opportunistic sightings, and deployment of two Song Meter acoustic recorders in potential habitat for six nights.

A targeted survey for the Night Parrot was undertaken in the Fortescue Valley area where areas of relatively high productivity (vegetative or seed) were identified from previous habitat assessments in floodplain, near claypans and the paleodrainage system of the Fortescue River floodplain. The ephemeral claypans and pools (Claypan habitat shown in Figure 2.3 of Spectrum 2024b) is outside of the Development Envelope and the habitat assessment did not find it suitable for placing an ARU. Instead, one was placed within the Calcrete Stony Plain habitat which was adjacent to the Claypan. ARUs were placed within the Chenopod/Cracking Clay Floodplains habitat abutting the drainage system and close to the Freshwater Claypan PEC.

SongMeter acoustic recorders were also deployed throughout the Survey Area in an effort to target the Night Parrot. These ARUs were deployed in seven locations within the long unburnt spinifex for a minimum of six nights, with three ARUs also deployed within the Chenopod/Cracking Clay Floodplain and Stony Spinifex Plains and Hillslopes habitat types during the initial targeted survey (*ecologia* 2021a).

The ARUs deployed by Spectrum in 2023 at two locations in Goodiadarrie Swamp in March 2023 were analysed using single parameters optimised for detecting Night Parrot calls by N. Leseberg, of Adaptive NRM (Spectrum 2023a).

Research in western Queensland has demonstrated Night Parrots occupy long-term stable roost sites for periods of up to several years. These long-term stable roost sites support both roosting and breeding. The birds also have predictable year-round calling periods at dusk and dawn (Murphy et al. 2017a, Leseberg et al. 2019). This ensures that if Night Parrots are roosting at a particular site, the likelihood of detecting them using ARUs is very high, provided the ARU is placed for a minimum of four nights in calm weather, and the recorder is set to record during the peak calling periods. During breeding, and following large rain events, calling is more frequent, extends throughout the night, and the likelihood of detection is increased (Murphy et al. 2017a). Preliminary results from research in central Western Australia suggest patterns of behaviour in that region are similar (Jackett et al. 2017).

The likelihood of detection is also influenced by the type of ARU being used. In calm conditions, a Song Meter 4 (Wildlife Acoustics, MA, USA) is known to be capable of reliably detecting 95% of Night Parrot calls out to a range of around 205 m (Leseberg et al. 2022).

Occurrence in the Development Envelope

No calls attributable to Night Parrots were detected on any of the recording units, despite considerable survey effort (*ecologia*, 2021a; Biologic 2022a, b; Spectrum 2023a; 2024a). Calls recorded in the 2024 targeted survey were analysed by Dr Nick Leseberg (Adaptive NRM and one of the leading subject matter experts for the Night Parrot) (Spectrum 2024a). Conclusion from the targeted survey was that no calls for the Night Parrot were detected from 131 recording nights (1,572 hrs of acoustic recordings) from 18 sites in habitat considered suitable for Night Parrot foraging. A total of 57 other species were recorded. It was determined that no Night Parrots existed within 200 m of the 18 sites. The number of nights of data collected was sufficient to allow robust conclusions around the presence of long-term stable roost sites in the immediate vicinity of each survey point at the time of the survey (Spectrum 2024a). The survey spanned the Development Envelope and extended outside.

There are no historical records of the Night Parrot within 40 km of the Development Envelope. Long unburnt spinifex is sparse in the Development Envelope and the few patches restricted to the Stony Spinifex Plains and Hillslopes in the northeast of the Development Envelope.

Habitat considered suitable for the Night Parrot within the Development Envelope includes Drainage Line/Floodplains and Stony Spinifex Plains and Hillslopes (ecologia 2021a). In the absence of long unburned spinifex, this habitat is considered as supporting only. Potential supporting (foraging) habitat for the Night Parrot is also found in Chenopod/Cracking Clay Floodplains.

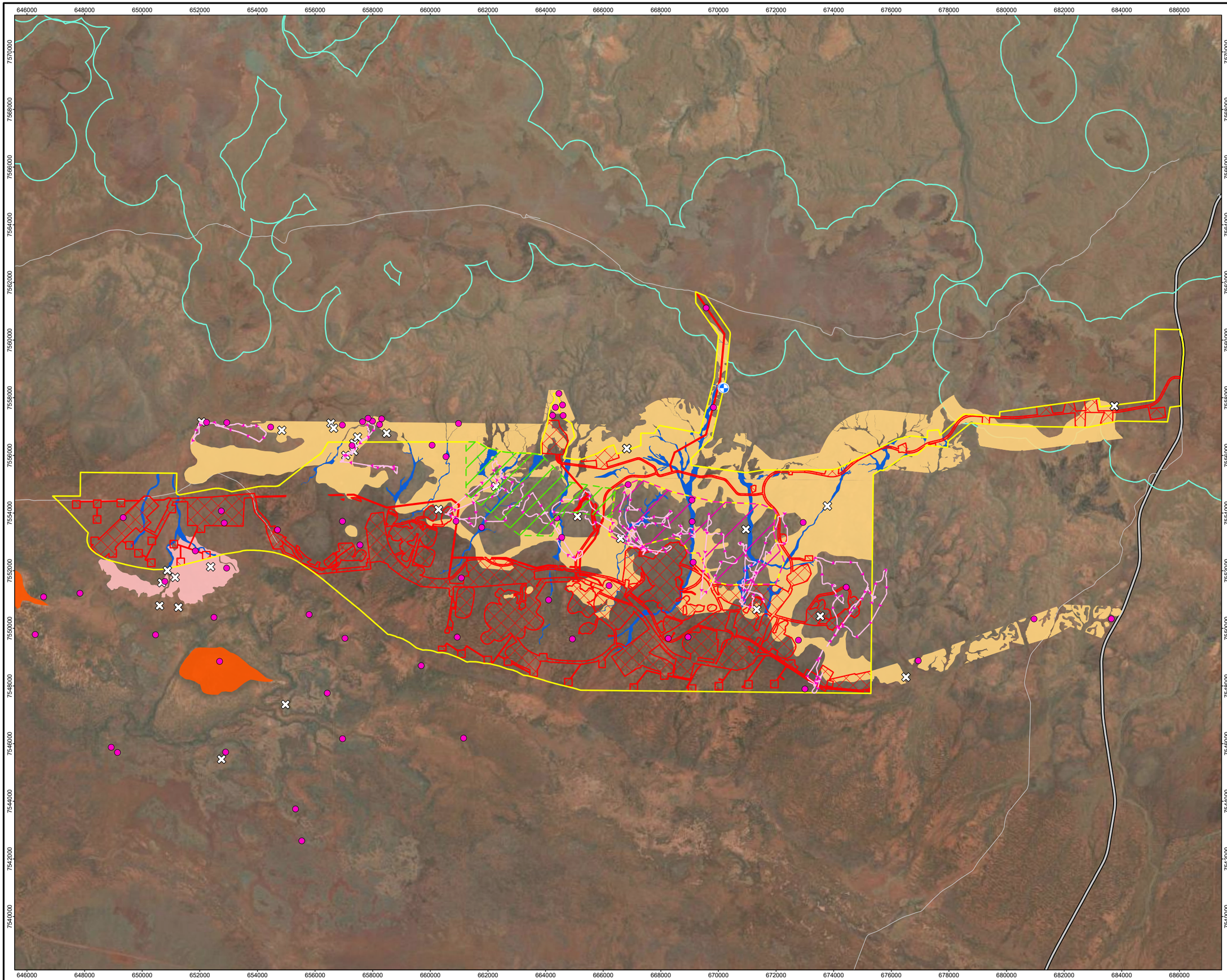
A targeted survey for the Night Parrot was undertaken in the Fortescue Valley area where areas of relatively high productivity (vegetative or seed) were identified from previous habitat assessments in floodplain, near claypans and the paleodrainage system of the Fortescue River floodplain (**Figure 10-13**). The ephemeral claypans and pools (Claypan habitat shown in Figure 2.3 of Spectrum 2024b) is outside of the Development Envelope and the habitat assessment did not find it suitable for placing an ARU. Instead, one was placed within the Calcrete

Stony Plain habitat which was adjacent to the Claypan. ARUs were placed within the Chenopod/Cracking Clay Floodplains habitat abutting the drainage system and close to the Freshwater Claypan PEC.

Other habitat which can support the Night Parrot are the Drainage Lines/Floodplains and Stony Spinifex Plains and Hillslopes and ARUs were also placed within these habitats. The survey was undertaken after above average rainfall with the floodplain area inundated in March 2024 (Spectrum 2024a) (**Figure 10-14**).

None of the surveys recorded any Night Parrot calls. The desktop assessment and results from the field surveys indicate that the Night Parrot, while not recorded, could potentially intermittently use the survey area (including within the Development Envelope), for foraging and dispersal. However, the habitats present are sub-optimal for the Night Parrot and it is unlikely that it resides in this area.

Figure 10-13: Night Parrot Survey Effort



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Night Parrot flight path UAV effort
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Minor Road

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Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

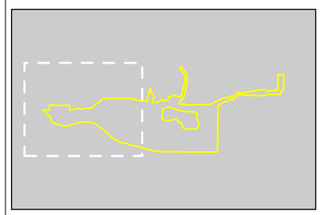
- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Night Parrot flight path UAV effort
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Minor Road



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Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 2 of 4

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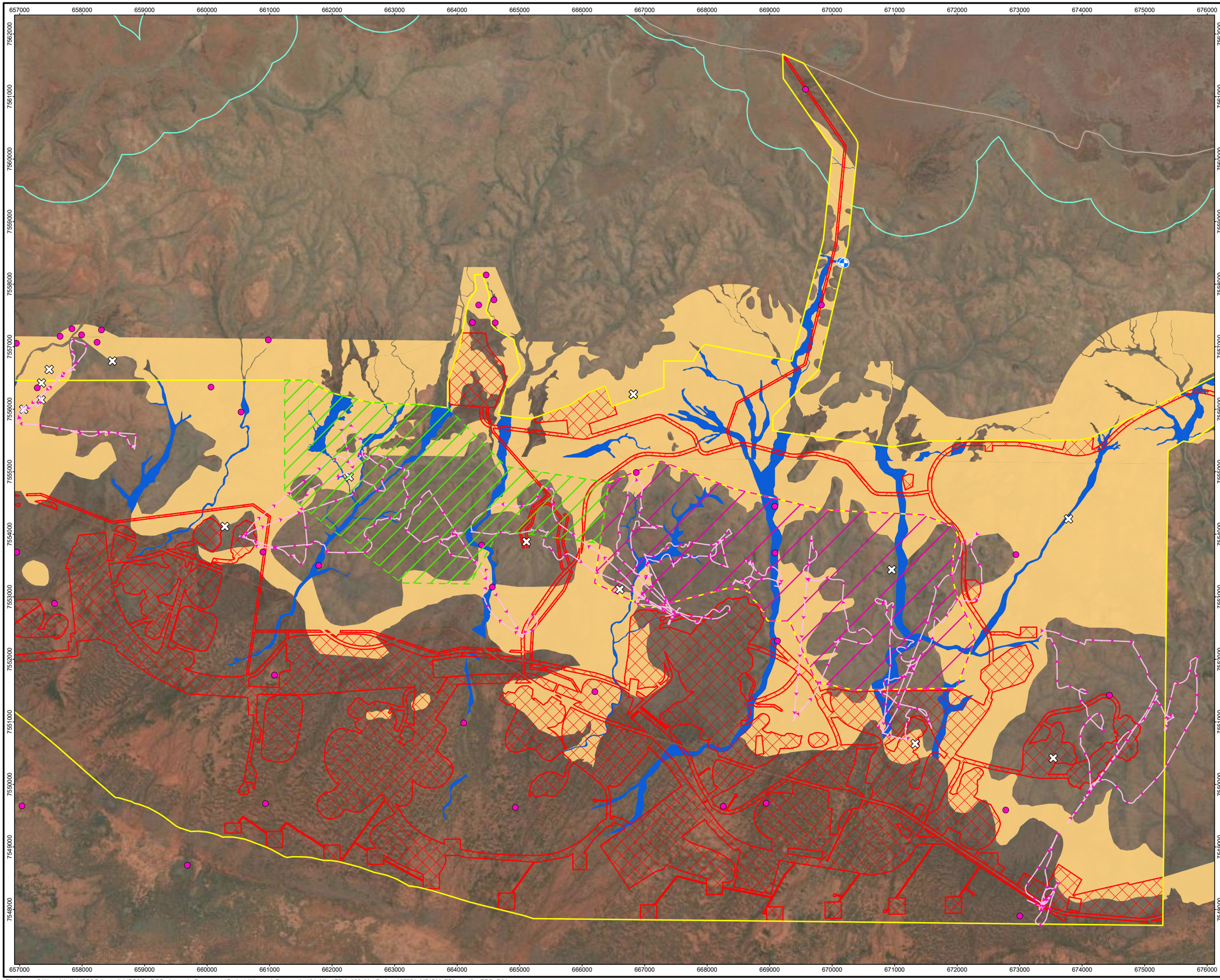

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Night Parrot flight path UAV effort
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Minor Road

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Kilometers

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Mulga Downs Iron Ore Mine
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NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 3 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Night Parrot flight path UAV effort
- Water feature
- Targeted surveys
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Minor Road

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT

FIGURE 10.13 Map 4 of 4

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Figure 10-14: Night Parrot Survey Effort from Spectrum 2024a

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Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

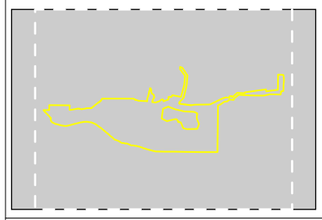
- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Water feature
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
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Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT (SPECTRUM 2024 TARGETED SURVEY NIGHT PARROT AND BILBY)

FIGURE 10.14 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Acoustic recorder

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT (SPECTRUM 2024 TARGETED SURVEY NIGHT PARROT AND BILBY)

FIGURE 10.14 **Map 2 of 4**

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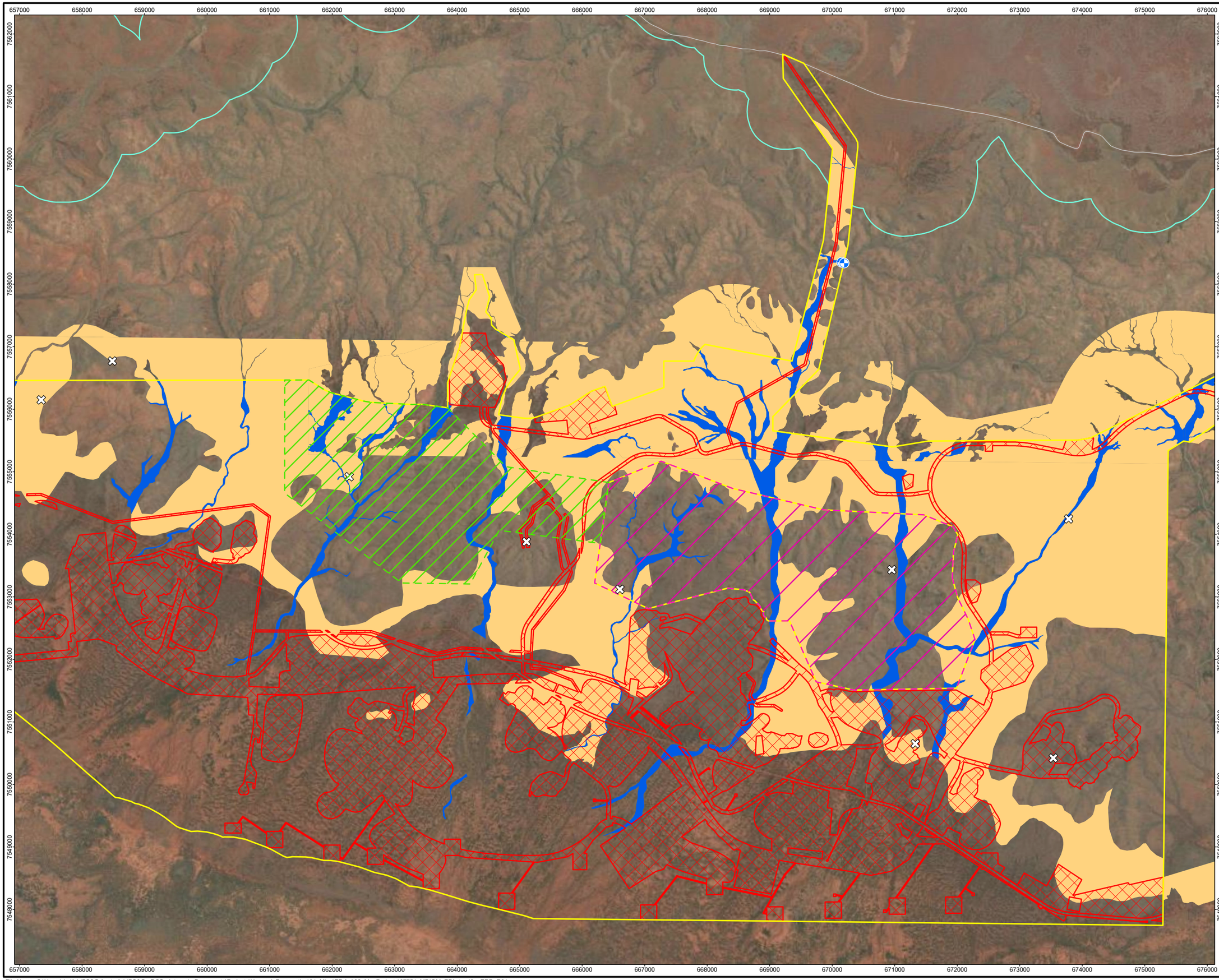
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

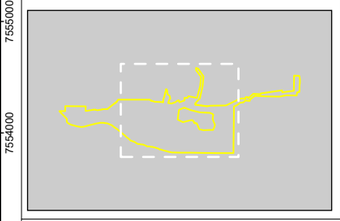
- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Water feature
- Acoustic recorder

Roads (LGATE-195)

- Minor Road



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Drawn By: dmills	Checked By: VC

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT (SPECTRUM 2024 TARGETED SURVEY NIGHT PARROT AND BILBY)

FIGURE 10.14 **Map 3 of 4**

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Suitable habitats

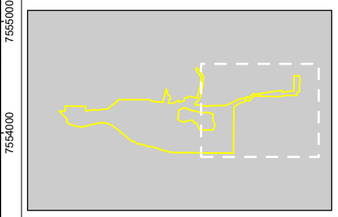
- Drainage Lines/Floodplains
- Stony Spinifex Plains and Hillslopes

Supporting habitats

- Chenopod/ Cracking Clay Floodplain
- Claypan
- Water feature
- Acoustic recorder

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

NIGHT PARROT SURVEY EFFORT (SPECTRUM 2024 TARGETED SURVEY NIGHT PARROT AND BILBY)

FIGURE 10.14 Map 4 of 4

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.3.7 Grey Falcon (*Falco hypoleucos*)

Conservation Status: BC Act: Vulnerable.

Distribution, Habitat and Ecology

The Grey Falcon is the rarest falcon in Australia with an estimated population size of <1000 individuals (Schoenjahn, 2013). They occur very sparsely in a wide variety of arid and semi-arid zones across an area of about 5 million km^2 (Schoenjahn, Pavey and Walter, 2020). They have not been found to be associated with any particular vegetation types, however climate characteristics such as temperature and rainfall appear to strongly influence the distribution of the species (Schoenjahn, Pavey and Walter, 2020).

Breeding occurs from June to November, with eggs laid in the old nests of other birds, particularly those of other raptors or corvids. The nests chosen are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but falcons also nest in telecommunication towers (Marchant & Higgins 1993).

The species is a resident or nomadic visitor to inland parts and occurs in lightly wooded riverine plains. It often nests in Eucalypts along watercourses and has been recorded from both River red gum (*Eucalyptus camaldulensis*) and Coolabah (*Eucalyptus coolabah*) (Garnett et al. 2011). Breeding habitat appears to be localised in zones with the highest annual average temperatures, and areas with persistently dry and winter drought climatic conditions (Schoenjahn, 2013). Grey Falcons, like most falcons, typically use the nests of other large birds (typically corvids and raptors) in trees or on human infrastructure such as repeater towers or power-line pylons (Olson and Olson, 1986b). Nests are often used over several years and can be near nests of other falcons or raptor species (Schoenjahn, 2013).

The Grey Falcon forages in open landscapes such as rocky plains with hummock grasslands, lower shrublands, and small drainage lines where they predominantly prey on birds, mainly pigeons and parrots (Olson and Olson, 1986b; Schoenjahn, 2013).

Surveys

The field surveys conducted for the Proposal included multiple basic, detailed, and targeted survey events between October 2018 and August 2023.

Surveys completed within the Development Envelope for the Grey Falcon include:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm. Haul Road, and Pipeline Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2023b) Mulga Downs Iron Ore Mine, Targeted Grey Falcon Survey, August 2023 (**Appendix 11i.2**).

The surveys were compliant with survey guidelines as outlined in:

- EPA Environmental Factor Guideline: Terrestrial Fauna (Environmental Protection Authority, 2016);
- EPA Technical Guidance Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (Environmental Protection Authority, 2020);
- Survey guidelines for Australia's Threatened birds (Department of the Environment Water Heritage and the Arts, 2010); and
- Conservation Advice – *Falco hypoleucos* Grey Falcon (Threatened Species Scientific Committee, 2020).

Field surveys were completed following EPA guidelines for terrestrial fauna and included multiple basic, detailed, and targeted surveys between October 2018 and August 2023. A targeted survey was undertaken in August 2023 over 7 days. Habitat identified as suitable for the Grey Falcon nesting was traversed and any potential nesting trees and potential nests were mapped (Spectrum 2023b). The habitats identified from the *ecologia* 2023a desktop assessment identified as potential habitat were the Mixed Eucalypt / Mulga Floodplain and Drainage Lines / Floodplains. Mixed Eucalypt / Mulga Floodplain is no longer in the Development Envelope however is present to discuss the area of occupancy for this species.

Surveys for avifauna used 20-minute set-time searches at each systematic trapping site by an experienced ornithologist. During each set-time survey, the number of individuals of each species observed was recorded while actively searching similar habitat within a 2 ha area surrounding the survey site. This approach is in accordance with systematic survey methods recommended by BirdLife Australia and *Technical Guidance: Sampling methods for terrestrial vertebrate fauna* (EPA 2016). Survey effort was conducted within three hours of dawn and dusk, which is deemed to be optimal for recording majority of bird species (*ecologia* 2021a).

Set time surveys were conducted at each systematic trapping site for avifauna on a minimum of two occasions. Opportunistic surveys were conducted at sites considered to potentially support a different avifauna assemblage to systematic trapping locations, with specific focus on areas exhibiting surface water (*ecologia* 2021a). The survey undertaken by Spectrum (2023a) included noting any Grey Falcon nesting trees or infrastructure in the survey area.

A desktop risk assessment was also prepared by *ecologia* (2023b), provided in **Appendix 11i.1**. The desktop assessment considered potential habitat within the Development Envelope and reviewed the most recent specific research undertaken for the Grey Falcon.

Following the desktop assessment a survey was undertaken targeting the Grey Falcon habitat in August 2023. The habitats identified from the *ecologia* 2023a desktop assessment identified as potential habitat were the Mixed Eucalypt / Mulga Floodplain and Drainage Lines / Floodplains. Mixed Eucalypt / Mulga Floodplain is not in the Development Envelope. Habitat identified as suitable for the Grey Falcon nesting was traversed and any potential nesting trees and potential nests were mapped (Spectrum 2023b).

The Spectrum (2023b) survey included targeted searches for individuals and suitable nests within potential Grey Falcon habitat (**Appendix 11i.2**).

The total targeted survey effort for the Grey Falcon by *ecologia* (2021b), Biologic (2022) and Spectrum (2023a; 2023b) included:

- 80 sites, 91.8 hrs;

- Targeted surveys for the Grey Falcon include 212 set time surveys (2,686 minutes); and
- Targeted searches at 54 sites including foot and driving traverses.

Occurrence in the Development Envelope

Based on the desktop assessments the Grey Falcon was considered likely to occur in the Development Envelope. DBCA Threatened and Priority Fauna database search results identified a total of eight Grey Falcon records occurring within 70 km of the Development Envelope

ecologia (2021b) recorded one individual of this species during a reconnaissance survey in the Mulga East tenement area. *ecologia* (2023a) found eight additional records from DBCA Threatened Fauna Database Search are located within 70 km of the Development Envelope. Suitable foraging habitat exists in the form of Drainage Lines/Floodplains.

A targeted survey for Grey Falcon nesting trees within the Development Envelope did not yield any records of Grey Falcons (2023b). The survey was undertaken during the known breeding season for the Grey Falcon (as per the Conservation Advice – TSSC 2020). The area surveyed was identified as suitable habitat in the desktop assessment (*ecologia* 2023b; Spectrum 2023b). A total of 46 nests were recorded from 27 locations and assessed for suitability for the Grey Falcon, all of these nests identified were suitable for potential breeding activities, but none were occupied or in use during the survey **(Figure 10-15**). No secondary evidence of Grey Falcon breeding activities was noted.

None of these nests were occupied by the Grey Falcon and no secondary evidence of breeding activity was found within those nests. It is considered likely that the Grey Falcon forages within the Development Envelope, at least on an occasional basis, and whilst no evidence of breeding was identified during multiple years of surveys, the Development Envelope contains habitats which potentially support breeding. However, this species is known to prefer nesting on man-made structures as they are higher than most trees and therefore any nests are out of the reach of predators. These structures are not present in the Development Envelope at this stage of the Proposal but may occur at nearby projects. Trees which contained potential Grey Falcon nests were predominantly *Eucalyptus vitrix*. Other trees which had potential Grey Falcon nests included *Acacia aneura* and *Corymbia* species. Nest locations were identified to the southwest of the mine pits within Drainage Lines / Floodplains and Mixed Eucalypt / Mulga Floodplains.

Although significant avifauna survey effort has been undertaken since 2013 within the Development Envelope, this species has only been recorded on one occasion, indicating intermittent visitation within the Development Envelope and surrounding areas, which aligns with the habits of this nomadic species (*ecologia* 2023b).

While habitat critical to the survival of this species has not been defined, the Conservation Advice (DCCEEW 2020) identifies that Grey Falcon nests are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but Grey Falcons also nest in telecommunication towers (Marchant & Higgins 1993; Schoenjahn 2013, 2018; Falkenberg 2010).

The tendency of Grey Falcons to utilise the nests of other birds (corvids and raptors) in the largest eucalypts restricts suitable nesting habitat presence within the Development Envelope to one habitat type (*ecologia* 2023b):

No examples of River Red Gum (*Eucalyptus camaldulensis*) or Coolibah (*E. coolabah*) have been recorded within the Development Envelope, however, the banks of some Drainage Line/Floodplains support *Eucalyptus victrix* trees that have the potential to be used for nesting if they possess previously built nests. The Grey Falcon recorded by *ecologia* (2021b) was in close proximity to a drainage line in the Mulga East portion of the Development Envelope**.**

The Mixed Eucalypt/Mulga Floodplain habitat type is associated with the Fortescue Marsh Environmentally Sensitive Area (ESA)(WA0066) as identified by the Directory of Important Wetlands in Australia (DIWA) and supports trees (*Eucalyptus victrix*) of a suitable size for nesting if they possess previously built nests (*ecologia* 2023b). This habitat type occurs outside of the Development Envelope (**Figure 10-15**).

Based on the results of surveys to date, it is likely that the Development Envelope is used by this species on an occasional basis for foraging and potential breeding.

The remainder of the habitat types within the Development Envelope are unlikely to provide suitable nesting habitat for the Grey Falcon. The Chenopod/Cracking Clay Floodplains habitat has been identified a suitable for foraging and has been considered in this assessment.

10.3.3.8 Peregrine Falcon (*Falco peregrinus*)

Conservation Status: BC Act Other Specially Protected Fauna.

Distribution, Habitat and Ecology

The Peregrine Falcon is one of the most widespread birds in the world, breeding on all continents except Antarctica (Olsen et al., 2006). It occurs across most of Australia though are an uncommon species and are rare across all states and territories (Bird Life Australia, 2012a). They are known to be both a nomadic and sedentary species and are uncommon in the Kimberley, Hamersley and Darling Ranges. They inhabit cliffs, coastal habitats, rivers, wooded water courses and lakes as well as urban environments. Peregrine Falcons usually nest by making a scrape on a high cliff edge but will also use stick nests of other large birds and tree hollows in some areas (Olsen et al., 2006). Hunting is mainly done during the day and feeding is primarily on small to medium sized birds caught in flight, often above drainage lines and rivers. Favoured prey species include the Galah (*Eolophus roseicapilla*) and Sulphur-crested Cockatoo (*Cacatua galerita*) (Bird Life Australia, 2012b).

Surveys

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments, including the Peregrine Falcon. These searches primarily focused on recording species from direct observation, secondary evidence and/or habitat features of importance likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023; **Appendix 11c**).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included identification of secondary evidence (Attexo 2023). At all times while surveying, all records pertaining to species not previously recorded during the

survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary evidence (Attexo, 2023).

Occurrence in the Development Envelope

One historical record of this species was found in the Development Envelope (*ecologia* 2020). It is also likely to occur in the Solar Farm area. Numerous additional records from the DBCA Threatened Fauna Database Search are located within 60 km of the Development Envelope.

This species occupies extremely diverse habitats and has the potential to occur in the Development Envelope in all the habitats present, for foraging. No suitable nesting habitat was recorded within the Survey Areas.

Figure 10-15: Grey Falcon records and potential nesting trees

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

Legend

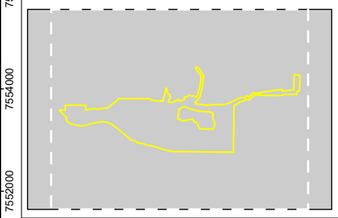
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem

EPBC Act Status

- Grey Falcon (VU)
- Suitable nest

Fauna habitat

- Chenopod/ Cracking Clay Floodplain
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed



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Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 14-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Four plant assemblages of the Wona Landsystem

EPBC Act Status

- Grey Falcon (VU)
- Suitable nest

Fauna habitat

- Chenopod/ Cracking Clay Floodplain
- Drainage Lines/Floodplains
- Mulga Woodland
- Rocky Hills
- Rocky Plains and Footslopes

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Kilometers

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 2 of 4

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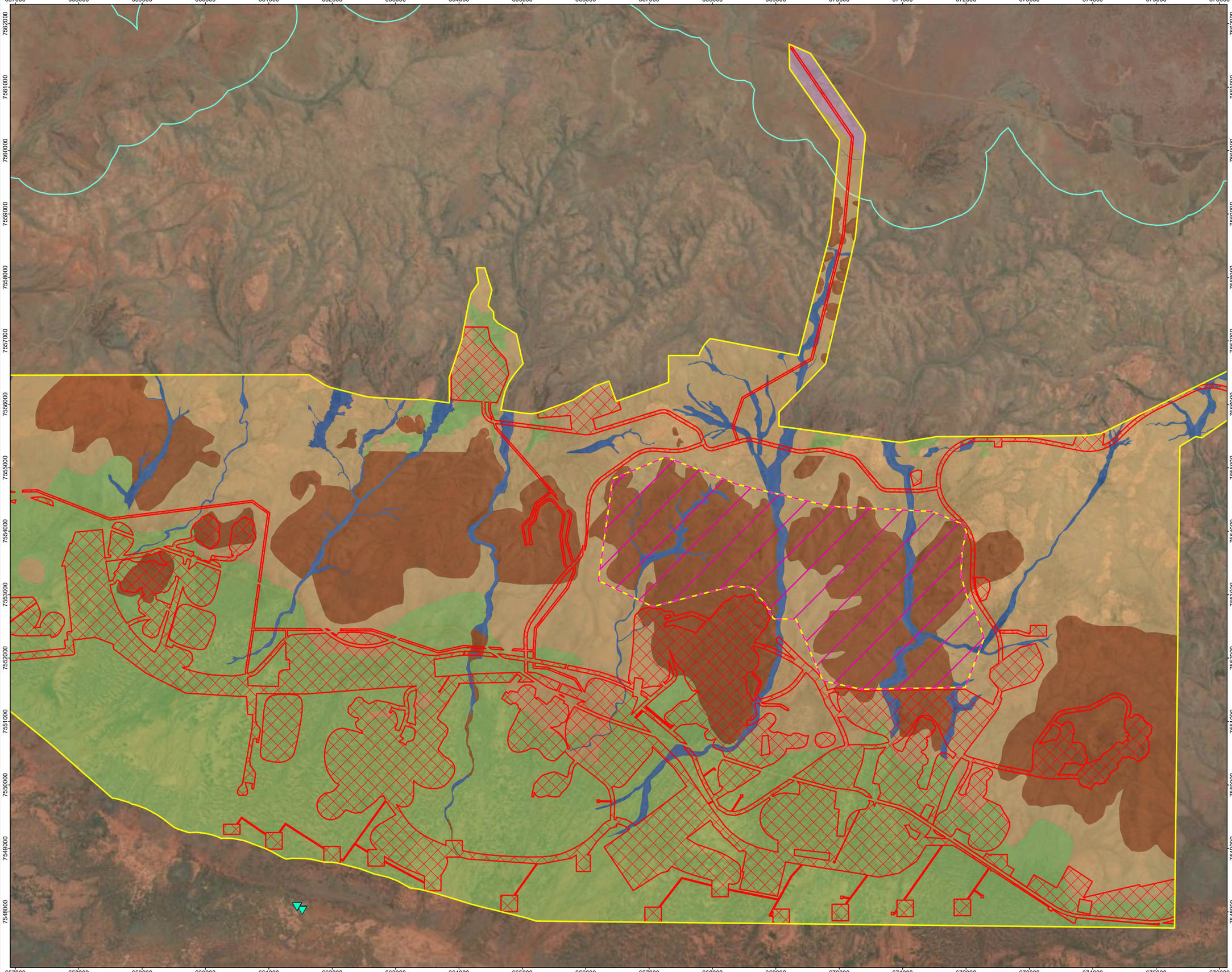
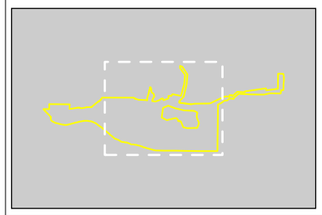


Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem
- Suitable nest

Fauna habitat

- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Rocky Plains and Footslopes



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Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 14-Oct-2024
Drawn By: droberts	Checked By: VC
Scale 1:55,000 at A3	

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 3 of 4

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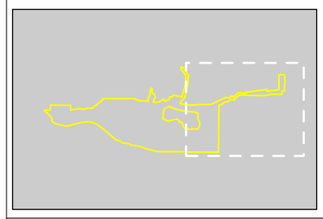
7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem

Fauna habitat

- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed



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Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 14-Oct-2024
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Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GREY FALCON RECORDS AND POTENTIAL NESTING TREES

FIGURE 10.15 Map 4 of 4

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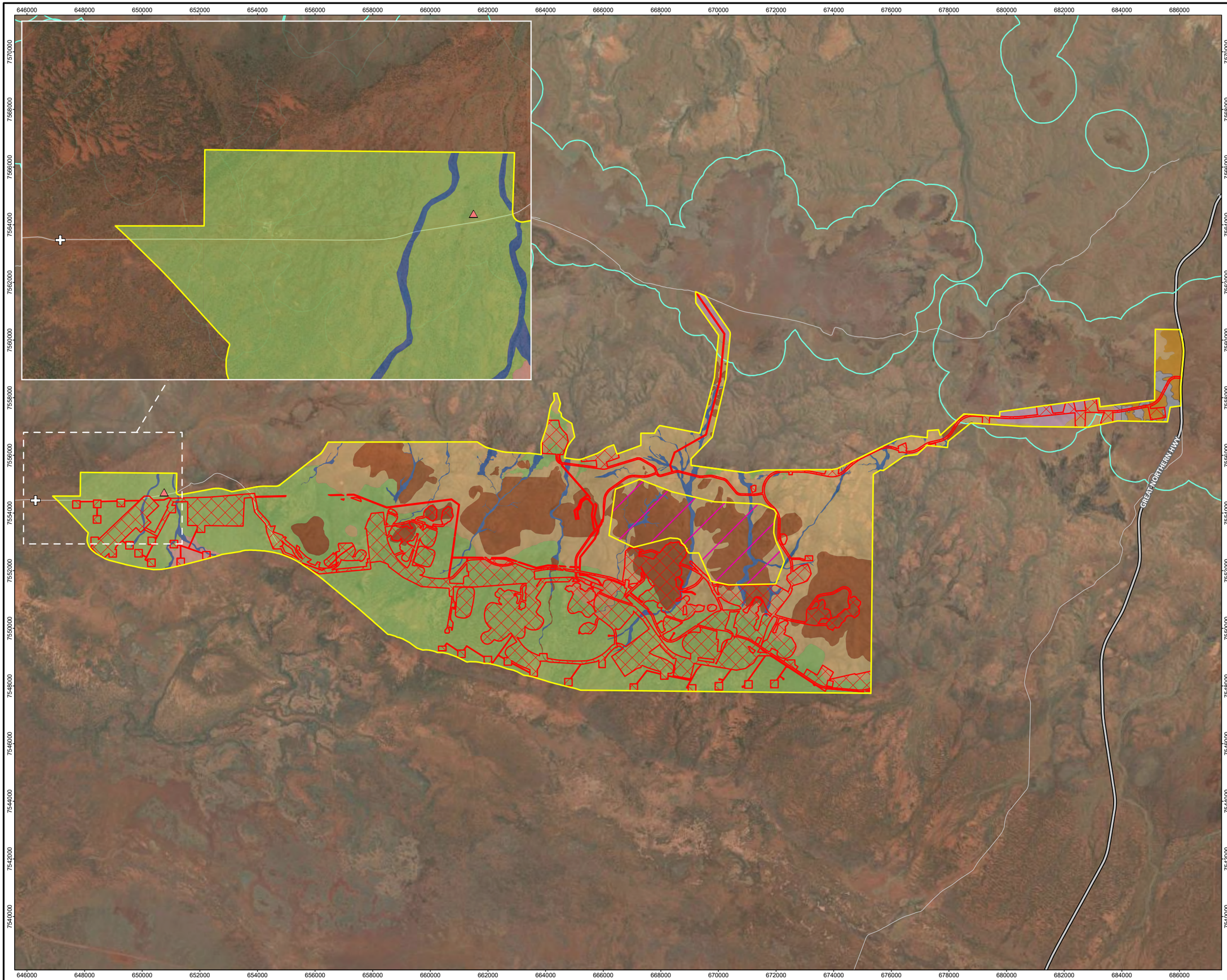
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 10-16: Peregrine Falcon and Grey Falcon Records and Habita



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- Four plant assemblages of the Wona Landsystem

Fauna habitat

- Chenopod/ Cracking Clay Floodplain
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed

BC Act Status

- Grey Falcon (VU)

DBCA lisitng

- Peregrine Falcon (OS)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 30-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

PEREGRINE FALCON AND GREY FALCON RECORDS AND HABITAT

FIGURE 10.16

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10.3.3.9 Gane's Blind Snake (*Anilios ganei*)

Conservation Status: DBCA: Priority 1.

Distribution, Habitat and Ecology

The Gane's Blind Snake is an elusive, moderately robust blind snake that lives primarily underground. Due to its subterranean lifestyle, the species is rarely recorded and relatively little is known of its ecology. The Gane's Blind Snake has a rounded snout that is greyish on the upper side and cream on the underside (Wilson and Swan, 2017). Its distribution is limited to the Pilbara region between Newman and Pannawonica (Wilson and Swan, 2017; DBCA 2021). The species is likely to enter social insect nests to feed on termite and ants, as well as their eggs and pupae. The Gane's Blind Snake is thought to be associated with moist gullies and gorges though little published information exists (Aplin, 1998b). A specimen was recorded in the Hamersley Range from a stony clay-loam valley floor vegetated with *Triodia* sp. suggesting that the species may utilize moist gullies and gorges though is not restricted to them (Ecoscape 2011).

Surveys

Surveys completed for the Proposal targeting the Gane's Blind Snake included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

The surveys included multiple basic, detailed, and targeted survey events between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA *Technical Guidance: Terrestrial Fauna Surveys* (EPA, 2016a). The surveys included multiple basic, detailed, and targeted surveys between April 2019 and June 2024. The detailed surveys were conducted following the period of maximum rainfall for the region as per the EPA Technical Guidance: Terrestrial Fauna Surveys (EPA, 2016a). Surveys undertaken were compliant with the required guidance. For the Gane's Blind Snake these were:

- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b).

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence and/or habitat features of importance likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area.

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included raking leaf litter and spoil heaps,

overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence (Attexo 2023). At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., shed skins) evidence (Attexo, 2023).

The total survey effort undertaken for the Gane's Blind Snake by *ecologia* (2021b), Biologic (2022b) and Spectrum (2023a; 2024b) and included:

- Motion sensor camera traps at 140 sites over 7,067 trap nights;
- Cage traps at 50 sites over 385 trap nights;

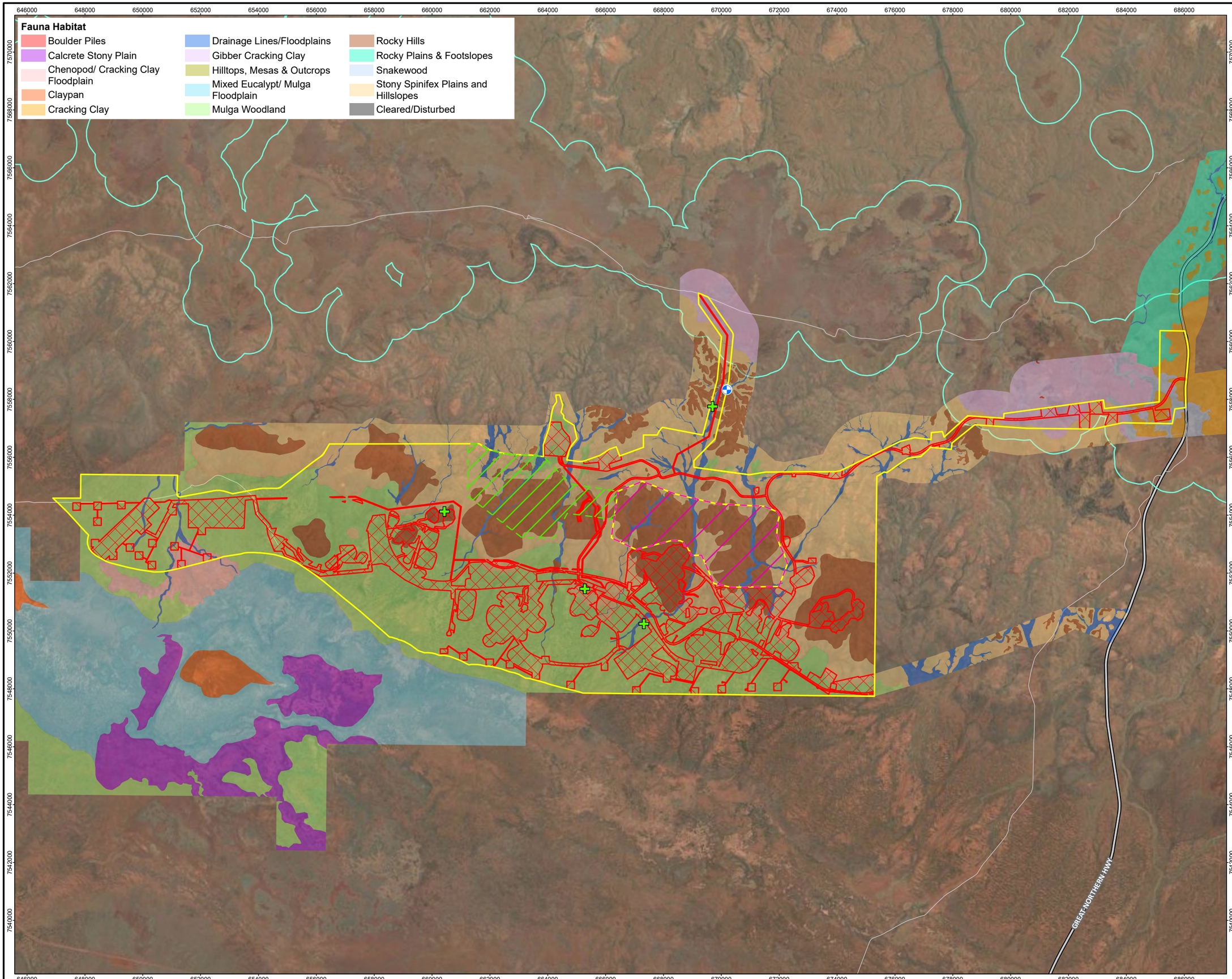
Targeted searches, including 229.38 hours targeted surveys and 55 hours of nocturnal searches.

Occurrence in the Development Envelope

Four individual Gane's blind snakes were recorded from two sites in phase 1 and on one occasion during phase 2 at another site MDPT017 by *ecologia* (2021a). This species was recorded within Mulga Woodlands and Stony Spinifex Plains and Hillslopes habitat types (*ecologia* 2020) and gullies and gorges. This species

Suitable habitat for the Gane's Blind Snake includes Rocky Plains and Footslopes, Rocky Hills, and Mulga Woodlands.

Figure 10-17: Gane's Blind Snake records and Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Gane's Blind Snake (P1) records
- Water feature

Roads (LGATE-195)

- Highway
- Minor Road

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Kilometers

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Central Pilbara, Western Australia

GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Gane's Blind Snake (P1) records

Roads (LGATE-195)

- Minor Road

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0 1 2
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Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 2 of 4

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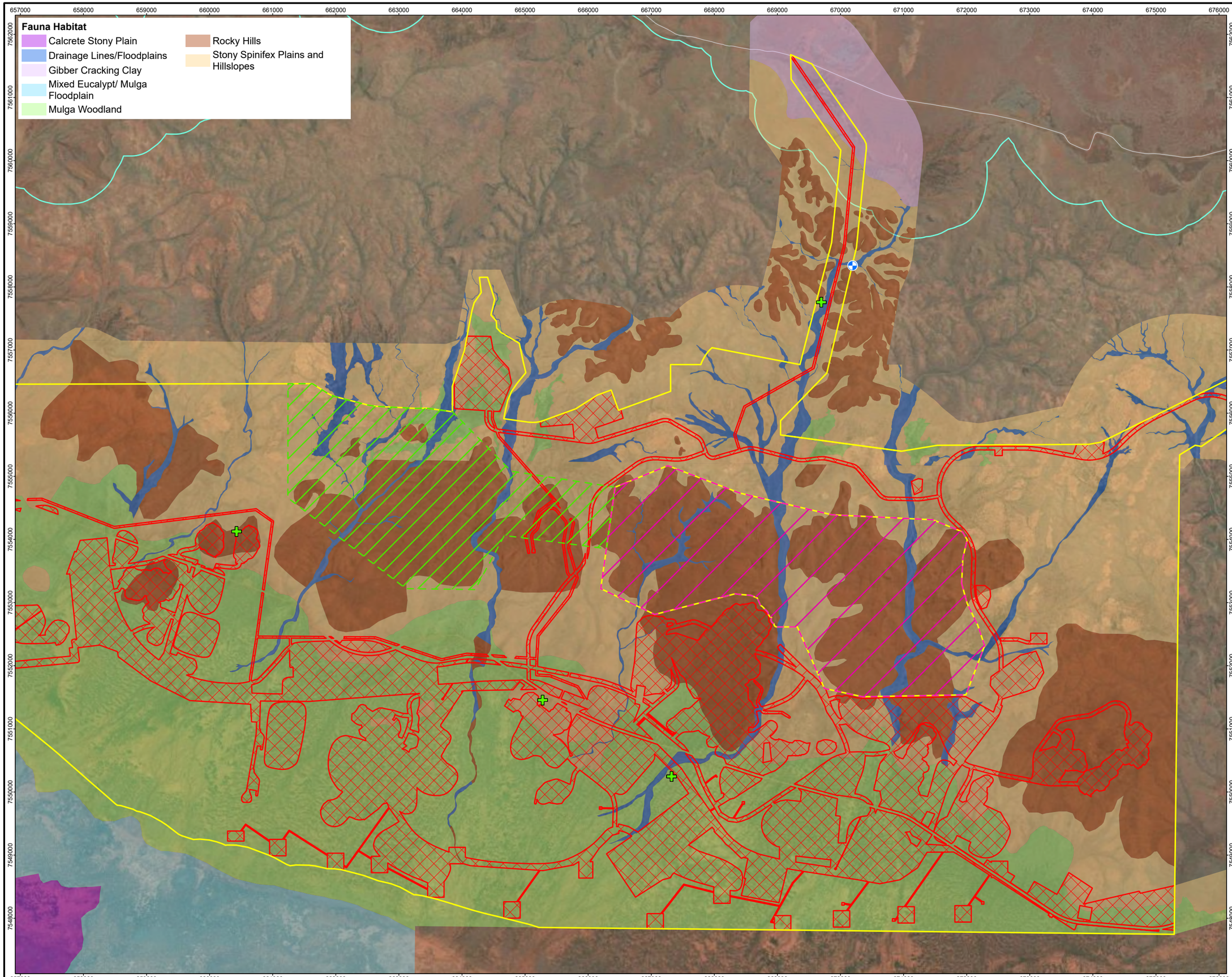

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Gane's Blind Snake (P1) records
- Water feature

Roads (LGATE-195)

- Minor Road

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
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GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 3 of 4

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Image Reference: World Imagery: Earthstar Geographics

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

GREAT NORTHERN HWY

Legend

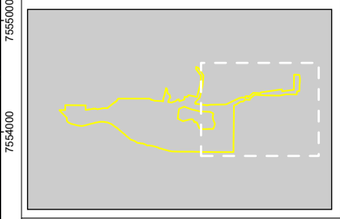
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)
- Water feature

Roads (LGATE-195)

- Highway
- Minor Road



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Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GANE'S BLIND SNAKE RECORDS AND HABITAT

FIGURE 10.17 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics

10.3.3.10 Spotted Ctenotus (*Ctenotus uber johnstonei*)

Conservation Status: DBCA: Priority 2.

Distribution, Habitat and Ecology

Habitat preferences for the Spotted Ctenotus are poorly known however previous records of the subspecies in the Pilbara region are associated with stony hillslope and plain habitats with variable vegetation cover often dominated by open Acacia shrubland and Triodia hummock grasslands (Cogger 2014).

Surveys

Surveys completed for the Proposal targeting the Spotted Ctenotus included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**); and
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

The total survey effort undertaken for the Spotted Ctenotus by *ecologia* (2021a), Biologic (2022b) and Spectrum (2023a; 2024b) and included 229.38 hours targeted surveys and 55 hours of nocturnal searches.

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats, shed skins and pebble-mounds) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included raking leaf litter and spoil heaps, overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence (Attexo 2023).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

No evidence of this species was recorded in the Development Envelope. This species has previously been recorded approximately 30 km west of the Development Envelope and is considered likely to be a resident of Mulga Woodland, Stony Plains and Slopes and Drainage Area/Floodplain habitats. It should be noted that there is currently some taxonomic uncertainty regarding the isolated Pilbara population of this subspecies, and the population may represent an undescribed taxon.

Habitat considered suitable for the Spotted Ctenotus include Mulga Woodland, Stony Spinifex Plains and Hillslopes, and Drainage Line/Floodplain.

10.3.3.11 Western Pebble-mound Mouse (*Pseudomys chapmani*)

Conservation Status: DBCA: Priority 4.

Distribution, Habitat and Ecology

The Western Pebble-mound Mouse is endemic to the Pilbara region of Western Australia. Distribution extends from southern and central Pilbara to the Little Sandy Desert (Van Dyck and Strahan, 2008a) It is one of three species of Australian rodent that constructs an underground burrow system with a permanent arrangement of stones above ground at the entrances (Anstee, Roberts and Shea, 1997a). They are found on pebbled soil in arid tussock grassland and acacia woodland on gentle slopes of rocky ranges, with hard spinifex and scattered shrubs. The mice have a complex social structure and are known to occur in groups of up to 12 animals, who may utilise several burrow structures (Anstee, Roberts and Shea, 1997b). Male home ranges were found to be considerably larger than those of females, particularly during breeding season (Anstee, Roberts and Shea, 1997b).

Surveys

Surveys completed for the Proposal targeting the Western pebble-mound Mouse included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey(**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**);
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Additionally, the Spectrum (2024a) Mulga Downs Iron Ore Mine Targeted Bilby and Night Parrot Survey identified mounds at 26 sites during this survey.

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats and pebble-mounds) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence (Attexo 2023).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., mounds, scratching, diggings, tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

The Western Pebble-mound Mouse was recorded across the Development Envelope via secondary evidence in the form of used and disused mounds. Gibber cracking clay habitat type is considered important breeding and foraging habitat but the records within the Development Envelope show the species occurs primarily within Stony Spinifex Plains and Hillslopes and Rocky Hills habitats (Table 10-6**;** Figure 10-18This habitat type is within the FHEZ and the FHEZ Corridor with numerous mounds, both active and inactive present.

Habitat which supports the Western Pebble-mound Mouse includes Rocky Plains and Footslopes, Gibber Cracking Clay, Stony Spinifex Plains and Hillslopes, and Rocky Hills.

10.3.3.12 Brush-tailed Mulgara (*Dasycercus blythi)*

Conservation Status: Priority 4, DBCA

Distribution, Habitat and Ecology

The Brush-tailed Mulgara is a significant mesopredator in arid Australia occupying both sand plains and gibber plain habitats, the latter being a new habitat for the species (Pavey et al., 2011). This species displays home ranges that overlap between sexes encompassing both mature spinifex and open regrowth. Mature spinifex hummocks appear to be important for protection from introduced predators (Kortner et al., 2017). The Brush-tailed Mulgara excavates single entrance burrows with multiple side tunnels that may terminate at surface 'pop-holes'. It is a nocturnal hunter, predating upon rodents, reptiles, and arthropods. Breeding takes places during the winter months with females recorded carrying young in September (Van Dyck and Strahan 2008).

Surveys

Surveys completed for the Proposal targeting the Brush-tailed Mulgara included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**);
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats) and/or habitat features of importance (i.e., den sites, roost caves and/or water features) likely to be utilized by these species. Unmanned Aerial Vehicles (UAVs) were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence (Attexo 2023).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., burrows, scratching, diggings, tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

The Brush-tailed Mulgara was not recorded during surveys within the Development Envelope, however is considered likely to occur. The nearest record of this species is located approximately 23 km north east of Mulga East. The likelihood of occurrence within the Development Envelope is possible as a resident of Drainage Area/Floodplain habitats where suitable vegetation cover and sandy or loamy substrates permitting burrowing are present. The species occurrence and abundance is dependent on seasonal conditions particularly following rainfall events when resources are more abundant.

10.3.3.13 Northern Short-tailed Mouse (*Leggandina lakedowensis*)

Conservation Status: Priority 4, DBC

Distribution, Habitat and Ecology

The Short-tailed Mouse is a small rodent with a 50-85mm snout vent length. The Short-tailed Mouse has been recorded sporadically across northern Australia from the tropical coast extending to semi-arid regions (Moro and Kutt 2008). They are found in a variety of habitats including spinifex and tussock grasslands, samphire shrublands, sedgelands and open woodlands. Most records are from seasonally inundated sandy clay or cracking clay soils in which it constructs simple, single chambered burrows (Kutt and Kemp, 2005). Its diet consists of primarily invertebrates but also plants, which supplement water requirements (Watts and Aslin 1981). This species is sparsely distributed across Australia with the most abundant population occurring on Thevenard Island and the recently established Serrurier Island (Moro and Morris 2000).

Surveys

Surveys completed for the Proposal targeting the Northern Short-tailed Mouse included:

- *ecologia* (2021a) Mulga East Project Baseline Terrestrial Vertebrate Fauna Assessment (**Appendix 11a.1**);
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) MDIOP Solar Farm, Haul Road and Pipeline, Vertebrate and Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**);
- Spectrum (2024b) Mulga downs Iron Ore Mine Supplementary Targeted Fauna Survey (2417) (**Appendix 11f**).

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence (i.e., tracks, scats) and/or habitat features of importance (i.e., den sites) likely to be utilized by these species. Unmanned Aerial Vehicles (UAVs) were utilized on several occasions to help identify suitable habitat for these species within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023).

Active forages were undertaken to supplement data and thus, help to define the species assemblages within the Survey Area. Active forages aimed to record any species, from direct observation or secondary evidence of species occurrence. Techniques incorporated into active forages included overturning rocks and logs, investigating dead trees and logs, burrows, rock piles and identification of secondary evidence (Attexo 2023).

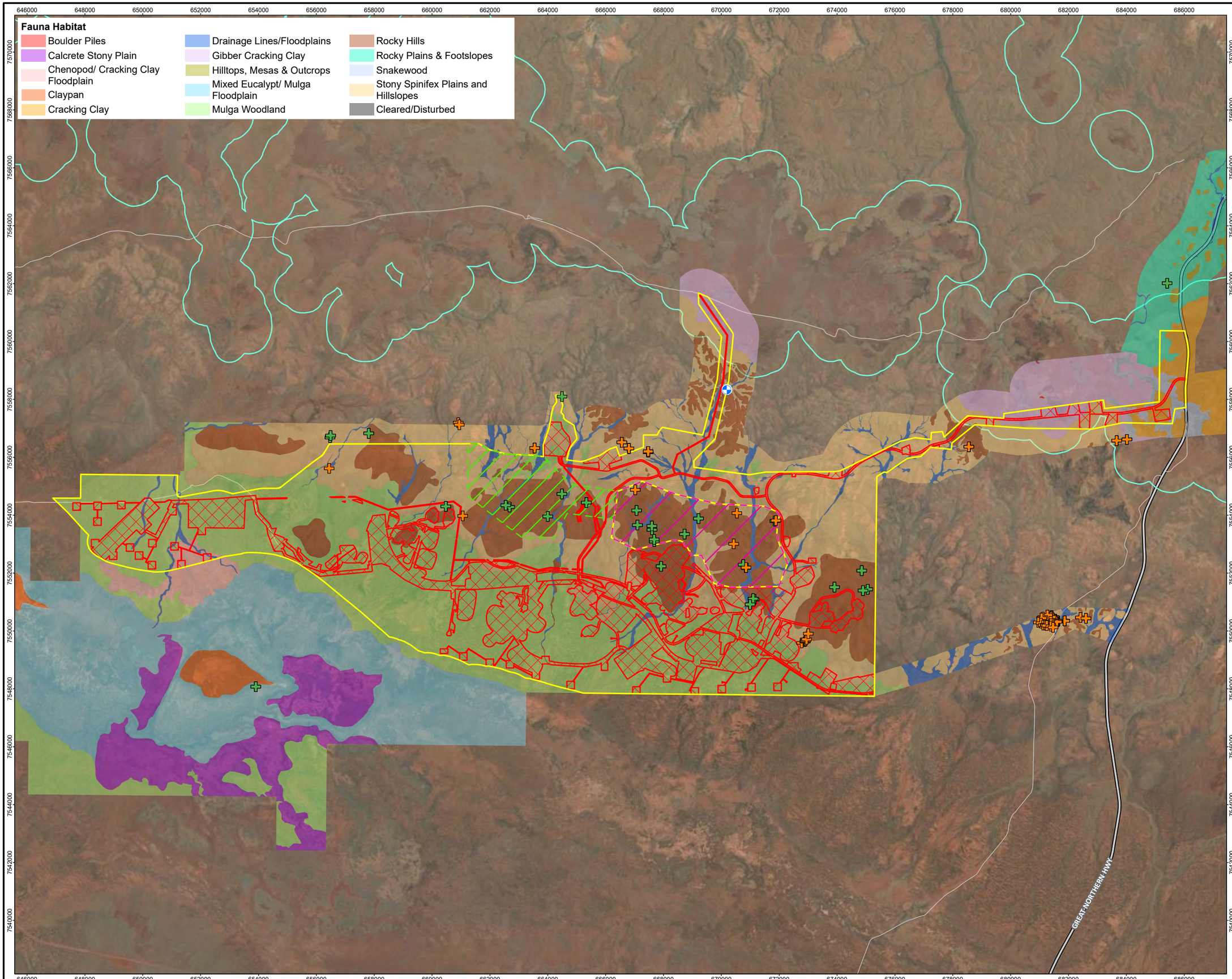
At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g., burrows, scratching, diggings, tracks and/or scats) evidence (Attexo, 2023).

Occurrence in the Development Envelope

The Northern Short-tailed Mouse was not recorded during surveys within the Development Envelope; however, it is considered likely to occur. Suitable habitat likely to support the species occurs within Drainage Area/Floodplains, Mulga Woodland and Gibber Cracking Clay habitats. Abundance within the Development Envelope is likely to fluctuate particularly following rainfall events when resources are most abundant.

Despite the targeted survey effort, no primary or secondary evidence of Northern Short-tailed Mouse was recorded in the Development Envelope from any of the surveys. The likelihood of Northern Short-tailed Mouse breeding and forming dens within the Development Envelope is considered low and this species is instead considered to be a visitor. The presence of cats, foxes and wild dogs, which are known predators of the Northern Short-tailed Mouse (DCCEEW 2023j; Pavey 2006), further decreases the likelihood of Northern Short-tailed Mouse being residents within the Development Envelope (*ecologia* 2021a).

Figure 10-18: Western Pebble-mound Mouse records and Habitat



Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature

Observation method

- Direct observation
- Secondary evidence

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

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Drawn By: droberts	Checked By: VC

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 1 of 4

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Fauna Habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)

Observation method

- Direct observation
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Roads (LGATE-195)

- Minor Road

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Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 2 of 4

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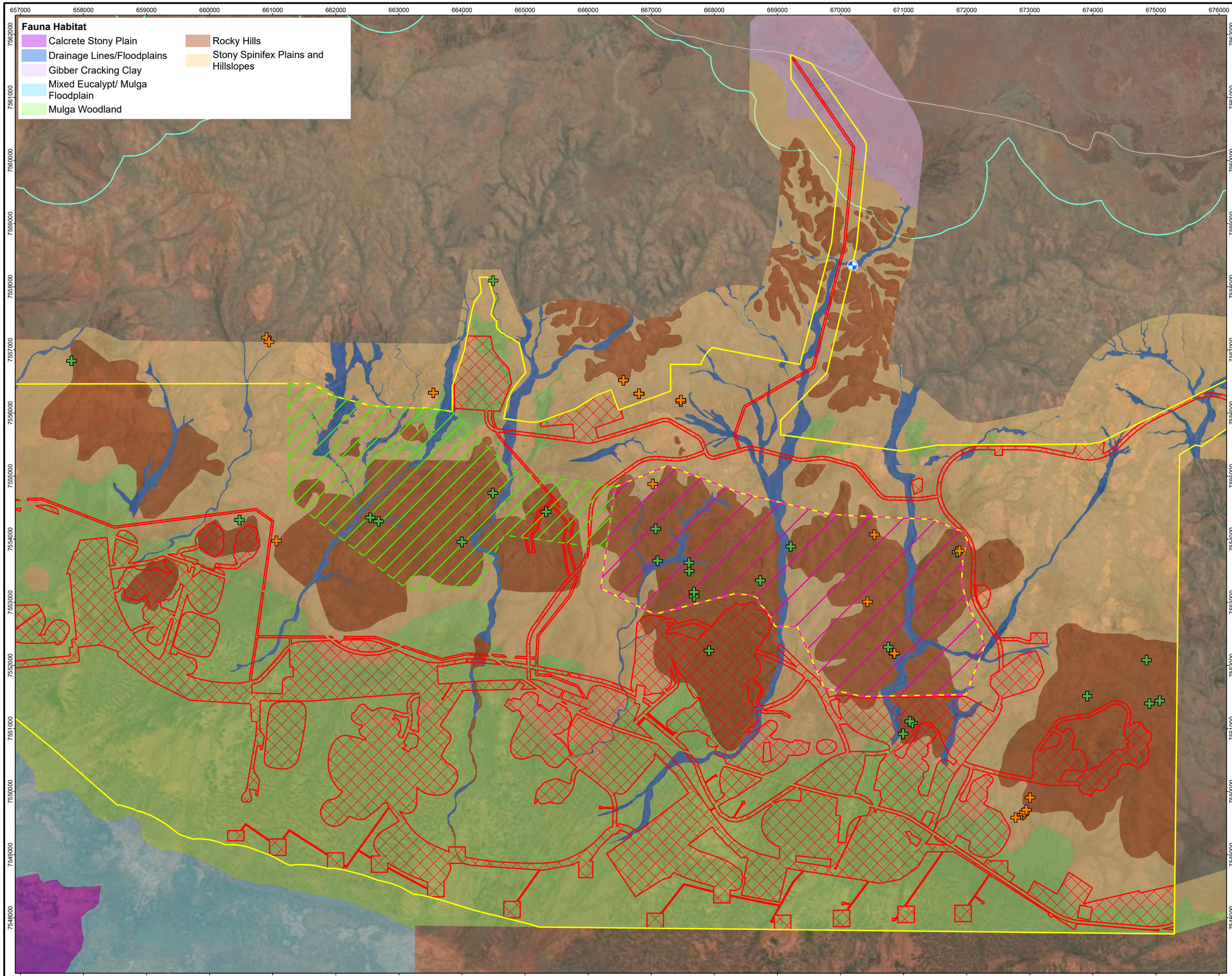

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
- Water feature

Observation method

- Direct observation
- Secondary evidence

Roads (LGATE-195)

- Minor Road

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WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 3 of 4

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Image Reference: World Imagery: Earthstar Geographics

Fauna Habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Prioirty 1)
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Observation method

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Mulga Downs Iron Ore Mine
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WESTERN PEBBLE-MOUND MOUSE RECORDS AND HABITAT

FIGURE 10.18 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics

10.3.3.14 Migratory Bird Species

The following migratory species have the potential to be located in the Development Envelope:

- Common Greenshank (*Tringia nebularia*);
- Wood Sandpiper (*T. glareola*);
- Glossy Ibis (Plegadis falcinellus); and
- Red-necked Stint (*Calidris ruficollis*).

Conservation Status: Migratory

Distribution, Habitat and Ecology

The migratory bird species which are considered of particular relevance to the Development Envelope are the Common Greenshank (*Tringia nebularia*), Wood Sandpiper (*T. glareola*), Red-necked Stint (*Calidris ruficollis*), and Glossy Ibis (*Plegadis falcinellus*). All are categorised as Migratory under the BC Act.

The Common Greenshank is a heavily built, elegant wader, 30 cm –35 cm in length, with a wingspan of 55 cm–65 cm and weight up to 190 g for both males and females. It does not breed in Australia. However, this species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia. In Western Australia, the Common Greenshank is generally absent from the Western Deserts although there are a few records from the Great Sandy Desert and the Nullarbor Plain. It occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberley, it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago (Higgins & Davies, 1996).

The Wood Sandpiper is species is of a similar size and has similar habits to the Common Greenshank. It breeds in northern Europe, north Asia and winters in southern areas including Australia where it inhabits shallow freshwaters (river pools, lakes, claypans, lagoons, swamps) and is less likely to occur in salty or brackish waters (Johnstone and Storr 1998, *ecologia* 2021a). This species is highly mobile and tends to be found around any open body of water including pools in drainage lines after rain. Largest numbers are recorded in north-west Australia, with all areas of national importance located in Western-Australia.

The Red-necked Stint is a small *Calidridinae* approximately 13 cm – 16 cm in length and is the smallest shorebird in Australia (Geering et al. 2007, JBS&G 2022). It is distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint has been recorded in all coastal regions and found inland in all states when conditions are suitable. Important populations are found at the Eighty Mile Beach (Ramsar Listed) and Port Hedland Saltworks and various other coastal areas in Australia. The Red-necked Stint breeds in Siberia and sporadically in north and west Alaska.

The Glossy Ibis is the smallest ibis known in Australia. It is found singularly, in pairs or in small flocks. Large flocks are also occasionally large, for example the largest was about 60 000 birds in the Alligator Rivers region, Northern Territory (Morton et al. 1989). The Glossy Ibis is found in the company of other ibis such as the Straw-necked Ibis (*Threskiornis spinicollis*) or Australian White Ibis (*Threskiornis molucca*). Breeding is colonial and often with or near other ibis, herons, and egrets (Marchant & Higgins 1990).

Surveys

Targeted searches were undertaken within areas considered to provide suitable habitat for conservation significant species identified in the desktop and literature assessments. These searches primarily focused on recording species from direct observation, secondary evidence and/or habitat features of importance likely to be utilized by these species. UAVs were utilized on several occasions to help identify suitable habitat within the Survey Area. This reconnaissance was used to refine the targeted and active foraging survey effort (Attexo 2023; **Appendix 11c**).

At all times while surveying, all records pertaining to species not previously recorded during the survey, particularly significant species or other fauna of interest were documented. These records include those from primary (i.e., direct observation of species) or secondary (e.g. scats, nests) evidence (Attexo 2023).

Occurrence in the Development Envelope

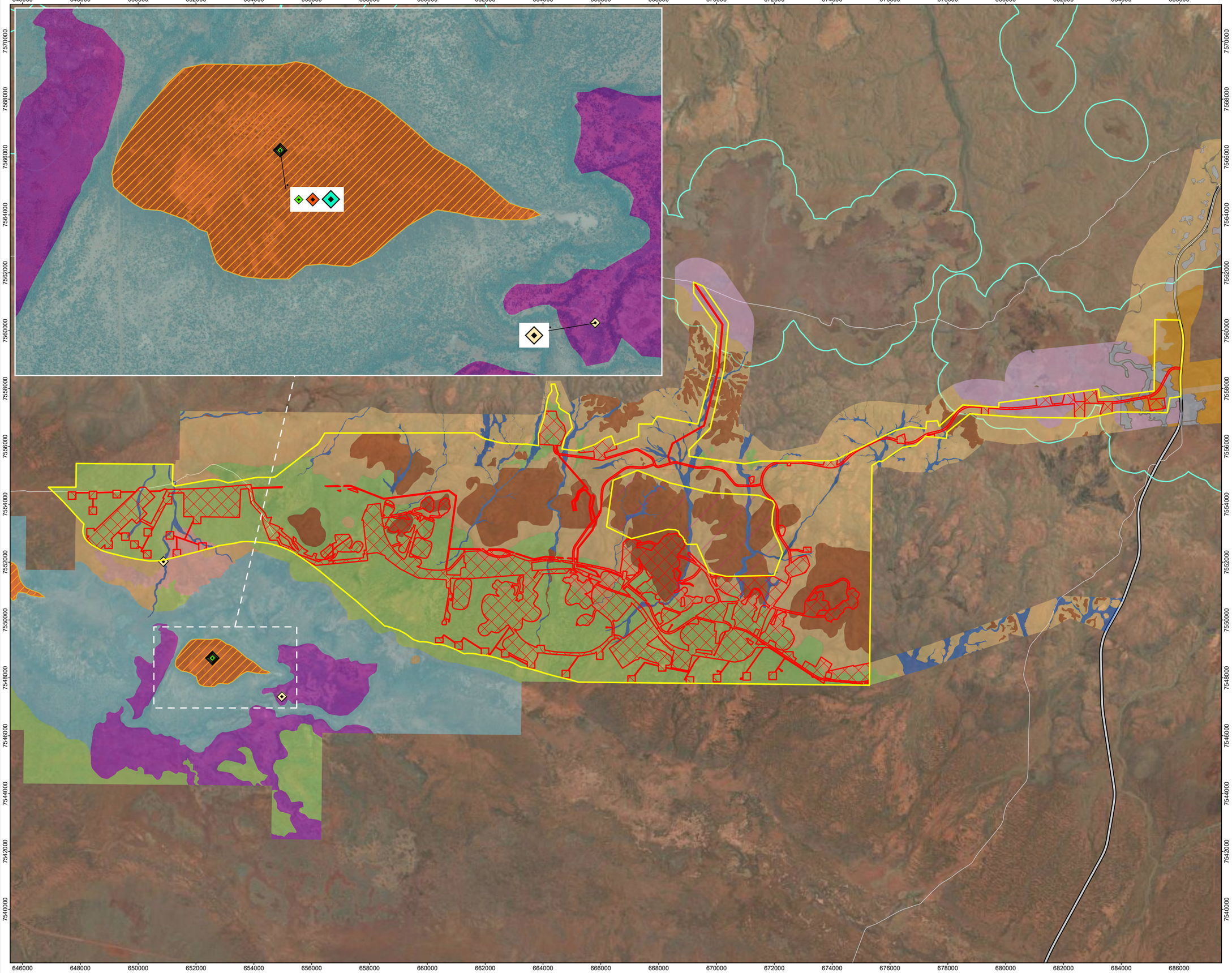
The Common Greenshank is highly mobile species and was recorded on several occasions utilising the surface water features within the Gnalka Gnoona Claypan. The species is considered to be an infrequent visitor to the Claypans and Drainage Lines habitat and Mixed Eucalypt/Mulga Floodplain within the Development Envelope, when these areas have been inundated after rainfall (**Figure 10-19**).

The Wood Sandpiper was recorded during surveys across the Mulga East area within the Gnalka Gnoona Claypan and is considered to be an infrequent visitor to the Claypan and Mixed Eucalypt/Mulga Floodplain habitats in the Development Envelope when this area is inundated after rainfall. This species has been previously recorded within the Upper Fortescue Marsh (EPA, 2013).

Two records of the Glossy Ibis were identified by database searches within 40 km of the Development Envelope including one historical record at the Gnalka Gnoona Claypan in 2004. Although this species was not recorded during surveys, it is likely to be an infrequent visitor to the Claypan habitat in the Development Envelope

Eight Red-necked Stints were recorded within the Gnalka Gnoona Claypan on two separate occasions during surveys across the Mulga East area. It is considered likely that this species will be an infrequent visitor to the Claypan habitats in the Development Envelope when inundated after rainfall. The large salt crust habitat on the margins of the Upper Fortescue Marsh is considered to be optimal foraging habitat for waders such as the stint.

Figure 10-19: Migratory Species Records



Legend

- Development Envelope
- Indicative Footprint
- Claypans
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Snakewood
- Rocky Plains and Footslopes
- Cleared/Disturbed

BC Act (Migratory)

- Common Greenshank
- Little Curlew
- Red-necked Stint
- Wood Sandpiper

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 02-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MIGRATORY SPECIES RECORDS

FIGURE 10.19

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics
World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.4 Vertebrate Fauna Habitat

Basic fauna habitat assessments were conducted throughout the Development Envelope to broadly describe areas of habitat that were distinguishable by vegetation, soil characteristics and land features. The identified habitats were considered likely to support different fauna assemblages to those found in adjoining habitat types. The assessment of the Development Envelope paid particular attention to the likelihood of conservation significant fauna to be present in each habitat type. Extensive ground truthing of habitat types during subsequent surveys allowed fauna habitat mapping within the Development Envelope to be further refined.

10.3.4.1 Habitat Types

Nine broad terrestrial fauna habitat types were identified within the Development Envelope (**Table 10-6**) and shown in Attexo (2023) and Spectrum (2023a). These habitats are:

- Stony Spinifex Plains and Hillslopes;
- Rocky Hills;
- Gibber Cracking Clay;
- Drainage Line/Floodplain;
- Mulga Woodland;
- Chenopod/Cracking Clay Floodplain
- Cracking Clay;
- Snakewood; and
- Rocky Plains and Footslopes.

The condition of the habitats within the Development Envelope ranged from 'Degraded' to 'Excellent' (Attexo 2023). Areas identified as 'Degraded' were primarily disturbed by cattle grazing. The Mulga Downs Station has been an operational pastoral lease for over 100 years. As a result, there is long-term impacts to vegetation from overgrazing, trampling, and from the spreading of weeds. The most impacted are the Chenopod/Cracking Clay Floodplain, Drainage Line and Mulga Woodland habitats which have a lower rating of 'Good'. The lower rating in habitat condition for the Mulga Woodland is a result of exploration activities, with areas cleared for drill lines (Attexo 2023) (refer to **Section 9**– Flora and Vegetation, **Figure 9-3** for mapped vegetation condition).

Table 10-6: Mapped Vertebrate Fauna habitat within the Development Envelope [2]

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
Mulga Woodland	Compacted alluvial loamy clay soils with occasional surface stones are generally not favourable for burrowing species with few burrows recorded during the surveys. Dead wood, peeling bark, stumps and leaf litter provide shelter for marsupials, monitors, geckos and skinks. Open woodland of *Acacia aneura, A. xiphophylla* with isolated *A. pruinocarpa* over *Acacia* spp., *Eremophila* spp., *Dodonaea petiolaris* and *Hakea* sp. over sparse soft grasses or *Triodia hummock* grasslands. The Mulga Woodland has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Regionally this habitat type is generally well represented.	43,575.10	8,203.43	2,824.74	**Low:** Considered generally of low value to conservation significant fauna. Fauna recorded: • Gane's Blind Snake; This habitat type is foraging habitat for: • Pilbara Leaf-nosed Bat (Priority 5 foraging habitat); • Bilby (not burrowing); • Peregrine Falcon; • Spotted Ctenotus; and • Northern Short-tailed Mouse.	
Rocky Hills	The Rocky Hills provides quality refugia, shelter and caves for conservation significant species. Ridgelines, boulders, crevices and caves provide shelter, denning and roosting habitat for species including Northern Quolls, Pilbara Leaf-nosed Bat, Ghost Bat , Pilbara Olive Python, Rothschild's Rock Wallaby, rock rats, monitor lizards and *Pseudantichinus* sp.. This habitat is recognised as an area where the Northern Quoll population have retreated, allowing for the population to persist. Rocky Hills are considered common and widespread throughout the Pilbara.	11,982.01	2,658.23	520.80	**High**: The Pilbara Leaf-nosed Bat and Northern Quoll were recorded within this habitat type within and outside of the Development Envelope. Provides shelter, denning and roosting habitat for species including: • Northern Quolls, • Pilbara Leaf-nosed Bat (Priority 2 foraging habitat), • Ghost Bat, • Pilbara Olive Python, • Ganes Blind Snake • Potential foraging habitat for the Peregrine Falcon. • Western Pebble-mound Mouse	
Stony Spinifex Plains and Hillslopes	Coarse stony red clay soils, the substrates and vegetation support termitaria which are a known refuge for vertebrate fauna. The coarse stony red clay soils provide habitat for the Western Pebble-mound Mouse (DBCA, Priority 4), recorded within and outside of the Development Envelope. Isolated E*ucalyptus leucophloia* over sparse shrubland of mixed *Acacia* spp. Over open spinifex hummock grassland. The *Triodi*a hummocks found are generally small and few isolated long unburnt patches are present. Stony Spinifex Plains and Hillslopes are widespread in the Pilbara.	62,690.54	4,758.15	813.97	**Moderate:** Stony Spinifex Plains and Hillslopes are considered as moderate value as they generally offer minimal refugia to species of conservation significance however, where they are adjacent to high value breeding habitat they are a supporting habitat. The following conservation significant species are known to forage within this habitat type: • Pilbara Olive Python • Northern Quoll; • Pilbara Leaf-nosed Bat (Priority 5 foraging habitat); and • Ghost Bat. • Grey Falcon • Night Parrot (in proximity to mature unburnt samphire only) • Potential foraging habitat for Peregrine Falcon, • Spotted Ctenotus • Westen Pebble-Mound Mouse	

[2] area calculations are based on multiple surveys with some overlap and as a result some figures may be an overestimate.

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
Chenopod/ Cracking Clay Floodplain	This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. This habitat type is not considered widespread in the Pilbara.	983.20	92.78	15.72	**Low:** Due to the condition of this habitat type within the Development Envelope, it is considered low value to species of conservation significance. This habitat type is: • Priority 5 foraging habitat for the Pilbara Leaf-nosed Bat. • Foraging habitat for Night Parrot – in proximity to mature spinifex only. • Potential foraging habitat for Peregrine Falcon.	
Drainage Line/Floodplain	The banks provide quality burrowing substrates for monitors while trees and shrub species provide habitat for birds such as honeyeaters and corellas. Drainage lines are of low to moderate conservation value as they provide foraging and dispersal habitat for fauna. This habitat is considered widespread in the Pilbara. The area has a vegetation system of scattered *Eucalyptus vict*rix or *Corymbia hamersleyana* over an open shrubland of *Acacia tumida* and *A. pyrifolia* over hummock and tussock grasses.	38,141.21	522.64	71.26	**Moderate - High**: Drainage lines are of moderate conservation value as they provide foraging and dispersal habitat for fauna. They are considered high value when they are within the home range for the Northern Quoll breeding habitat. Conservation significant species known to utilise drainage lines include: • Northern Quoll – dispersal and foraging habitat; • Ghost Bat - foraging habitat; and • Pilbara Leaf-nosed Bat - Priority 5 foraging habitat. • Greater Bilby; • Potential foraging habitat for Peregrine Falcon, • Spotted Ctenotus • Brush-tailed Mulgara • Northern Short-tailed Mouse This habitat type may also support foraging and potential breeding habitat for the Grey Falcon.	
Gibber Cracking Clay	This habitat was previously known as the 'Cracking Clays of the Chichester and Mungaroona Range' P1 Priority Ecological Community (PEC). This PEC is a stony gibber community occurring on the tablelands and forms one of the plant assemblages of the 'Four Plant Assemblages of the Wona Land System' P1 PEC. Primarily a stony gibber community with very little vegetative cover during the dry season with a suite of ephemerals/annuals and short-lived perennials during wet season. While sporadic in nature, this habitat is considered widespread in the Pilbara.	3,556.27	257.69	56.48	**Moderate:** This habitat type is known to be important breeding, foraging and dispersal habitat for: • Short-tailed Mouse; • Western Pebble-mound Mouse. This habitat also supports non-critical foraging habitat for the following species: • Ghost Bat; and • Peregrine Falcon.	

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
Cracking Clay	Cracking Clay habitat overlaps the 'Four plant Assemblages of the Wona Land System' Priority Ecological Community (PEC) (Priority 1). The land system consists of cracking clays with little vegetation cover during the dry season. With the onset of the wet season numerous ephemerals/annuals and short-lived perennials emerge. Vegetation type: Sparse chenopod shrubland of *Sclerolaena trigona*, *S. bicornis, S. densiflora* over low tussock grasses of *Eragrostis xerophila* on a substrate of cracking clays. Vegetation is generally very sparse with patches of scattered Snakewood *(Acacia xiphophylla)* and occasional Mulga over Buffel and scattered native grasses. Leaf and wood litter was sparse or absent due to lack of vegetation; however, basalt rock cover was found to be abundant. While sporadic in nature, this habitat is considered widespread in the Pilbara.	5529.69	217.84	28.10	**Low:** This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. Marginally suitable as foraging habitat for the Night Parrot. This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby.	
Snakewood	Vegetation type: Vegetation dominated by discrete patches of Snakewood (*Acacia xiphophylla*). The Snakewood (*Acacia xiphophylla*) habitat is restricted to scattered patches within the cracking clay habitat type. Other vegetation recorded in this habitat type included *Acacia inaequilatera* and scattered Mulga and Mesquite over Buffel grass. Leaf and wood litter was very sparse and basalt rock cover was abundant. This habitat occurs within the 'Four plant Assemblages of the Wona Land System' PEC (Priority 1) in association with the Cracking Clay habitat and support the same conservation significant fauna.	731.62	96.55	8.04	**Low:** Provides potential foraging for fauna which occur on Cracking Clay habitat. This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby.	
Rocky Plains and Footslopes	Vegetation characterising this habitat includes *Corymbia hamersleyana*, *Acacia inaequilatera* and *Hakea chordophylla* over hummock grassland of *Triodia* sp.. This habitat type comprises flat to low undulating areas and low hills. Much of the Rocky Plain and Footslope habitat occurs within the lower lying plain which can often be subjected to sheetflow following large rainfall events. In this habitat type there was high abundance of pebbles and stones, while leaf litter was generally very sparse to absent and restricted to beneath shrubs with occasional fallen timber. The substrate of this habitat type consists of loamy clay soils.	32,444.58	37.75	0.00	**Low:** This habitat provides potential foraging habitat in the drainage lines and grasslands. This habitat type has the potential to support: • Northern Quoll • Western Pebble-mound Mouse; • Gane's Blind Snake; • Grey Falcon; • Brush-tailed Mulgara; • Greater Bilby; • Night Parrot (however no suitable breeding habitat was known nearby and the area was recently burnt); and • foraging habitat for the Ghost Bat and Peregrine Falcon.	
Cleared / Disturbed		771.02	3.47	0.04		

Habitat Type	Habitat Description	Total Mapped Extent of Survey (Table 10-2)*	Extent within the Development Envelope (ha)	Extent within the Indicative Footprint (ha)	Potential to Support Conservation Significant Vertebrate Fauna	Representative Photos
Total		**184,423.23**	**16,848.53**	**4,339.16**		

10.3.4.2 Regional Extent of Habitat

Detailed fauna habitat mapping has been completed within the Development Envelope and extending beyond (refer to Attexo 2022 for extent of mapping and refer to Figure 10-20)**.** Mapping is not available for the broader Pilbara region; however, an assessment of land systems provides an indication of the diversity and distribution of fauna habitats present. Van Vreeswyk et al. (2004) classified and mapped the land systems of the Pilbara according to similarities in landform, soil, vegetation, geology and geomorphology.

The land systems represented and typical mapped fauna habitats within the Indicative Footprint are outlined in **Table 10-7.** The dominant land systems within the Development Envelope are also the dominant land systems surrounding the Development Envelope. All mapped land systems extend well beyond the Development Envelope in the Pilbara Bioregion (refer to **Figure 3-2**) with the Development Envelope representing 11% or less of the mapped extent of any system.

Table 10-7: Land Systems and Related Fauna Habitat

Land System	Description	Current Extent in the Pilbara Bioregion (ha)	Extent within Development Envelope (ha)	% of mapped extent in the Pilbara Bioregion that occurs within Development Envelope	Key Aligned Fauna Habitat Types within the Indicative Footprint
Bonney System	Low rounded hills and undulating stony plains supporting soft spinifex grasslands.	74,940.55	61.07	0.08	Gibber Cracking Clays
Boolgeeda System	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	955,011.33	1,681.95	0.18	Stoney Spinifex plains
Brockman System	Level non-saline alluvial plains with clay soils and gilgai microrelief and flanked by slightly more elevated hardpan wash plains.	74,102.33	91.39	0.12	Chenopod / Cracking Clay Floodplain
Hooley System	Level plains of clayey and stony alluvium as a mosaic of surfaces with gilgai microrelief, sometimes stony and non-gilgaied surfaces with abundant stony mantles.	59,081.14	1,578.16	2.67	Mulga Woodland
Jamindie System	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	192,227.16	6,881.74	3.58	Mulga Woodland
Jurrawarrina System	Plains receiving overland sheet flow and with prominent drainage groves.	66,431.76	17.79	0.03	Mulga Woodland Drainage Lines / Floodplains
McKay System	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary	424,812.89	1,514.26	0.36	Stoney Spinifex Plains

Land System	Description	Current Extent in the Pilbara Bioregion (ha)	Extent within Development Envelope (ha)	% of mapped extent in the Pilbara Bioregion that occurs within Development Envelope	Key Aligned Fauna Habitat Types within the Indicative Footprint
	rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.				Rocky Plains and Footslopes
Newman System	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,986,807.91	4,282.31	0.22	Rocky Hills Stoney Spinifex Plains Rocky Plains and Footslopes
Wona System	Basalt upland gilgai plains supporting Roebourne Plains grass and Mitchell grass tussock grasslands, minor hard spinifex grasslands or annual grasslands/herbfields.	194,792.87	583.40	0.30	Chenopod / Cracking Clay Floodplain
Rocklea System	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.	2,881,635.56	156.49	0.01	Rocky Plains and Footslopes

10.3.4.3 Claypans

Two claypans, which form part of the 'Freshwater claypans of the Fortescue Valley' P1 PEC occur outside the Development Envelope: Gnalka Gnoona to the south-east and Koodjeepindarranna to the west (refer to **Section 9.3.5.2**). They are considered to provide temporary habitat for migratory species following rain and the ponding of surface water. While these claypans are not within the Development Envelope, they are located in the vicinity of the Proposal (refer to **Figure 9-4**).

The claypans also support a diverse and highly unique aquatic invertebrate assemblage which are discussed further in **Section 10.3.6**.

The potential impact to these claypans from the Proposal is addressed under the environmental factors Inland Waters in **Section 7** and Flora and Vegetation in **Section 9**.

10.3.4.4 Caves

The Proposal is located within the Chichester IBRA subregion flanking the Fortescue Valley IBRA subregion. The area contains rocky outcrops known to support numerous caves which may provide habitat for fauna. Extensive searches were conducted of all rocky outcrops within the Survey Area by *ecologia* (2021a) to identify the presence of suitable diurnal roosting caves. Any caves within the Survey Area with the characteristics to be used as a diurnal roost were surveyed using autonomous recording units (ARUs). Rocky ridgelines and breakaways

were identified using aerial imagery and unmanned aerial vehicles (UAVs), and subsequently traversed on foot to undertake cave habitat assessments, with the aim of outlining potentially suitable roosting caves for the Pilbara Leaf-nosed and Ghost bats (*ecologia*, 2021a; 2023a).

A total of 82 caves, all located within the Rocky Hills habitat type, were assessed within the Survey Area for characteristics required for bat roosts. Cave habitats were assessed against the following criteria (*ecologia* 2023a):

- **Permanent diurnal (Categories 1 and 2) roosts** - Permanent diurnal roosts - Category 1 permanent roosts are maternity roosts where seasonal presence of young is proven. These often have large colonies present. Category 2 permanent roosts are occupied year-round but without the proven presence of young. Based on wet season presence, these must also be classed as maternal sites, and these often have smaller colonies present. Both categories are considered as critical habitat that is essential for the daily and long-term survival of the Pilbara Leaf-nosed Bat and Ghost Bat.
- **Category 3** - Semi-permanent diurnal roosts - These are used diurnally during some part of the year, but not occupied year-round. They may be used during the breeding cycle and also may facilitate long distance dispersal in the region, particularly in the autumn. They are often associated with a nearby Category 1 or 2 permanent roost as a 'satellite' roost, that together make up a colony. They are considered as critical habitat that is essential for the long-term survival of the Pilbara Leaf-nosed Bat and Ghost Bat.
- **Category 4** - Nocturnal refuge - These are occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. These are not considered critical habitat but are important for persistence in a local area. Most moderately deep caves and shallow abandoned mines fall into this category.

From earlier surveys, one cave (MEC016) was identified as a potential transitory roost (Category 3) for the Pilbara Leaf-nosed Bat (*ecologia* 2021b). Further assessment by *ecologia* (2023a) along with a comprehensive peer review of the long-term data collected at MEC016 (Specialised Zoological 2021) concluded that Cave MEC016 is a Category 4 nocturnal refuge or place of occasional visitation (*ecologia* 2023a). The assessment and the peer review are provided in **Appendix 11h**.

No known or suspected Category 1, 2 or 3 caves exist within the Development Envelope or documented within a 30 km radius. There is anecdotal evidence of roost caves south of the Fortescue Valley within the Hamersley ranges (Bob Bullen pers. comm in *ecologia* 2023a). A summary of the caves surveyed, and the assigned roost categories is presented in Table 2.3 of *ecologia* (2023a).

Of these 82 cave assessments within the Survey Area, 51 were determined as having characteristics of a Category 4 cave (nocturnal refuge) (**Table 10-8**).

In applying the mitigation hierarchy, HPPL identified an area which was not proposed for mining and supported habitat considered high value for MNES. The FHEZ was initially removed from the Development Envelope via a section 43A (EP Act) variation to the Proposal. The FHEZ was expanded via a subsequent section 43A variation to include the Rocky Hill habitat to the west. This measure has resulted in the preservation of 36 caves which are suitable as Category 4 nocturnal roosts within 1,320.82 ha exclusion zone (FHEZ). The FHEZ contains Rocky

Hills (950.81 ha), Drainage Line/Floodplains (107.62 ha) and Stony Spinifex Plains and Hillslopes (262.39 ha) habitat, all are important for conservation significant fauna when proximal to Rocky Hills habitat.

Given the high value of the FHEZ and the significance that fragmentation may have on fauna, HPPL implemented further mitigation with the establishment of a corridor (FHEZ Corridor). This area is within the Development Envelope and comprises 991.45 ha which connects the FHEZ to the Chichester Ranges north of the Development Envelope. The FHEZ Corridor allows for the continuation of high value habitat (548.14 ha of Rocky Hills habitat) which is interspersed by Drainage Lines/Footslopes (75.00 ha) with Stony Spinifex Plains and Hilltops habitat (331.16 ha) (refer **Figure 10-20**). Fauna can forage and disperse along the Drainage Lines/Footslopes which also connect to the McKay Land System which supports Rocky Hills, ridges, plateaux remnants and breakaways.

Of the 51 Category 4 caves, 36 will remain in the FHEZ. The FHEZ will not be developed as it is not in the Development Envelope. The FHEZ supports habitat considered high value to the Pilbara Leaf-nosed Bat, Ghost Bat and Pilbara Olive Python. It also supports habitat critical for the survival of the Northern Quoll. An additional six Category 4 caves are located in the FHEZ Corridor and will also be avoided. In total 42 caves found suitable for the Pilbara Leaf-nosed Bat and/or Ghost Bat will be preserved (**Table 10-8**).

Of the 51 Category 4 caves found suitable for Pilbara Leaf-nosed Bat, 15 are located within the Development Envelope and eight are within the Indicative Footprint. Twenty-four of the 51 Category 4 caves were found suitable for the Ghost Bat. Nine are located within the Development Envelope of which five are within the Indicative Footprint. Of the remaining caves suitable for the Ghost Bat which will be preserved – 15 are located outside the Development Envelope within the FHEZ and five are in the FHEZ Corridor (**Table 10-8**).

These Category 4 caves are nocturnal refuge with the potential for these caves to be used at night for resting, feeding or other purposes. They are not considered critical habitat for both the Pilbara Leaf-nosed and Ghost Bat species but may play a role for the persistence of the species in the local area, with the majority of moderately deep caves in the Pilbara falling into this category (Bat Call WA 2021b).

Figure 10-20: Mapped Vertebrate Fauna Habitat

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communties (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 15-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint
- FHEZ Corridor

Priority Ecological Communities (DBCA)

- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A | Date: 15-Nov-2024

Drawn By: droberts | Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 2 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
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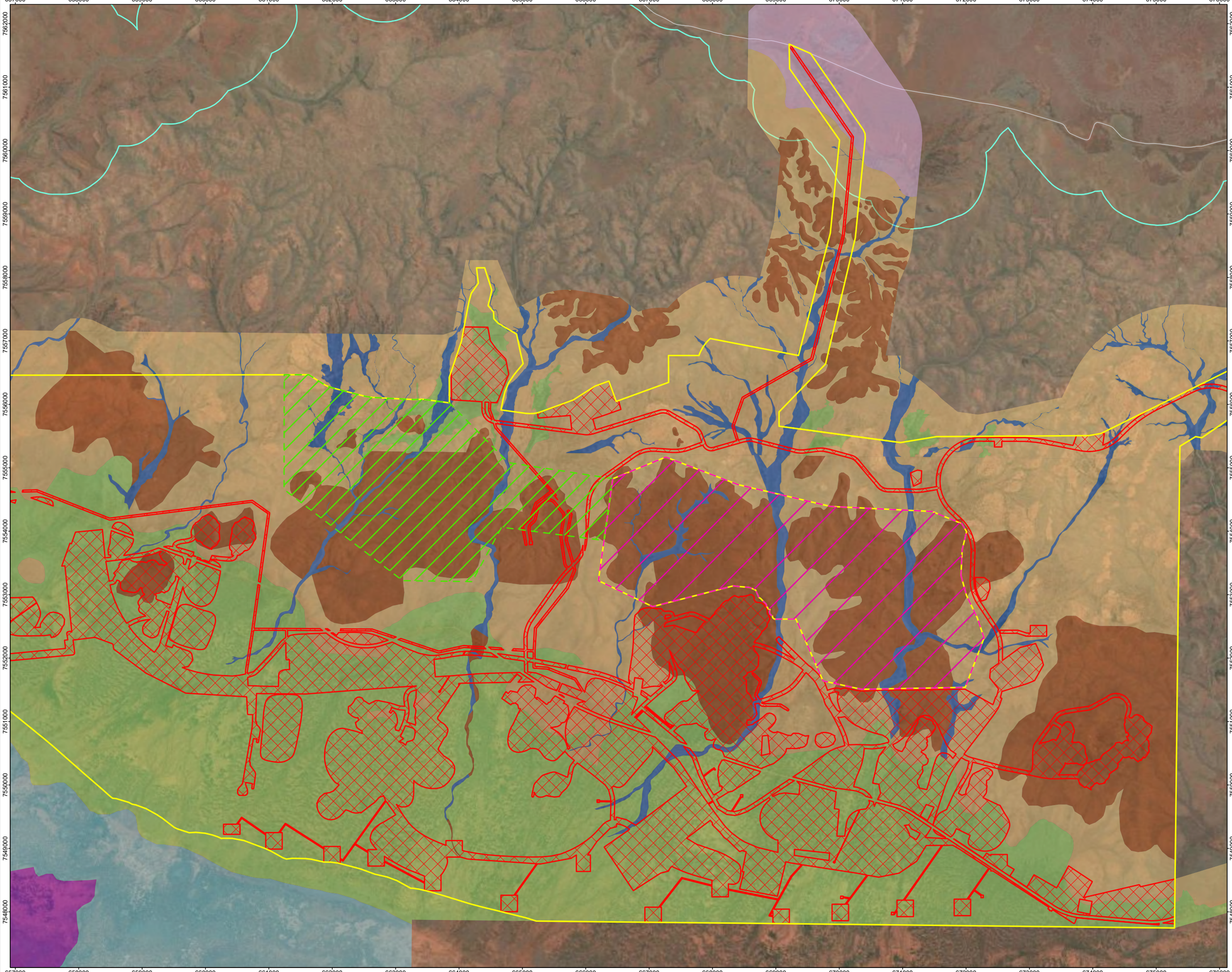


Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Priority Ecological Communities (DBCA)

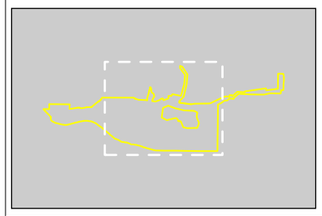
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road



JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 15-Nov-2024
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Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 3 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

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7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Priority Ecological Communities (DBCA)

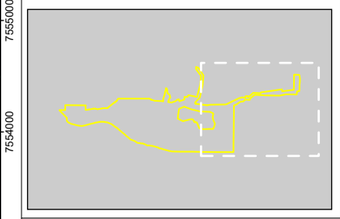
- Four plant assemblages of the Wona Landsystem (Priority 1)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road



JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 15-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:55,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

MAPPED VERTEBRATE FAUNA HABITAT WITHIN THE DEVELOPMENT ENVELOPE

FIGURE 10.20 Map 4 of 4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Table 10-8: Category 4 Caves Surveyed for Pilbara Leaf-nosed and Ghost Bats (X = cave found to be suitable)

Cave ID	Caves in the Development Envelope		Caves in the Disturbance Footprint		Caves in the FHEZ		Caves in FHEZ Corridor[1]	
	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat
MEC001					X	X		
MEC002					X	X		
MEC004					X	X		
MEC006					X	X		
MEC007					X	X		
MEC008					X			
MEC009					X			
MEC010					X			
MEC012					X	X		
MEC015	X	X					X	X
MEC016					X	X		
MEC017	X						X	
MEC018	X	X					X	X
MEC022	X	X					X	X
MEC024	X	X					X	X
MEC025					X			
MEC027					X	X		
MEC030					X	X		
MEC031					X			
MEC033					X			

Cave ID	Caves in the Development Envelope		Caves in the Disturbance Footprint		Caves in the FHEZ		Caves in FHEZ Corridor[1]	
	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat
MEC034					X			
MEC035					X	X		
MEC036	X	X	X	X				
MEC037	X	X	X	X				
MEC038	X							
MEC039					X	X		
MEC041	X	X	X	X				
MEC042	X	X	X	X				
MEC044					X	X		
MEC045					X			
MEC046					X			
MEC048	X							
MEC049					X			
MEC052					X			
MEC054					X			
MEC055					X			
MEC056					X			
MEC062					X			
MEC063					X			
MEC065					X			
MEC066					X			

Cave ID	Caves in the Development Envelope		Caves in the Disturbance Footprint		Caves in the FHEZ		Caves in FHEZ Corridor[1]	
	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat	Pilbara Leaf-nosed Bat	Ghost Bat
MEC068					X	X		
MEC069					X	X		
MEC070					X			
MEC073					X	X		
MEC074					X			
MEC075	X							
MEC076	X						X	
MEC079	X	X	X	X				
MEC080	X							
MEC082					X			
Total suitable for each Species	**15**	**9**	**5**	**5**	**36**	**15**	**6**	**4**
Total Suitable Bat Caves	**15**		**5**		**36**		**6**	

10.3.4.5 Water Bodies/Pools

No permanent water pools were found within the Development Envelope during the surveys (*ecologia* 2023a; Biologic 2022b, Spectrum, 2023a, b). A temporary water body (identified as a persistent channel pool in AQ2 2024b) was noted within the Development Envelope during a biological survey (Biologic, 2022a). This feature is located within the northern infrastructure corridor. Two pools were located immediately adjacent to one another spanning a total length of approximately 40 m with a maximum depth of approximately 0.5 m. *Melaleuca glomerata* was recorded immediately adjacent to the pool. Although *Melaleuca glomerata* prefers subsurface soil moisture, it is a low-level indicator of a GDE. The pool is temporary (persisting for up to 3 months), with the presence of water likely due to rainfall preceding and during the survey (Biologic, 2022a). This pool is likely to provide foraging habitat for Northern Quoll, Pilbara leaf-nosed Bat, Ghost Bat and Pilbara Olive Python, particularly given their preference for dispersal corridors such as drainage lines.

Camera traps were placed at this site in 2022 (Biologic, 2022a). An ARU placed at this location recorded the presence of a Pilbara leaf-nosed Bat. No taxa were recorded on the motion cameras placed at this location. This pool does not fall within the Indicative Footprint. This pool will be retained given the importance of this habitat.

10.3.5 Short Range Endemic Invertebrate Fauna

SRE invertebrates are invertebrates which have naturally small distribution which can be influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions, and historical conditions. These not only influence their distribution but also the tendency for differentiation and speciation (Ponder & Colgan, 2002). The range criterion proposed by Harvey (2002) for terrestrial short-range endemism (for terrestrial invertebrates) of less than 10,000 km^2 (or 100 km x 100 km) has been adopted for EIA (EPA, 2016e). Some better-known SREs have been listed under State legislation. The incomplete taxonomic resolution of many SRE taxa has resulted in a limited number of listings, as such the majority of the SREs are categorised as Potential SREs.

The SRE categorization follows the Western Australia Museum's (WAM) revised classification system for SRE invertebrates, based upon the 10,000 km^2 range criterion proposed by Harvey (2002), and uses three categories (Confirmed SRE, Potential SRE, and Widespread) to describe the degree of certainty with which a species can be considered to be SRE or not (**Table 10-9**).

Table 10-9: SRE categorization

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
Species range < 10,000 km^2	• Confirmed SRE. • A known distribution of < 10,000 km^2. • The taxonomy is well known. • The group is well represented in collections and/or has been comprehensively sampled.	• Potential SRE. • Patchy sampling has resulted in incomplete knowledge of geographic distribution. • Incomplete taxonomic knowledge. • The group is not well represented in collections.

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
Species range > 10,000 km^2	Widespread • A known distribution of > 10,000 km2. • The taxonomy is well known. • The group is well represented in collections and/or has been comprehensively sampled.	• Any other significant knowledge gaps occur.

10.3.5.1 Desktop Assessment

SRE invertebrate desktop assessments undertaken as part of the *ecologia* (2021a), Biologic (summarised in 2022c report) and Spectrum (2023a) faunal assessment yielded 888 records of specimens collected in 144 taxa. Comparing these records and those found through the literature review, a total of 15 Confirmed and 91 Potential SRE invertebrate taxa occur within a 40 km radius of the Development Envelope. Of the potentially occurring taxa, 12 have previously been recorded within the Development Envelope. A summary of the confirmed and potentially occurring SRE invertebrate taxa that have been previously recorded within the Development Envelope are provided in **Table 10-10**.

Table 10-10: SRE Invertebrate Taxa (Confirmed and Potential SRE Status) Identified in Desktop Assessments.

Higher Taxon	Taxon	SRE Status
Araneae		
Actinopodidae	*Missulena* sp. indet.	Potential
Anamidae	*Kwonkan* `MYG325`	Confirmed
	Aurecocrypta `chichester`	Potential
Barychelidae	*Synothele* `MYG237`	Confirmed
	Synothele `MYG311`	Confirmed
Halonoproctidae	*Conothele* `MYG279`	Confirmed
Idiopidae	*Anidiops* `sp. B02`	Potential
	Idiosoma `MYG083`	Confirmed
	Idiosoma `MYG085`	Confirmed
	Idiosoma `MYG300`	Confirmed
Selenopidae	*Karaops banyjima*	Confirmed
	Karaops fortey	Confirmed
Pseudoscorpiones		
Garypidae	*Synsphyronus gracilis*	Confirmed
Scorpiones		
Buthidae	*Lychas* `SCO036`	Potential

Higher Taxon	Taxon	SRE Status
	Lychas `bituberculatus complex`	Potential
	Lychas `*splendens* ms`	Potential
	Lychas sp. indet.	Potential
Urodacidae	*Urodacus* `firetail`	Confirmed
Millipedes		
Paradoxosomatidae	*Antichiropus antius*	Confirmed
	Antichiropus nimbus	Confirmed
Isopods		
Armadillidae	*Acanthodillo* `sp. B14`	Potential
	Buddelundia `sp. 20`	Confirmed
	Buddelundia `sp. B47`	Potential
	Buddelundia `sp. B48`	Potential
	Buddelundia `sp. B49`	Potential
	Buddelundia `sp. B50`	Potential
	Buddelundia `sp. B53`	Potential
Gastropoda		
Camaenidae	*Quistrachia* `*cancellate*` n. sp.	Confirmed

10.3.5.2 Field Surveys

Details of the SRE surveys are presented in **Table 10-2.**

Surveys targeting SREs for this Proposal included:

- *ecologia* (2020) Baseline Terrestrial Invertebrate Fauna (SRE) Level 2 Assessment; (**Appendix 11d**)
- Biologic (2022b) Mulga Downs Iron Ore Project: Transport Corridor to Great Northern Hwy Terrestrial Fauna Survey (**Appendix 11b.2**);
- Biologic (2022a) Mulga Downs Iron Ore Project: Mulga West Borefield and Mulga East Southern Corridor Terrestrial Fauna Survey (**Appendix 11b.1**);
- Spectrum (2023a) Solar Farm, Haul Road & Pipeline: Vertebrate & Short-Range Endemic Terrestrial Fauna Assessment (**Appendix 11g**).

Across all SRE surveys, 705 invertebrate specimens were collected from 60 sample sites. Only one isopod was identified as a confirmed SRE species – *Buddelundia* 56. Consolidation of the data identified that up to 31 potential, at total of 32 SREs OTUs (potential and confirmed) , SREs (**Table 10-11**). This species was recorded during the *ecologia* Phase 2 survey and the Biologic detailed Phase 2 survey. The record is outside the Development Envelope (**Figure 10-21**).

Each survey included dry pitfall trapping, hand foraging, litter collection as well as active burrow searches (*ecologia* 2020; Biologic 2022a; Spectrum 2023a). JBS&G (2024) provides a summary of SRE surveys undertaken and the phases completed and the limitations.

Details of targeted searches are provided in *ecologia* (2020), Biologic (2022a, b, c) and Spectrum (2023a). Searches were each undertaken according to the *Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna* (EPA 2020). **Table 10-2** provides and overview of the relevant survey reports.

Specimens which were unidentifiable were submitted for DNA sequencing, each subsequent survey comparing with the original sequences. DNA was extracted and DNA barcoding sequences (COI) were cross checked with publicly accessible sequences in GenBank and with databases derived from research projects. Fauna-specific genetic distances thresholds for delimiting species (identification) and operational taxonomic units (OTUs – final assigned names) were used wherever possible, based on published literature and the previous survey reports. Where these thresholds were not available, the assessment used average divergence thresholds for related groups or higher taxa developed by broad level studies. In general, ≤ 8% COI divergence is considered appropriate to determine OTUs (Herbet et al. 2003) and this has been applied to the data for MDIOM (refer to Biologic 2022b). Details for the genetic analyses and interpretations are provided in each of the reports.

A summary of the outcomes from each of the surveys is provided below.

ecologia (2021a) collected 496 invertebrate specimens from 52 sites across two Phases of survey. These specimens were from seven target SRE groups including 152 isopods, 129 spiders, one harvestman, 75 pseudoscorpions, 58 scorpions, 33 millipedes and 48 land snails.

Of the specimens recorded, a single isopod species collected during Phase 2 was a confirmed SRE species (*Buddelundia* 56) and 23 species were considered potential SRE species. These include isopods, arachnids, harvestman, pseudoscorpions, millipede and a terrestrial snail. The *Buddelundia* 56 was recorded in the Drainage Line/Floodplain habitat and in the Chenopod/Cracking Clay Floodplain habitat (**Figure 10-21**).

Nine specimens could not be delimited due to a lack of morphological features and were from known or potential SRE groups. These specimens were sent for molecular investigation at the Western Australian Museum (WAM) to determine identity. Single specimens of *Dampetrus* HBI-6519, *Conothele* sp. indet., *Beierolpium* '8/3', *Indolpium* sp. 1, *Indolpium* sp. 2, Olpiidae sp. 3 were selected for molecular analysis. In addition, specimens from each of the scorpion species complexes *Lychas* '*bituberculatus* complex', *Lychas* 'hairy tail complex' and *Lychas* '*multipunctatus* complex' were selected.

Biologic (2022a) found 140 invertebrate specimens representing 28 morphological and molecular taxa, collected from sites outside the Development Envelope. The specimens collected were comprised of mygalomorph spiders (all morphologically identified as the widespread species *Aname mellosa*), pseudoscorpions, scorpions, a polyxenid millipede, aquatic and land snails, and terrestrial isopods. Fifty specimens were sequenced for further elucidation of their identification by Biologic (2022a). The isopod *Buddelundia* 56 was the only confirmed SRE (**Appendix 11**). Both records were from the same site in the Mulga West Borefield which is no longer part of the Proposal as this area has been removed from the Development Envelope.

Additional SRE survey was undertaken by Spectrum in 2023 on the pipeline route, solar farm area and a section of the haul road (Spectrum 2023a; **Appendix 11g**). A total of 69 invertebrate specimens were collected from 10 invertebrate taxa, which included seven potential SRE taxa. The potential SRE taxa included one scorpion, three pseudoscorpions, two isopods and one snail. The majority of the specimens were collected from Mulga Woodland habitat, with the remainder in Drainage Line/Floodplains, Stony Spinifex Plains and Hillslopes and Alluvial Clay Plain.

The majority of the collected OTUs across the surveys were assessed as having limited ranges determined SREs based on lack of available information. The habitats which supported these SREs within the Development Envelope are not fragmented and SRE records indicate dispersal from the eastern most section to past the Mulga West Borefield (no longer part of the Proposal). As the same habitat has been found to extend beyond the Development Envelope it is expected that the SREs are capable of dispersal. Many of the specimens were found at multiple sites, demonstrating dispersal capability.

The consolidated outcomes of the SRE surveys undertaken within the Development Envelope are provided in **Table 10-11**. Full taxon/OTU lists are provided in the reports in **Appendix 11**. A consolidation of the Confirmed and Potential SREs within the Development Envelope and Indicative Footprint is presented in **Table 10-11.**

Table 10-11: SREs (confirmed and potential) located within the within the Development Envelope. Data is a consolidation of all SRE records following DNA Barcoding. Taxa are presented as OTUs (operational taxonomic units)

Taxon/OTUs	SRE Status	Development Envelope	Indicative Footprint	Total in Survey Area
Buddelundia **`sp. SJ_14FMa`_DNA**	Potential	3	0	3
Buddelundia **`sp. SJ_14FMc`_DNA**	Potential	2	0	2
Buddelundia **'10MA'/ SJ_10MA_DNA**	Potential	4	0	6
Buddelundia **14fm**	Potential	4	1	6
Buddelundia **'14FM-c'**	Potential	1	0	1
Buddelundia **'14FM-d'**	Potential	1	1	2
Buddelundia **56**	Confirmed	1	0	14
Buddelundia **indet.**	Potential	1	1	2
Buddelundia **indet. 1**	Potential	0	1	1
Buddelundiinae **'Nyi01'**	Potential	0	1	3
Buddelundiinae **sp. indet.**	Potential	3	1	142
Buddelundiinae **sp. indet.A**	Potential	1	0	1
Buddelundiinae **sp. indet.B**	Potential	1	0	1
Conothele **MYG716**	Potential	1	0	1
Kwonkan **(Yilgarnia) sp. indet.**	Potential	1	0	1
Lychas **hairy tail complex'**	Potential	5	0	6
Lychas **'hairytail complex' (SCO052)**	Potential	2	0	2
Lychas **SCO024**	Potential	4	3	9

Taxon/OTUs	SRE Status	Development Envelope	Indicative Footprint	Total in Survey Area
***Lychas* SCO046**	Potential	1	0	5
***Missulena* sp. indet.**	Potential	0	1	1
***Olpiidae* `sp. PSE176`**	Potential	6	1	11
***Urodacus* sp.**	Potential	2	0	3
***Xenolpium* sp.**	Potential	0	7	17
***Antichiropus* forcipatus**	Potential	2	0	2
***Austrostrophus* sp.**	Potential	2	1	3
***Dampetrus* OPI001**	Potential	0	1	1
***Indolpium* PSE174**	Potential	9	1	17
***Indolpium* PSE175**	Potential	7	1	10
***Indolpium* `sp. MD1`**	Potential	4	0	21
***Indolpium* sp.**	Potential	4	0	5
***Indolpium* sp. indet.**	Potential	1	0	38
***Sepedonophilus* 'ME01'**	Potential	3	0	3

Figure 10-21: Location of confirmed and potential SRE taxa

Legend

Confirmed SRE

- Buddelundia `56`

- Buddelundia `sp. SJ_14FMa`_DNA
- Buddelundia `sp. SJ_14FMc`_DNA
- Buddelundia '10MA'
- Buddelundia 14fm
- Buddelundia '14FM-c'
- Buddelundia '14FM-d'
- Buddelundia indet.
- Buddelundia indet. 1
- Buddelundiinae 'Nyi01'
- Buddelundiinae sp. indet.
- Buddelundiinae sp. indet.A
- Buddelundiinae sp. indet.B
- Antichiropus forcipatus
- Austrostrophus sp.
- Dampetrus OPI001
- Indolpium PSE174
- Indolpium PSE175
- Indolpium `sp. MD1`
- Indolpium sp.
- Indolpium sp. indet.
- Sepedonophilus 'ME01'
- Conothele MYG716
- Kwonkan (Yilgarnia) sp. indet.
- Lychas hairy tail complex'
- Lychas 'hairytail complex' (SCO052)
- Lychas SCO024
- Lychas SCO046
- Missulena sp. indet.
- Olpiidae `sp. PSE176`
- Urodacus sp.
- Xenolpium sp.

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

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Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 1 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Legend

Confirmed SRE

- Buddelundia `56`
- Buddelundia `sp. SJ_14FMc`_DNA
- Buddelundia 14fm
- Buddelundia indet.
- Buddelundiinae sp. indet.
- Buddelundiinae sp. indet.A
- Indolpium PSE174
- Indolpium PSE175
- Indolpium sp.
- Lychas hairy tail complex'
- Lychas SCO024
- Lychas SCO046
- Urodacus sp.
- Xenolpium sp.

644000 645000 646000 647000 648000 649000 650000 651000 652000 653000 654000 655000 656000 657000 658000 659000 660000 661000 662000 663000

7562000 7561000 7560000 7559000 7558000 7557000 7556000 7555000 7554000 7553000 7552000 7551000 7550000 7549000 7548000

Legend

- Development Envelope
- Indicative Footprint

Fauna habitat

- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Drainage Lines/Floodplains
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Roads (LGATE-195)

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Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 2 of 4

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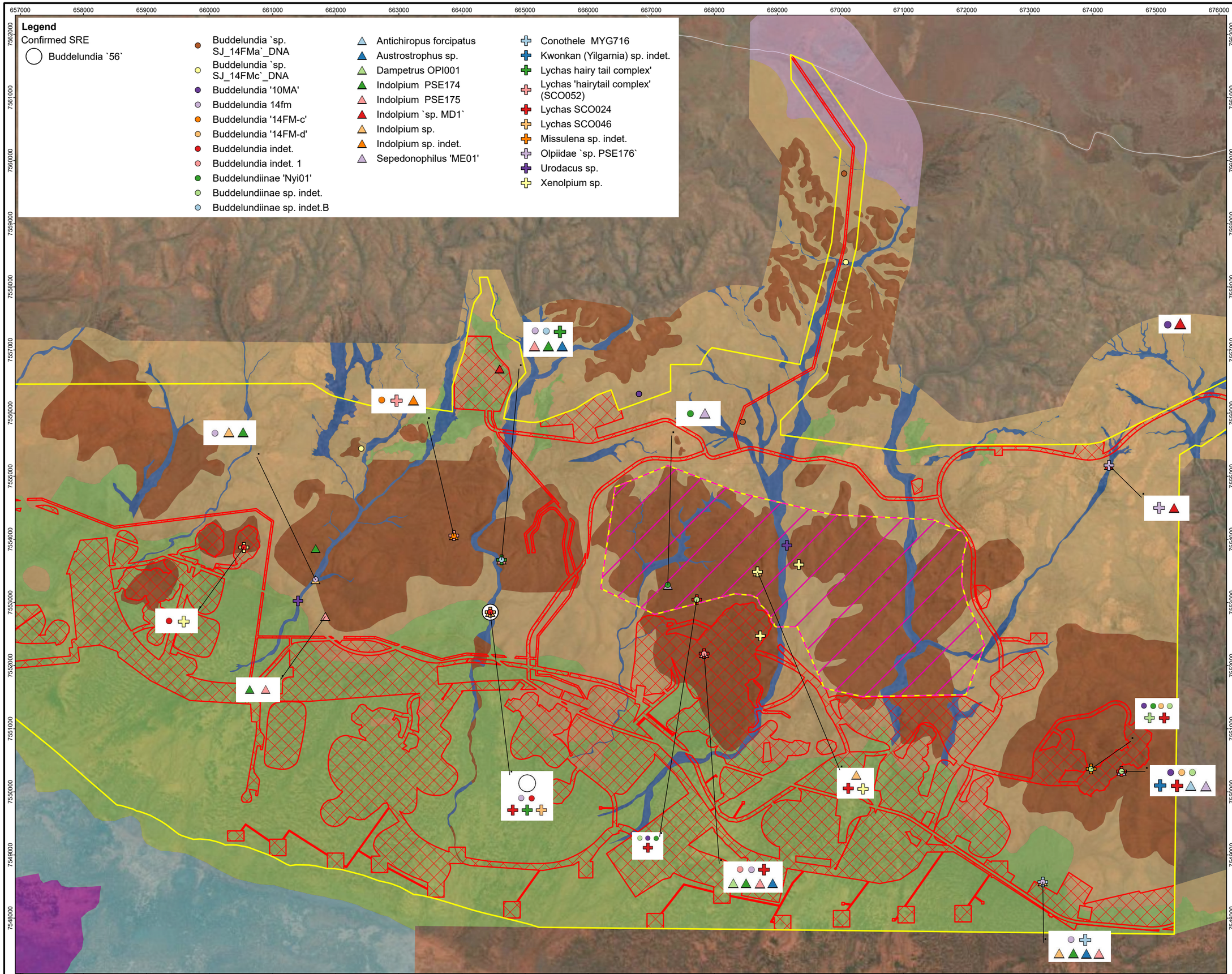
Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.



Legend

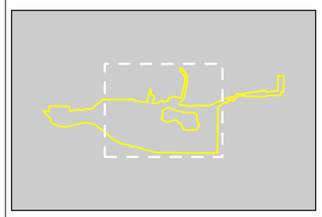
- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Calcrete Stony Plain
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Stony Spinifex Plains and Hillslopes

Roads (LGATE-195)

- Minor Road



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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:55,000 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 3 of 4

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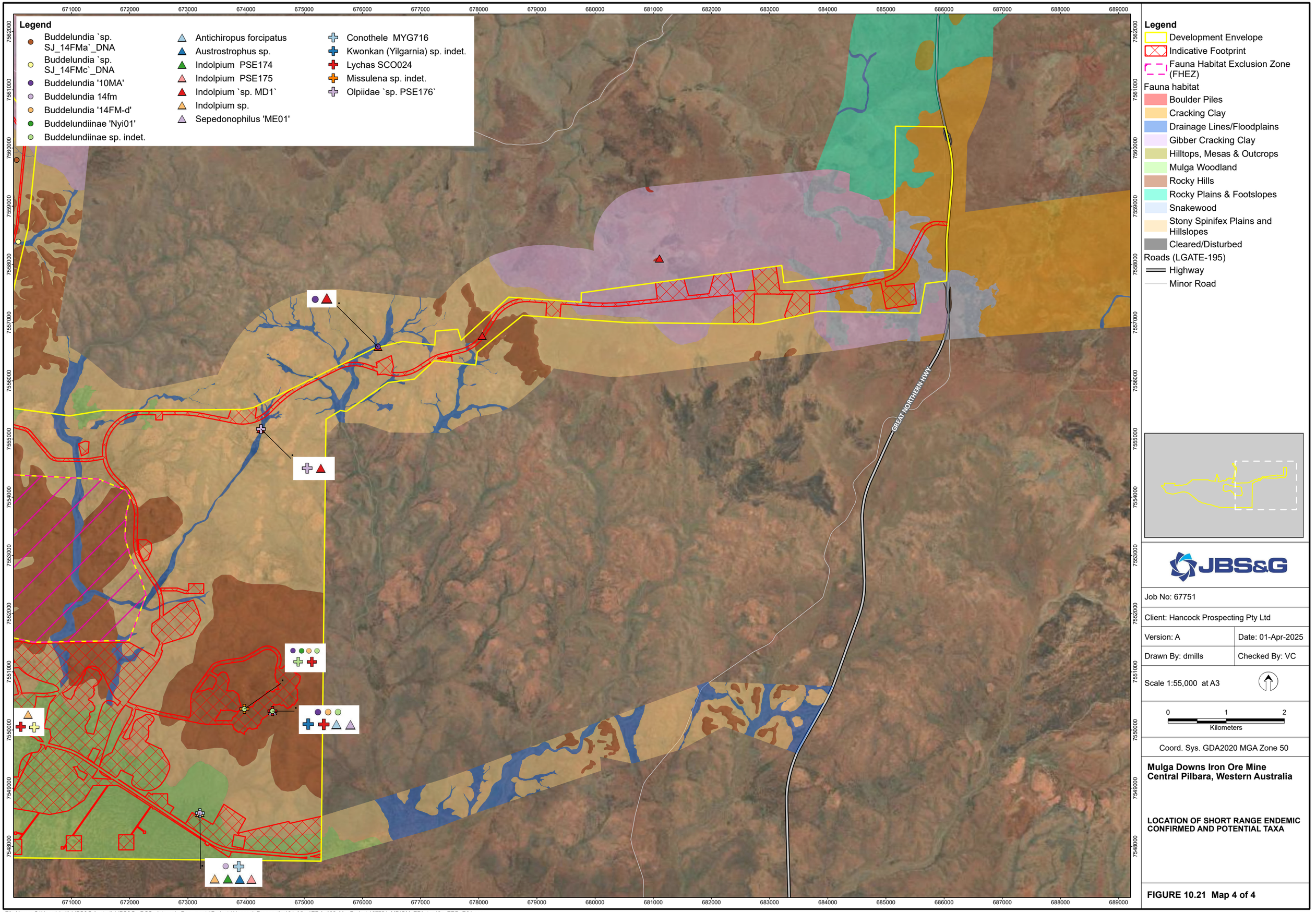

Legend

- Development Envelope
- Indicative Footprint
- Fauna Habitat Exclusion Zone (FHEZ)

Fauna habitat

- Boulder Piles
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC
Scale 1:55,000 at A3	

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SHORT RANGE ENDEMIC CONFIRMED AND POTENTIAL TAXA

FIGURE 10.21 Map 4 of 4

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

10.3.5.3 Habitat Types

As with the vertebrate fauna habitat types (refer to **Sections 10.3.4.1** and **10.3.4.2**). Habitat assessment and mapping was undertaken across the Development Envelope following detailed SRE desktop assessments. Seven broad SRE habitats were mapped based on aerial imagery, previous survey data and then confirmed during the surveys (**Figure 10-21**). The broad scale mapping, continuity of habitat types and the habitat naming conventions reflect those previously mapped in the adjacent areas of the Development Envelope. The habitats defined as suitable for SREs within the Development Envelope are:

- Stony Spinifex Plains and Hillslopes;
- Rocky Hills;
- Drainage Line/Floodplain;
- Mulga Woodland;
- Chenopod/Cracking Clay Floodplain; and
- Rocky Plains and Footslopes.

Potential terrestrial SRE taxa were recorded in most habitat types, though Snakewood had little prospect and other habitat types which after rain were readily inundated. The most prospective SRE habitat is associated with mesic environments including breakaways and small gorges within the Rocky Hills and Drainage Lines/Floodplains.

Mulga Woodland and Calcrete Stony Plain and were considered moderately likely to promote short range endemism, followed by Stony Spinifex Plains and Hillslopes and Chenopod/Cracking Clay Floodplain which were given low to moderate habitat suitability rankings. The most common habitat types (Mulga Woodlands, Stony Spinifex Plains and Hillslopes) were identified to be generally continuous swathes of similar habitat and widespread in a regional context.

Isopod and scorpion specimens from SRE target groups were collected from all habitat types surveyed. Habitat preferences for target SRE groups were highly variable, with different invertebrate groups exhibiting habitat preferences likely to be associated with variations in microhabitat requirements. Drainage Lines/Floodplains were found to support the greatest diversity of scorpions. Rocky Hills provided the greatest diversity of pseudoscorpions and millipedes, and the Mulga Woodland habitat supported isopods and harvestmen.

Sheltered, isolated, and often relictual mesic habitats have an increased likelihood of hosting short-range endemic (SRE) invertebrates. The gradual aridification of the Australian continent that began in the early Miocene has resulted in the contraction and isolation of mesic habitats and by association those relictual faunal groups that utilise them (Harvey 2002).

In arid landscapes such as the ranges of the Pilbara region, permanently moist, shaded, and sheltered microhabitats as associated with SREs are typically limited and isolated by barriers of exposed, dry habitat not conducive to the dispersal SRE species. This isolation restricts or eliminates gene flow between populations and may result in speciation via selective pressures, genetic drift, and mutation. Even where speciation has not yet

occurred, the geographical distribution of these species has severely contracted and fragmented. Isolated gorges and gullies that host complex microhabitats (heavy vegetation, deep leaf litter beds and varied rock cover) and protect relictual mesic habitat characteristics are more likely to host SRE taxa than simple widespread habitats exposed to climatic extremes. Isolated freshwater habitats associated with springs are also likely to provide conditions suitable for SRE taxa. Regionally extensive and exposed habitat types with high connectivity such as spinifex grassland are unlikely to host SRE taxa (Durrant, 2011).

Vegetation, geological, land system, and topographic mapping as well as aerial imagery may be used as surrogates to estimate habitat connectivity and distributional boundaries of potential SRE species. This is to be considered in circumstances where further survey is deemed unlikely to yield more specimens and further taxonomic or distributional information is not available via the museum and subject matter specialists (EPA 2016b).

These habitat types occur on a broader scale outside of the Development Envelope as detailed in **Section 10.3.4.2.** As shown in **Table 10-7** these habitats are extensive.

10.3.6 Aquatic Invertebrates

A desktop assessment (using a 40 km radius from within the Development Envelope) was completed by Biologic Environmental Pty (Biologic 2023) (**Appendix 24**). The desktop provided an overview of the aquatic ecology of the freshwater claypans which lie within the Fortescue Valley south of the Development Envelope. The desktop includes a synopsis of taxa of significance and assess the threats and potential impacts of the Proposal to the freshwater claypans. The ecological requirements of resident and transient biota were considered and summarised.

Two of the larger claypans of the system, Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan, are located immediately to the south of the Development Envelope. The claypans support a diverse and highly unique aquatic invertebrate assemblage. The claypans considered in the Biologic (2023) Desktop Assessment Search Area may contain over 50% of the aquatic invertebrate taxa known from the Fortescue Valley (including the Fortescue Marsh), while at the regional scale, the claypans of the Fortescue Valley are likely to support more than half of the aquatic invertebrate species that occur across the Pilbara region. This includes a high richness of aquatic crustacean and rotifer taxa, which are considered sensitive receptors for the claypan systems.

In total, five significant invertebrate taxa were recorded during the database search and literature review. The significant invertebrates were new to science and therefore potentially restricted to claypans in the Biologic (2023) Desktop Assessment Area. These included:

- *Asplancha* n. sp. (Rotifera);
- *Pleurata* n. sp. (Rotifera);
- *Unionicola* n. sp. (Acarina);
- *Mesochra* n. sp. (Copepoda); and
- *Anisops* n. sp. (Notonectidae).

10.4 Potential Impacts

A preliminary assessment of the potential direct and indirect impacts of the Proposal to terrestrial fauna values in consideration of the EPA objectives is provided below.

10.4.1 Direct Impacts

Potential direct impacts as a result of the Proposal include:

- Loss of fauna individuals (collision and entrapment) resulting from ground disturbance, vehicle strike (including heavy haulage vehicles), machinery, infrastructure and mining operations.
- Loss of fauna habitat resulting from clearing for ore extraction, construction and operation (mining infrastructure) – this includes clearing of vegetation and removal of landforms (caves, ridges).

10.4.1.1 Loss of Fauna Individuals

Due to the direct interface between vehicle and machinery movement and fauna habitats, vertebrate fauna would be most at risk of death or injury during clearing activities. The risk of injury/mortality from vehicle strike and vehicles and machinery during construction and operation of the Proposal.

Fauna most at risk from vehicle strike are nocturnal species. Ghost Bats have been known to collide with mine SUVs as they attracted by the light. Visibility driving at night is impeded with the likelihood of collision higher. The risk of vehicle strike for raptors is higher with increased carrion availability. Large raptors require more time to take flight which often places them in direct path of travelling vehicle.

Fauna may also become trapped in large containers, uncapped drill holes, trenches, excavations or water storage structures. They are unable to escape and may be either injured or die. A trapped animal can become stressed leading to injury or death, overheat if trapped during the day, drown or at greater risk of becoming prey.

Dispersal is an affective survival strategy however it is costly especially in arid environments. Many species burrow and may not be visible. Death can be cause by burrow collapse or blocking of the entrance/exit to burrows or dens.

The level of impact to significant habitat or populations of SRE taxa from mining activities in a particular area can be assessed by considering the taxa recorded for an area and the level to which significant habitats have been surveyed.

Clearing, earthworks and excavation activities can also lead to the loss of SRE invertebrates including the mygalomorphs burrows.

10.4.1.2 Loss of Fauna Habitat

This section presents the indicative loss of vegetation based on the Indicative Footprint; however, the final location of Proposal elements within the Development Envelope may change through the detailed design phase.

The Proposal will require the clearing of up to 4,339.16 ha of native vegetation across eight of the nine fauna habitat types within the Development Envelope (**Table 10-12**). This will result in a reduction of available habitat for terrestrial fauna, including SREs.

Based on the Indicative Footprint, the habitat type that will be subject to the largest area of clearing is Mulga Woodland. The Proposal will result in the loss of 34.44% of Mulga Woodland mapped within the Development Envelope, followed by Gibber Cracking Clay (22.00%), Rocky Hills (19.59%), Stony Spinifex Plains and Hillslopes (17.11%), Chenopod/Cracking Clay Floodplain (16.94%), Drainage Line/Floodplain (13.63%), Cracking Clay (12.9%) and Snakewood (8.33%). While present in the Development Envelope, the Proposal will not directly impact Rocky Plains and Footslopes habitat from clearing.

All habitat types were found to extend outside of the Development Envelope (refer to Figure 10-20). The percentage impact to the local mapped extent from surveys undertaken for the Proposal to each habitat type is shown in **Table 10-12**. No more than 6.48% of the total local mapped extent any fauna habitat types will be impacted as a result of the Proposal.

Table 10-12: Loss of Terrestrial Fauna Habitat

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
Chenopod/Cracking Clay Floodplain	• Scorpions • Snails • Isopods	Foraging only: • Night Parrot (EN) – in proximity to mature spinifex only. • Priority 5 foraging habitat for Pilbara Leaf-nosed Bat (VU).	983.20	15.72	92.78	0.55	16.94	1.60
Rocky Hills	• Scorpions • Isopods • Pseudoscorpions • Millipedes • Snails	Shelter, denning and roosting habitat: • Northern Quoll (EN) • Pilbara Leaf-nosed Bat (VU) • Ghost Bat (VU) • Pilbara Olive Python (VU) Foraging Habitat: • Peregrine Falcon (OS)	11,982.01	520.80	2,658.23	15.78	19.59	4.35
Mulga Woodland	• Mygalomorphs • Scorpions • Millipedes • Snails • Pseudoscorpions	Foraging only: • Bilby (VU) • Priority 5 foraging habitat for the Pilbara Leaf-nosed Bat (VU).	43,575.10	2,824.74	8,202.43	48.69	34.43	6.48
Stony Spinifex Plains and Hillslopes	• Scorpions • Isopods • Mygalomorph spiders	Foraging only: • Ghost Bat (VU) • Pilbara Leaf-nosed Bat (VU) • Northern Quoll (EN)	62,690.54	813.97	4,758.15	28.24	17.11	1.30

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
	• Pseudoscorpions • Millipedes • Snails	• Western Pebble-mound Mouse (P4) • Grey Falcon (VU) • Night Parrot (CEN) in proximity to mature, unburnt samphire only.						
Drainage Line/Floodplain	• Scorpions • Pseudoscorpions • Isopods • Mygalomorph spiders • Millipedes • Snails	Foraging only: • Ghost Bat (VU) • Pilbara Leaf-nosed Bat (VU) • Peregrine Falcon (OS) • Grey Falcon (VU) Dispersal and foraging: • Northern Quoll (EN) • Gane's Blind Snake (P1)	34,141.21	71.26	522.64	3.10	13.63	0.21
Gibber Cracking Clay	• Scorpions • Pseudoscorpions • Isopods • Mygalomorph spiders	Foraging only: • Ghost Bat (VU) • Peregrine Falcon (OS) • Grey Falcon (VU) Breeding, foraging and dispersal habitat: • Short-tailed Mouse (P4) • Western Pebble-mound Mouse (P4)	3,556.27	56.48	257.69	1.53	21.92	1.59

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
Cracking Clay	Not considered suitable habitat	This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby	5,529.69	28.10	217.84	1.29	12.90	0.51
Snakewood	Not considered suitable habitat	This habitat type has the potential to support (provide foraging habitat): • Short-tailed mouse; • Grey Falcon; • Marginally suitable as foraging habitat for the Night Parrot; and • Greater Bilby.	731.62	8.04	96.55	0.57	8.33	1.10
Rocky Plains and Footslopes	• Scorpions • Pseudoscorpions • Isopods • Mygalomorph spiders • Millipedes • Snails	This habitat type has the potential to support foraging for: • Northern Quoll • Western Pebble-mound Mouse; • Gane's Blind Snake; • Grey Falcon; • Brush-tailed Mulgara;	32,444.58	0.00	37.75	0.22	0.00	0.00

Habitat Type	SRE Invertebrates	Potential Conservation Significant Fauna Species	Total Mapped Survey Extent (ha)	Total Impact within the Indicative Footprint (ha)	Extent within the Development Envelope (ha)	% of Development Envelope	% Impact to habitat type within the Development Envelope	% Impact to mapped extent
		• Greater Bilby; • Night Parrot (however no suitable breeding habitat was known nearby and the area was recently burnt); and • foraging habitat for the Ghost Bat and Peregrine Falcon						
Cleared / Disturbed			771.02	0.04	3.47	0.02	1.15	0.01
Total			**184,423.23**	**4,339.15**	**16,848.53**	**100**		

Caves

In addition to the broad habitat types, the Proposal will also impact caves. A total 82 caves were assessed in the Survey Area of which 51 were identified as having characteristics required as Category 4 (nocturnal roosts) Caves. The remaining 31 caves were not identified as Category 4 caves as they lacked the characteristics required.

In respect to the Pilbara Leaf-nosed Bat, of the 51 Category 4 caves, 36 will remain in the FHEZ. The FHEZ will not be developed as it is not in the Development Envelope. An additional six Category 4 caves are located in the FHEZ Corridor and will also be avoided.

In respect to the Ghost Bats, 23 of the 51 Category 4 caves were found suitable as Ghost Bat roosts of which 8 are located within the Development Envelope with 5 of these in the Indicative Footprint. The remaining 15 Category 4 caves are located within the FHEZ and as such will remain as available caves.

All caves located within the Development Envelope that have been identified as suitable for either species were assessed as Category 4 caves (nocturnal refuge) which are not considered critical habitat but are important for persistence in the local area. No Category 1, 2 or 3 caves were identified during surveys (as summarised in *ecologia* 2023).

In total, a minimum 42 caves found suitable for the Pilbara Leaf-nosed Bat and/or Ghost Bat will be preserved (**Table 10-8**).

The caves in the FHEZ and FHEZ Corridor also support habitat critical for the survival of the Northern Quoll, of which caves are important to this species.

The implications of impacts to caves for relevant conservation significant species are discussed in **Section 10.6**.

10.4.2 Indirect Impacts

Potential indirect impacts to terrestrial fauna as a result of the Proposal may include:

- A decline or change in health/composition of fauna habitat arising from:
  - Deposition of dust during construction and operation of the mine and use of saline water for dust suppression;
  - Altered hydrological and hydrogeological regimes;
  - Impacts (i.e. cave collapse) from blasting/vibrations;
  - Introduction and spread of weeds; and
  - Altered fire regimes.
- Disruption of natural foraging and breeding patterns of terrestrial fauna due to:
  - Fragmentation;
  - Noise, light, vibration and vehicle movements; and
  - Increased feral animals.

10.4.2.1 A decline or change in health/composition of fauna habitat.

Dust and Use of Saline Water for Dust Suppression

The Proposal has the potential to indirectly impact on terrestrial fauna habitat through the generation of dust during clearing, constructions of roads, vehicle movement and the transport and handling of ore during operation. There is the potential for the Proposal to indirectly impact terrestrial fauna habitat from the use of saline water for dust suppression during the construction and operation of the Proposal. This can result in vegetation mortality, or an increase in soil salinity leading to a decline in vegetation and flora, and subsequently habitat, health.

Altered Hydrological and Hydrogeological Regimes

Diversion of surface water flows, abstraction of groundwater and the reinjection of mine dewater via MAR will result in changes to the natural hydrological regime which could result in altered or degraded fauna habitat. Relevant mechanisms which will cause these changes are:

- Groundwater drawdown caused by orebody dewatering;
- Groundwater mounding caused by the reinjection of surplus water via a MAR bore network; and
- Surface catchment modifications resulting in changed surface water regimes (flows and levels) and surface water quality, in particular reduced inflows to portions of the valley environment.

Given that the vegetation is inferred to be disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. Therefore, changes to groundwater as a result of drawdown is not expected to impact fauna habitat.

As discussed in **Section 9,** the principal change risk to vegetation, and therefore fauna habitat, is groundwater mounding as a result of MAR. As dewatering exceeds water demands, excess water will be disposed of by MAR through re-injection within the Development Envelope. Without management practices in place, there is the potential for detrimental impacts to fauna habitat resulting from changes to groundwater levels and / or quality as a result of MAR).

The presence of water within the drainage lines in the Pilbara is temporary/ephemeral and flows only in response to rainfall events. Permanent pools are present throughout the Pilbara, however within the Development Envelope they have not been found. During operations, Surface water flows along the drainage/creek lines will be diverted as a result of mine pits, waste rock dumps, borrow pits, airport, haul and access roads, pipelines, and other infrastructure associated with the Proposal. These diversions will be constructed to a design appropriate for the life of the operations.

Upon cessation of operations, non-permanent diversion structures will be removed, and the surface will be re-shaped to blend into adjacent ground levels, reinstating natural drainage lines where feasible. Some permanent diversion and water management structures may remain post closure. Such permanent structures will be designed with consideration of an agreed future rainfall intensity scenario and final landform features, at least 5 years prior to the end of mine

The receptors which may potentially be impacted by the Proposal are fauna habitat (vegetation and cave microclimates) and watercourses, plus the Fortescue Valley, including the claypans, swamp and persistent pools, which could be altered or degraded from indirect impacts.

Additionally, where mine development areas block drainage paths, there is a risk of increased inundation on the upstream side of the development area. The increased inundation may lead to vegetation death due to water logging and changes to vegetation composition with more water tolerant vegetation species (including weeds) potentially taking over in these areas (AQ2 2024b).

Impacts (i.e. cave collapse) from blasting/vibrations

Construction, operation activities (including blasting) which result in noise and vibrations can affect the integrity/characteristics (microclimate) of caves that may support conservation significant species such as Pilbara Leaf-nosed Bat and Ghost Bat.

Introduced Weeds

Clearing, vehicle and machinery movements have the potential to increase the spread and/or introduce weed species. Weeds are often able to rapidly invade locations due to disturbance, land clearing and/or altered hydrological regimes. Weed species recorded within the Development Envelope are discussed in **Section 9.3.7**.

Alteration Fire Regimes and Increased Fire Risk

Altered fire regimes can damage fauna habitat, resulting in the loss of fauna species. Fires too early in the year can prevent the establishment of resilient seed banks which are resistant to periods of fire, characteristic of the Pilbara and other arid zones. Frequent fires also lead to an increase of some weeds species, which can result in the loss of foraging habitat and habitat becoming more bushfire prone.

10.4.2.2 Disruption of natural foraging and breeding patterns of terrestrial fauna

Fragmentation

Fragmentation of habitat from land clearing can reduce the ability for individuals of a species to move freely across a landscape. This can result in the isolation of populations and reduce gene flow. Habitat fragmentation has the potential to exacerbate other threats, such as predation by feral species, by providing improved access into habitats which were previously difficult to access.

Noise, Light, Vibration and Vehicle Movements

Construction, operation activities which result in an increase in light, noise and vibrations which can affect the foraging and breeding behaviours of native species, resulting in a decline in local populations.

Light spill caused by lighting of the Proposal and vehicle movements at night has the potential to cause disturbance to light sensitive species or cause other behavioural changes, e.g. changes in prey item distribution and aggregation for insectivorous species, resulting in changes to foraging behaviour.

Noise has the potential to cause behavioural changes in fauna, with fauna likely to avoid loud areas. Species using audible cues for breeding such as birds may experience disruption to breeding cycles or reduced breeding success.

Vibration from blasting can disrupt foraging behaviour and force an early exit from a cave exposing the bats to dehydration. Blasting also has the potential to generate higher concentrations of NOx which can impact bats roosting in Category 4 caves.

Feral Animals

Construction of infrastructure is known to increase the movement of feral predators such as cats, foxes and wild dogs, all which have been recorded in the Development Envelope. Construction can force native fauna into areas where they are at greater risk of predation. Presence of waste materials can also attract feral animals that are predators to native fauna as well as competing for resources.

10.4.3 Cumulative Impacts

The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, will have a cumulative impact on terrestrial fauna at a regional scale through:

- The loss and fragmentation of terrestrial fauna habitats, including that of SREs, from clearing; and
- The fauna individuals as a result of the clearing activities.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in **Section 17**.

10.5 Mitigation

HPPL has applied the mitigation hierarchy of avoid, minimise, and rehabilitate during the Proposal design to reduce the potential impacts to terrestrial fauna.

The design of the Proposal has been planned to avoid direct impacts and minimise indirect impacts to key environmental values identified within the Development Envelope where possible since its referral in 2021. Three applications to amend the Proposal (under s43A of the EP Act) have been submitted by HPPL, each change resulting in a reduction in the potential environmental impacts of the Proposal on fauna and fauna habitat. Overall, there has been a total reduction in the Development Envelope and Indicative Footprint of 23,804.97 ha and 5,288.84 ha, respectively.

10.5.1 Exclusion Areas

Since the referral of the Proposal HPPL has applied avoidance as the main mitigation to reduce potential impacts to fauna. HPPL has identified two areas within the Development Envelope which will not be developed:

- Fauna Habitat Exclusion Zone (FHEZ) - comprising an area of 1,320.82 ha which was removed from the Development Envelope under section 43A of the EP Act.

- FHEZ Corridor - comprising an area of 991.45 ha within the Development Envelope. No permanent mining activities will be undertaken within this corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor.

These areas have been identified as 'exclusion zones' as they exclude activities associated with the Proposal. The purpose of these is exclusion zones is to mitigate impacts to the conservation significant fauna. The FHEZ is 1,320.82 ha of high value Rocky Hills, Drainage Line/Floodplains and Stony Spinifex Plains and Hillslopes habitats. The value of the FHEZ is enhanced and maintained by the inclusion of the FHEZ Corridor which comprises 991.45 ha of similar and supporting habitats. The purpose of the FHEZ Corridor is to ensure connection of the high value habitat within the FHEZ to habitat outside of the Development Envelope to allow for the dispersal of fauna from the FHEZ to the Chichester Ranges and preventing fragmentation of terrestrial fauna habitat for species such as the Northern Quoll. The area also comprises habitat which is considered high value SREs.

A summary of mitigation measures applied to address the key potential impacts on terrestrial fauna is provided in **Table 10-13.** A Conservation Significant Fauna Management Plan (CSFMP, **Appendix 12**) has also been developed for the Proposal to outline HPPL's approach to managing potential impacts on conservation significant terrestrial fauna.

Table 10-13: Mitigation Measures for Terrestrial Fauna

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Direct Impacts			
Loss of fauna individuals (in particular individuals of fauna of conservation significance)	Establishment of the FHEZ and FHEZ Corridor exclusion areas.	Implementation of the CSFMP (Appendix 12).	Implementation of the CSFMP (Appendix 12).
Loss of fauna habitat.	• Establishment of a Fauna Habitat Exclusion Zone (FHEZ) which avoids impact to 1,320.82 ha of habitat (including native vegetation). • Establishment of FHEZ Corridor which both avoids andminimises impact within 991.45 ha of habitat (including native vegetation) • Impacts to the 'Freshwater Claypans of the Fortescue Valley' Priority 1 PEC are avoided which provide important habitat for migratory species	• Utilise areas of existing disturbance before clearing of new ground where possible. • Where possible Proposal elements have been located to avoid impacts on environmental factors. • Removal of Mulga West Borefield from the Development Envelope which reduces the extent of clearing and associated impacts. • HPPL will ensure clearing only occurs in approved ground disturbance areas (in accordance with a Ground Disturbance Permit). • No more than 4339.16 ha of clearing within a Development Envelope of 16,848.53 ha. • Where possible Proposal elements have been located to minimise impacts on environmental factors. • Phase the works to enable progressive clearing and rehabilitation. • Manage construction and operational works through an Environmental EMS.	• Implementation of the CSFMP (Appendix 12). • Construction areas no longer required for operations will be rehabilitated upon completion of construction. • Progressive rehabilitation of operational areas no longer required, throughout life of mine. • Decommissioning and rehabilitation of disturbed areas at the end of LoM. • Consultation with Banjima to determine which species are ideal for seed collection, as informed by the ethnobotanical surveys.

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
	• Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor. Freshwater Claypans of the Fortescue Valley P1 PEC is outside the Development Envelope. This is habitat for Migratory species when inundated and foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat, Northern Quolls and potentially the Night Parrot.	• Implement programs for induction and education of the workforce with respect to flora and vegetation protection and management. • No permanent mining activities will be undertaken within the FHEZ corridor, however supporting activities may be required such as access tracks and a provision for a future conveyor and ancillary service corridor. Disturbance within the FHEZ corridor will be limited to no more than 5 ha following approval of the Hub & Spur Proposal. • Clearing will be managed as outlined in the CSFMP.	
Indirect Impacts			
A decline or change in health/composition of fauna habitat arising from: • Deposition of dust during construction and operation of the mine and use of saline water for	• Avoidance of 36 Category 4 caves within the FHEZ. • Avoidance of six Category 4 caves within the FHEZ Corridor.	• Implement the CSFMP (Appendix 12). • Implement the Water Management Plan (Appendix 6) • Appropriate permits will be obtained under the RiWI Act. • Blasting requirements will be designed to meet vibration thresholds of susceptible caves.	• Implement the CSFMP (Appendix 12). • Implement the Water Management Plan (Appendix 6)

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
dust suppression; • Altered hydrological and hydrogeological regimes; • Altered structural integrity of caves from vibration impacts • Introduction and spread of weeds; and • Altered fire regimes.		• All machinery and vehicles shall be cleaned down of all soil and vegetation material prior to arriving or entering on site. Any soil and vegetation removed from machinery or vehicles during clean down upon arrival, but prior to entry on site shall be collected and disposed of offsite; • All vehicles and machinery mobilised to site shall be inspected prior to entry to site and issued with a Weed & Soil Hygiene Certificates; • Imported fill or other potential weed mediums to be certified by the supplier as being free from weed free sources prior to arrival on site; • Areas of known weed-infestation will be identified and managed separately to weed free areas; • Where areas of weed-infestation are to be disturbed or cleared, material will be stockpiled/placed in windrows separately from weed-free material; • Targeted control of infestations; • An emergency management plan shall be developed and implemented and shall include methods for managing major environmental incidents, including but not limited to fire • Ensure compliance with the Bushfire Act 1954;	

Potential Impacts	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
		• Compliance with internal Hot Works Procedures; • Fire-control equipment shall be available in fire-risk areas including but not limited to hazardous material storage areas, hot works job sites, service trucks; An adequate number of personnel shall be trained in basic fire awareness, fire response and use of fire suppression equipment.	
Disruption of natural foraging and breeding patterns of terrestrial fauna due to: • Fragmentation; • Noise, vibration, lighting and vehicle movements; and • Increased feral animals.	Establishment of the FHEZ and FHEZ Corridor protecting breeding and foraging for conservation significant fauna and allowing dispersal across high value Rocky Hills Habitat.	• Implement the CSFMP (Appendix 12).	• Implement the CSFMP (Appendix 12). • Rehabilitation of areas of land utilised for construction purposes will occur upon completion of construction. • Progressive rehabilitation of temporary disturbance areas will be undertaken (such as borrow pits and temporary construction areas).

10.6 Assessment and Significance of Residual Impacts

10.6.1 Direct Impacts

10.6.1.1 Loss of Fauna Individuals

The use of vehicles and heavy machinery for the clearing of native vegetation and other construction activities can result in injury to native fauna, and there is the possibility of mortalities via collision. Nocturnal species are at greater risk from collision due to limited visual ability for machine operators.

The construction phase of the Proposal will occur predominantly during daylight hours with vegetation clearing commencing from a disturbed edge to an undisturbed area, where practicable, to encourage mobile fauna to naturally relocate into adjacent areas.

During operation, mining will be undertaken on a 24-hour basis, seven days per week. However, light vehicle movements will occur mostly during the day.

Significant fauna in the Development Envelope may be vulnerable to injury or mortality from vehicle and machinery movements, mainly when foraging or whilst warming up on roads (e.g. Pilbara Olive Python). Vehicle movements at night are predicted to be much lower than during the day.

Vehicle speed limits will be implemented during both construction and operation, reducing the potential for fauna strikes as outlined in the CSFMP (**Appendix 12**). However, it is acknowledged that individuals will be subject to direct impacts associated with mortality or injury from vegetation clearing or vehicle strike, and the loss of some individuals may be unavoidable. In the event of a fauna strike, the impact will be limited to an individual and will not result in population-wide impacts. As a result, the potential impacts on fauna from interactions with vehicles and machinery are not expected to be significant to the extent that the conservation status of any of the species present would be affected. The use of vehicles and machinery associated with the Proposal are therefore considered unlikely cause significant impact or result in the significant decline of a population of any of the conservation significant vertebrate or SRE invertebrate fauna known to occur within the Development Envelope.

Fauna also may become trapped in containers, uncapped drill holes, trenches, excavations or water storage structures resulting in injury or death. Measures will be implemented including fauna egress points and regular monitoring as outlined in the CSFMP (**Appendix 12**) to minimise the loss of fauna from entrapment.

The use of barbed wire fencing has the potential to result in entanglement of bat species (Pilbara Leaf-nosed Bat and Ghost Bat), which may result in injury or mortality of individuals. HPPL will avoid the use of barbed wire fencing where possible. Where barbed wire fencing cannot be avoided, HPPL will install reflectors to increase conspicuousness to bats.

HPPL will maintain records of any known fauna injury or mortality observed within the Development Envelope in order to inform the review and ongoing improvement of management measures. Overall, in conjunction with proposed management measures, the number of individuals potentially affected by collision or entrapment is expected to be low and not significant in terms of local populations.

The establishment of the FHEZ and the FHEZ Corridor will provide refuge for conservation significant fauna and allow for the dispersal of fauna from the high value habitat within the FHEZ to habitat outside of the Development Envelope. This reduces the potential impacts that may be caused by fragmentation. Establishment of these areas also protects 42 Category 4 caves which are nocturnal roosts for the Pilbara Leaf-nosed and Ghost Bats allowing for their movement across the regions, reducing potential loss of individuals from dehydration during their breeding season. These caves are also important refuge and breeding sites for the Northern Quoll and the Pilbara Olive Python, protecting them from predation from feral fauna such as cats.

A total of 15 Confirmed and 91 Potential SRE invertebrate taxa have been recorded within a 40 km radius of the Development Envelope. Of the potentially occurring taxa, 12 have previously been recorded within the Development Envelope. Only one confirmed SRE taxon has been recorded in any of the surveys undertaken; the Isopod *Buddelundia* 56. There was only one record of this species in the Development Envelope. This species was not found in the Indicative Footprint. There are numerous records of *Buddelundia* 56 outside of the Development Envelope recorded from the various surveys for this Proposal (Biologic 2022 a; b; *ecologia* 2021a; Spectrum 2023a) (**Appendix 11**)

Up to 31 potential/possible SREs were identified in the Development Envelope. Of these, four are only found within the Indicative Footprint (**Table 10-12**). These four are the isopods *Buddelundi*a indet. 1 and Buddelundiinae 'Nyi01'; the Arachnid *Missulena* sp. indet.; and the Arthropod *Dampetrus* OPI001.

The CSFMP **(Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes minimising incidental mortality or injury of conservation significant terrestrial fauna from clearing activities, vehicle strike or mining related activities resulting from the Proposal.

10.6.1.2 Loss of Fauna Habitat

Implementation of the Proposal will result in the clearing of fauna habitat within two Pilbara IBRA bio-subregions – the Fortescue and Chichester subregions. While Proposal includes some flexibility to alter the final location of the Proposal elements within the Development Envelope regardless of where the final footprint is implemented, no more than 4339.16 ha of fauna habitat will be removed.

There are nine broad fauna habitat types (not including habitat classified as Disturbed/Cleared) which have been mapped across the Development Envelope of which eight will be impacted by clearing. The assessment of impacts to each fauna habitat types is discussed in **Table 10-14**.

Both the Development Envelope and Indicative Footprint for the Proposal has been modified to minimise direct impacts to high-value fauna habitat to the extent possible. Based on the Indicative Footprint, approximately 1,462.03 ha of high value habitat (comprising Rocky Hills, Stony Spinifex Plains, Hillslopes, Drainage lines/Floodplains and Gibber Cracking Clay) will be cleared for the Proposal. Detailed fauna habitat mapping has been completed for approximately 227,118.87 ha within and outside the Development Envelope.

In addition, a FHEZ and a FHEZ Corridor have been established, excluding these areas of high value habitat from development and from mining activities. These areas comprise habitat types that are considered high value for conservation significant fauna, including Rocky Hills, Drainage Line/ Floodplains, and Stony Spinifex Plains and

Hillslopes habitats. These habitats provide foraging habitat proximal to the Category 4 nocturnal roosts for the Pilbara Leaf-nosed Bat and Ghost Bat. The FHEZ supports 36 Category 4 Nocturnal Roosts for the Pilbara Leaf-nosed Bat and 15 for the Ghost Bat, in addition to high quality foraging habitat for the bats. The FHEZ also protects habitat for the Northern Quoll and the Pilbara Olive Python as well as potential foraging habitat for the Night Parrot. The FHEZ has also been found to support numerous Western Pebble-mound Mouse mounds which will not be impacted by the Proposal.

Potential impacts to the conservation significant fauna recorded from within the Development Envelope are discussed in **Table 10-15**.

The likely SRE groups and any confirmed SREs and their supporting habitats are listed in **Table 10-12** and the extent of impact (clearing) shown as the Indicative Footprint in all figures.

Table 10-14: Fauna Habitat – Assessment of Impacts

Habitat Type	Assessment of Impacts
Mulga Woodland	The Proposal will result in the removal of approximately 2,824.74 ha of Mulga Woodlands habitat, representing 34.44% of the mapped habitat within the Development Envelope and 6.48% of the extent mapped during surveys associated with the Proposal. This habitat is generally considered low value for conservation significant fauna and is widespread and common throughout the Pilbara region. However, it is habitat considered critical to the survival of the Bilby and foraging habitat for the Northern Quoll and supports Gane's Blind Snake. The Mulga Woodland also provides non-critical foraging habitat for the Pilbara Leaf-nosed Bat. The Mulga Woodland mapped within the Development Envelope has been disturbed by exploration activities (clearing tracks and drill pads) and evidence of grazing by cattle is present. Given the retention of approximately 5,378.22 ha (65.56%) in the Development Envelope (and 93.52% of the local mapped survey extent) this is not considered a significant impact.
Rocky Hills	The Proposal will result in the removal of approximately 520.80 ha of Rocky Hills habitat, representing 19.59% of the mapped habitat within the Development Envelope and 4.35% of the extent mapped during surveys associated with the Proposal. This habitat is of high value as it provides shelter, denning and roosting habitat for conservation significant species and is widespread and common throughout the Pilbara region. Breakaways, gorges and gullies within the Rocky Hills habitat type are known to provide potential caves, denning and foraging habitat considered to be critical habitat for the survival of Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat. The occurrence of breakaways and caves in the Rocky Hills habitat type is relatively common at a regional level, particularly within the Chichester and Hamersley Ranges bioregions. The Rocky Hills habitat is considered common and widespread throughout the Pilbara. Within the Development Envelope, this habitat type is associated with the Newman land system. The Development Envelope contains less than 0.21% of the known extent of this land system. The Proposal will retain approximately 2,137.43 ha (80.41%) in the Development Envelope, of which 950.81 ha occurs within the FHEZ, and 95.65% of the local mapped survey extent. Given the high value of this habitat type for conservation significant species this is considered a locally significant residual impact to terrestrial fauna and environmental offsets will be provided (Section 16). The FHEZ Corridor contains 548.14 ha of this habitat.
Stony Spinifex Plains and Hillslopes	The Proposal will result in the removal of approximately 813.97 ha of Stony Spinifex Plains and Hillslopes habitat, representing 17.11% of the mapped habitat within the Development Envelope and 1.3% of the extent mapped during surveys associated with the Proposal. Stony Spinifex Plains and Hillslopes are considered of moderate value as they generally offer minimal refugia to species of conservation significance however, where they are adjacent to high value breeding habitat they are a supporting habitat. This habitat is widespread and common throughout the Pilbara region. This is primarily habitat for the Western Pebble-mound Mouse, the Pilbara Leaf-nosed Bat, Northern Quoll and Gane's Blind-snake. The Stony Spinifex Plains and Hillslopes habitat type provides stones of a suitable size for

Habitat Type	Assessment of Impacts
	the Western Pebble-mound Mouse to construct mounds. Several mounds were found in this habitat type in the Development Envelope. Given the retention of approximately 3,944.18 ha (82.89%) in the Development Envelope (and 99.7% of the local mapped survey extent) and 262.39 ha occurs within the FHEZ. Up to 331.16 ha of this habitat occurs in the FHEZ Corridor.
Chenopod/ Cracking Clay Floodplain	The Proposal will result in the removal of approximately 92.78 ha of Chenopod/ Cracking Clay Floodplain habitat, representing 16.94% of the mapped habitat within the Development Envelope and 1.6% of the extent mapped during surveys associated with the Proposal. Chenopod/Cracking Clay Floodplains is habitat considered critical foraging for the survival of the Night Parrot and the Bilby and as supporting habitat for the migratory birds; however, due to the condition of this habitat type within the Development Envelope, it is considered low value to species of conservation significance. Given the retention of approximately 77.06 ha (82.89%) in the Development Envelope (and 99.4% of the local mapped survey extent) this is not considered a significant impact.
Drainage Lines/ Floodplains	The Proposal will result in the removal of approximately 71.26 ha of Drainage Lines/ Floodplains habitat, representing 13.36% of the mapped habitat within the Development Envelope and 0.21% of the extent mapped during surveys associated with the Proposal. Drainage lines are of moderate conservation value as they provide foraging and dispersal habitat for fauna. They are considered high value when they are within the home range for the Northern Quoll breeding habitat. This habitat type is known to provide foraging and dispersal habitat for Pilbara Leaf-nosed Bat, Ghost Bat and the Northern Quoll. It also has the potential to support foraging and potential breeding habitat for the Grey Falcon. The FHEZ contains up to 107.62 ha of this habitat and the FHEZ Corridor will conserve a further 75 ha. Given the retention of approximately 451.38 ha (86.64%) in the Development Envelope (and 99.8% of the local mapped survey extent) and 107.62 ha occurs within the FHEZ this is not considered a significant impact.
Gibber Cracking Clay	The Proposal will result in the removal of approximately 56.69 ha of Gibber Cracking Clay habitat, representing 22.00% of the mapped habitat within the Development Envelope and 1.59% of the extent mapped during surveys associated with the Proposal. This habitat type is known to be important breeding, foraging and dispersal habitat for the Short-tailed Mouse (P4, DBCA) and Western Pebble-mound Mouse and supports non-critical foraging habitat for the Ghost Bat and Peregrine Falcon. While sporadic in nature, this habitat is considered widespread in the Pilbara. Given the retention of approximately 201.00 ha (78%) in the Development Envelope (and 99.6% of the local mapped survey extent) this is not considered a significant impact.
Cracking Clay	The Proposal will result in the removal of approximately 28.10 ha of Cracking Clay habitat, representing 12.90% of the mapped habitat within the Development Envelope and 0.51% of the extent mapped during surveys associated with the Proposal. This habitat type exhibits little to no leaf litter and woody debris providing few niches for trappable fauna such as marsupials and reptiles. Due to the condition of this habitat type it is considered low value to species of conservation significance. However, it may be marginally suitable as foraging habitat for the Night Parrot. Given the retention of approximately 189.74 ha (87.10%) in the Development Envelope (and 99.49% of the local mapped survey extent) this is not considered a significant impact.
Snakewood	The Proposal will result in the removal of approximately 8.04 ha of Snakewood habitat, representing 8.32% of the mapped habitat within the Development Envelope and 1.10% of the extent mapped during surveys associated with the Proposal. This habitat is of low value and is widespread and common throughout the Pilbara region. Provides potential foraging for fauna which occur on Cracking Clay habitat. Given the retention of approximately 88.51 ha (91.68%) in the Development Envelope (and 98.90% of the local mapped survey extent) this is not considered a significant impact.
Rocky Plains and Footslopes	While present in the Development Envelope, the Indicative Footprint avoids this habitat. This habitat provides potential foraging habitat in the drainage lines and grasslands and has the potential to support and number of conservation significant species.

Table 10-15: Impacts to Conservation Significant Fauna

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
Northern Quoll	High value habitat for the survival of the Northern Quoll is habitat for denning and foraging located within their home range (from 35 ha up to 100 ha during the breeding season). This includes habitat of low rocky hills – such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or tree lined creek lines (CoA, 2016). Within the Development Envelope, the Rocky Hills habitat is considered critical habitat for the Northern Quoll. Multiple patches of suitable habitat for this species were identified in the Rocky Hills habitat area which would be considered habitat critical to the survival of this species. These micro-habitats provide shelter for breeding and refuge from fire/predation. Should the cane toad invade, this habitat is considered to provide protection to the Northern Quolls (CoA, 2016). The Rocky Hills habitat is considered common and widespread throughout the Pilbara (Attexo 2023). The Drainage Line habitat provides Northern Quoll populations dispersal habitat. Foraging habitat is recognized to be any land comprising predominantly native vegetation in the immediate area (i.e. within 1 km) of shelter habitat, or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species (CoA, 2016). Potential foraging/dispersal habitat for the species within the Development Envelope consists of: ▪ Drainage Line/Floodplain; ▪ Rocky Hills; ▪ Stony Spinifex Plains and Hillslopes.	Rocky Hills	Rocky Hills	520.80	1,406.03	**Loss of habitat** The Northern Quolls were only recorded within the Rocky Hills habitat in the Development Envelope. Records were primarily adjacent to the FHEZ, which will be retained and has been expanded to include areas that support foraging habitat for the species and improve connectivity of habitat to areas within and outside the Development Envelope. Since determination of the FHEZ in 2023, no exploration activities have occurred within the area. The area does contain minimal disturbance limited to an existing access track however areas of existing disturbance and linear and not expected to fragment and impact movement of the species within the FHEZ with the inclusion of the FHEZ Corridor. This area supports high value habitat which allows continuity across the Development Envelope. The Proposal will result in the loss of a total of 520.80 ha of high value (Rocky Hills) habitat for this species, which represents 19.59% of available habitat within the Development Envelope. The Rocky Hills habitat extends outside of the Development Envelope and Drainage Line habitat which can be used for dispersal intersects the Rocky Hills. The FHEZ contains 950.81 ha of Rocky Hills habitat. Drainage lines are also important to the Northern Quoll for dispersal and the FHEZ contains 107.62 ha of Drainage Line/Floodplain habitat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. The FHEZ and the FHEZ Corridor have been found to support a high density population. Studies in the Pilbara have found that that shelters are of higher abundance in rocky-riparian and rocky habitats. These areas have been shown to provide the highest quality habitat for the Northern Quoll, especially as there is also a higher prey availability associated with the more open Stony Spinifex Plains and Hills (Hernandez-Santin et al. 2021). Connectivity across habitats is vital to the survival of species. While the FHEZ is surrounded by the Development Envelope, connectivity will be maintained with the inclusion of the FHEZ Corridor. Additionally, installation of fauna friendly culverts will allow the Northern Quoll to continue dispersal outside of the FHEZ to the north and across the other Rocky Hill habitats. This impact will be managed through the CSFMP and it will include access via culverts, reduced speed within areas which align with Northern Quoll habitat and the use of appropriate lighting as per the Lighting Guidelines. Clearing of 520.80 ha of Rocky Hills habitat will have a direct, long-term impact on the local populations of Northern Quoll within the Development Envelope. It will not impact the long-term survival of the regional Northern Quoll population as Rocky Hills habitat is considered common and widespread throughout the Pilbara (*ecologia* 2021a). While clearing of 885.23 ha of other potential foraging habitat will have a direct impact on foraging habitat for the Northern Quoll within the Development Envelope, it will not have a significant impact on foraging for regional populations as Drainage Line/Floodplain, and Stony Spinifex Plains and Hillslopes habitats, are considered widespread throughout the Pilbara. Habitat suitable for the Northern Quoll is widespread and common in the Pilbara and extends outside the Development Envelope, interconnected by drainage lines along the Chichester Range and Fortescue Valley. **Changes to surface and groundwater conditions** The Proposal will result in modified surface water flow patterns across the Development Envelope. However, the vegetation types and the corresponding fauna habitat types which may be affected by any hydrological changes do not contain critical or foraging habitat for the Northern Quoll (AQ2 2024b). The areas which may be affected by changes include Fortescue Valley floodplain areas which are not habitat for the Northern Quolls. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Stony Spinifex Plains and Hillslopes	NA	813.97		
		Drainage Line/Floodplain	NA	71.26		
Ghost Bat		Rocky Hills	Rocky Hills	520.80	1462.72	**Loss of habitat**

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
	There are no species-specific policy guidelines on what constitutes high value habitat for the Ghost Bat, or what is defined as an important population; however, the conservation advice for the species indicates that persistence of the species in the Pilbara depends on the physiologically benign day roosts found deep underground in humid, temperature stable caves (TSSC 2016a). No roosting habitat has been identified within the Development Envelope for the Ghost Bat. Despite extensive surveys, no known or suspected Category 1, 2 or 3 caves for the Ghost Bat have been identified within the Development Envelope or documented within a 30 km radius. There is anecdotal evidence of a known roost occurring approximately 30 km south of the Development Envelope across the Fortescue Valley, near Wittenoom in the Hamersley Ranges (Bob Bullen pers. comm in *ecologia* 2023a). Of the 82 cave assessments undertaken, 51 cave structures within the Development Envelope are considered as Category 4 (nocturnal refuges). It is unlikely a permanent Ghost Bat roost site exists. The species has the potential to forage in all habitat types within the Development Envelope (Attexo 2023). However, given the absence of critical roosting habitat and permanent water sources in the Development Envelope, habitats present are considered to be of low value to Ghost Bats.	Stony Spinifex Plains and Hillslopes	NA	813.97		The Proposal has been designed to avoid areas of high value fauna habitat as far as practicable. The key avoidance measure for protection of Ghost Bats has been the establishment of the FHEZ and exclusion of this area from the Development Envelope to minimise impacts to habitat that is known to support conservation significant species. The FHEZ is 1,320.82 ha in total, including 950.81 ha of high value Rocky Hills fauna habitat type. The FHEZ also includes Drainage Line, and Stony Spinifex Plains and Hillslopes habitat types which provide other suitable foraging and dispersal habitat for the Ghost bat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. Based on the location of the mineral deposits and subsequent mine pits the development of the Proposal will result in the loss of up to five potential Category 4 Ghost Bat roosts. These are not considered critical habitat (Bat Call 2021a). These caves are associated with Rocky Hills habitat which is widespread throughout the Pilbara region. Further, Ghost Bat occurrence and habitation within the Development Envelope is low with only a few records of this species occurring. A lack of deep caves limits the suitability for diurnal roosting for this species within the area. After extensive survey effort, no permanent known or suspected Category 1, 2, or 3 caves have been identified within the Development Envelope, or has been documented within 30 km of the area (*ecologia* 2023a). Clearing required for the Proposal will have a local impact on the use of habitats by the Ghost Bat, but the impact to the local population will not be significant as Rocky Hills habitat is considered common and widespread throughout the Pilbara. Approximately 6,789.20 ha (82.27%) suitable habitat for this species will remain in the Development Envelope. As the Bats can travel more than 15 km at night while foraging and there are no permanent roosts within the Development Envelope, clearance of foraging habitat for the Proposal will not have a significant direct impact on the Ghost Bat. However, given the absence of critical roosting habitat and permanent water sources in the Development Envelope, habitats present are considered to be of low value to Ghost Bats. **Noise and Vibration** Noise and vibration from the Proposal will not have a significant impact on Ghost Bats, as there are no permanent or maternity caves (No category 1,2,3, caves) within the Development Envelope. As such, breeding will not be impacted by the Proposal during the maternity season, and bat colonies will not be forced to relocate roosts. A minor impact will be had on Category 4 caves for noise and vibration activities conducted at night, where Ghost Bats are likely to avoid using these caves to feed or rest. Research by Bat Call WA (2021a) indicates Ghost Bats may become accustomed to high noise levels and continue to depart from roosts and transit to foraging areas in a typical manner. LGA conducted an Environmental Noise Assessment (LGA, 2024) to determine the likely impacts of noise created by the Proposal on bats. As there are no legislated noise criteria, the noise levels were assessed based on relevant studies on the impact of noise on the Ghost Bat, specifically a study undertaken by Bullen and Creese (2014) that indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost. Applying this criterion, the noise modelling undertaken for the Proposal indicates that noise from operations to nearby caves is predicted to be below the 70 dB threshold, and it would be unlikely for the bats to cease utilising the caves. Ground vibration levels at the closest caves, within 200 m are most critical (LGA, 2024). PSM was engaged to undertake a geotechnical assessments of caves located in close proximity to Proposal activities to understand potential impacts of the Proposal as a result of blasting and operational vibration. A copy of this assessment is provided in **Appendix 28**. The assessment result in maximum vibration limits that should be achieved at caves as assessed as either high or medium susceptibility of damage from vibration Mitigation and management of medium and high-risk caves are outlined in the CSFMP (**Appendix 12**). **Changes to surface or groundwater** Changes to surface and groundwater conditions resulting from the Proposal will not impact the Ghost Bat. Available data suggests that the longest distance from a roost to a permanent water source is 8.7 km (Bat Call WA 2021b). Current best practice is to consider semi- and permanent water sources within 5 km of a Category 1 or 2 roost to be important but not critical habitat for the species (Bat Call 2021a, p. 21). Considerable survey effort undertaken within the Development Envelope has failed to
		Drainage Lines/Floodplain	NA	71.26		
		Gibber Cracking Clay	NA	56.48		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
						locate a permanent water source. Semi-permanent water sources within creek lines (small pools) may be found within the area following rain, which may persist for weeks to months. As no Category 1, 2, or 3 roots occur within the Development Envelope, and no permanent water sources have been identified within the Development Envelope (*ecologia* 2023a), changes to surface water will not impact the Ghost Bat. Further, water permanency in the claypans will not be affected by the Proposal. Karijini National Park located 10 km south of the Proposal, contains permanent surface water sources for the Ghost Bat. Changes to groundwater levels from the Proposal will not impact on local or regional populations of the Ghost Bat as there are no Ghost Bat roosts in underground mines connected to the water table within the Development Envelope. Karijini National Park located 10 km south of the Proposal, contains permanent surface water sources. There are also known Ghost Bat roosts within the Karijini National Park (Roy Hill Expansion Project,2020). Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2,** respectively.
Pilbara Leaf-nosed Bat	No habitat considered to be critical for the survival of the Pilbara Leaf-nosed Bat was identified in the Development Envelope. Habitat considered critical for this species includes gorges bounded by sheer rock walls containing water lasting weeks or months (Priority 1) typical of the Wittenoom and Karijini gorges. Rocky Hills within the Development Envelope support Priority 2 and Priority 3 foraging habitat, while Drainage Lines/ Floodplains support Priority 4 foraging habitat and Stony Spinifex Plains and Hillslopes support Priority 5 foraging habitat. These habitat types are considered widespread in the Development Envelope and in a regional context (in Attexo 2023; Spectrum 2023a). Regular detections in all seasons within the target valley indicate that the Drainage Lines are a preferred commuting and foraging area and considered critical foraging habitat (*ecologia* 2021b). This is consistent with other studies in the Pilbara (Northover et al. 2023). Considerable survey effort undertaken within the Development Envelope has failed to locate permanent water sources within the area (Priority 1 habitat). Semi-permanent water sources within creek lines (small pools) may be found within the area following rain that may persist for weeks or months (*ecologia* 2023a). Habitat considered critical for this species includes Category 1, 2 or 3 roosts, as defined in Bat Call WA (2021b). Foraging habitat within 10 km radius of Category 1, 2 or 3 caves is also considered critical as is any permanent water source within 5 km – 7 km (according to literature, refer to Northover et al 2023). Targeted surveys in the Development Envelope included 82 cave habitat assessments, 44 ARU survey sites and all rocky ridgeline habitats were searched on foot for suitable roost sites (*ecologia* 2023a). All caves with the potential to be used as a diurnal roost have been surveyed using ARUs and there is no evidence to suggest there is a Category 1, 2 or 3 diurnal roost for the Pilbara Leaf-nosed Bat within the Development Envelope. Thirty-two Category 4 caves were identified in the Development Envelope. The *ecologia* 2023a desktop risk assessment for this species compiles all the search data and provides a peer review of the information.	Rocky Hills	Rocky Hills	520.80	1,406.03	**Loss of habitat** The Proposal has been designed to avoid areas of high value fauna habitat as far as practicable. The key avoidance measure for protection of Pilbara Leaf-nosed Bats has been the establishment of the FHEZ and exclusion from the Development Envelope to minimise impacts to high value habitat. The FHEZ is 1320.82 ha in total, including 950.81ha of high value Rocky Hills fauna habitat type. The FHEZ also includes 107.62 ha of Drainage Line, and 262.39 ha of Stony Spinifex Plains and Hillslopes habitat types which provide other suitable foraging and dispersal habitat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. Habitat considered high value for this species includes Category 1, 2 or 3 roosts. Foraging habitat within 10 km radius of Category 1, 2 or 3 caves is also considered high value as is any permanent water source within 8.7 km of theses caves. After extensive survey effort, no permanent known or suspected Category 1, 2, or 3 caves have been identified within the Development Envelope or has been documented within 30 km of the area (*ecologia* 2023a). In addition, the Development Envelope does not contain permanent water sources. A total of 51 caves were assessed as being characteristic of a Category 4 cave (nocturnal refuge) with the potential to be used at night for resting, feeding, or other purposes within the Development Envelope. These are not considered high value habitat but are important for persistence of the species in a local area. The Rocky Hills habitat within the Development Envelope supports Priority 2 and Priority 3 foraging habitat, while Drainage Lines/Floodplains and Stony Spinifex Plains and Hillslopes support Priority 4 foraging habitat; however, in the absence of high value habitat and permanent water sources, is unlikely to be considered high value for this species. Pilbara Leaf-nosed Bat echolocation calls were recorded at 103 locations during surveys (within and outside the Development Envelope). The majority of records were located on flight paths in creek lines or in open habitats away from cave entrances indicating that the creek line is a preferred commuting and foraging area and is considered high value habitat for the species. Rocky Hills within the Development Envelope support Priority 2 and Priority 3 foraging habitat, while Drainage Lines/ Floodplains and Stony Spinifex Plains and Hillslopes support Priority 5 foraging habitat. Approximately 6532.99 ha (82.29%) suitable habitat for this species will remain in the Development Envelope. These habitat types are also considered widespread in a regional context. There is a continued presence of the Pilbara Leaf-nosed Bat within the Development Envelope, and regular detections within the target valley indicate that the Drainage Lines are the preferred commuting and foraging habitat. The loss of the above foraging habitat for this species is not considered significant and these foraging habitats are widespread within the Pilbara. The Pilbara Leaf-nosed Bat can forage up to 20 km from a diurnal roost (Bat Call 2016). Extensive survey effort did not identify any Category 1, 2 or 3 diurnal roosts to be present within the Development Envelope
		Stony Spinifex Plains and Hillslopes	NA	813.97		
		Drainage Line/Floodplain	NA	71.26		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			(*ecologia* 2023a) or within 30 km, so high value Pilbara Leaf-nosed Bat roosts are unlikely to be significantly impacted by the Proposal. The residual impact on the Pilbara Leaf-nosed Bat from the Proposal will not be significant as foraging habitats to be cleared are considered widespread within the Pilbara, no Category 1, 2 or 3 diurnal roosts critical to the Pilbara Leaf-nosed Bat were identified within the Development Envelope, and only eight of the 51 Category-4 caves occur within the Indicative Footprint and have the potential to be removed. **Noise and Vibration** Noise and vibration from the Proposal will not have a significant impact on Pilbara Leaf-nosed Bats, as there are no permanent or maternity roosts (No Category 1,2, or 3 roosts) within the Development Envelope. As such, breeding will not be impacted by the Proposal during the maternity season. Noise and vibration activities conducted at night may result in impacts to the Category 4 nocturnal roosts and bat foraging activities in nearby habitat. A study undertaken by Bullen and Creese (2014) indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost and this can be transferred to the Pilbara Leaf-nosed Bat feeding habitat. LGA conducted an Environmental Noise Assessment (LGA, 2024) to determine the likely impacts of noise created by the Proposal on bats. As there are no legislated noise criteria, the noise levels were assessed based on relevant studies on the impact of noise on the Ghost Bat, specifically a study undertaken by Bullen and Creese (2014) that indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost. Applying this criterion, the noise modelling undertaken for the Proposal indicates that noise from operations to nearby caves is predicted to be below the 70 dB threshold, and it would be unlikely for the bats to cease utilising the caves. Ground vibration levels at the closest caves, within 200 m are most critical (LGA, 2024). HPPL engaged PSM to undertake a geotechnical assessment of caves located in close proximity to Proposal activities to understand potential impacts of the Proposal as a result of blasting and operational vibration. A copy of this assessment is provided in **Appendix 28**. The assessment result in maximum vibration limits that should be achieved at caves as assessed as either high or medium susceptibility of damage from vibration. **Changes to surface and groundwater conditions** Changes to surface and groundwater conditions resulting from the Proposal will not impact the Pilbara Leaf-nosed Bat. No permanent water sources have been identified within the Development Envelope (Priority 1). Semi-permanent water sources within creek lines (small pools) may be found in the area following rain that may persist for weeks or months (*ecologia* 2023a). Water permanency of surface water within the Development Envelope will not be affected by the Proposal. Karijini National Park located 10 km south of the Proposal, contains permanent surface water sources. Changes to groundwater levels from the Proposal will not impact on local or regional populations of the Pilbara Leaf-nosed Bat as there are no Pilbara Leaf-nosed Bat roosts in underground mines connected to the water table within the Development Envelope. There are also known Pilbara Leaf-nosed Bat roosts within the Karijini National Park (Roy Hill Expansion Project, 2020). The national park also has an extensive groundwater system (Johnson and Wright 2003). An assessment on the significance of hydrological changes to fauna habitat from the Proposal found that habitat critical to the Pilbara Leaf-nosed Bat would not be affected by any changes. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
Grey Falcon	The Conservation Advice (DCCEEW 2020) identifies that Grey Falcon nests are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but Grey Falcons also nest in telecommunication towers (Marchant & Higgins 1993; Schoenjahn 2013, 2018; Falkenberg 2010). The tendency of Grey Falcons to utilise the nests of other birds (corvids and raptors) in largest eucalypts restricts suitable nesting habitat presence within the Development Envelope to one main habitat type (*ecologia* 2023b), Drainage Lines/Floodplain (522.64 ha recorded in the Development Envelope); The banks of some Drainage Lines support *Eucalyptus victrix* trees that have the potential to be used for nesting if they possess previously built nests. The remainder of the habitat types within the Development Envelope are unlikely to provide suitable nesting habitat for the Grey Falcon; however, the following habitat types may provide suitable foraging habitat: • Stony Spinifex Plains and Hillslopes; • Cracking Clay; • Snakewood; and • Rocky Plains and Slopes (not mapped withing the Indicative Footprint).	Drainage Lines/Floodplains		71.26	921.37	**Loss of habitat** Although significant avifauna survey effort has been undertaken since 2013 within the Development Envelope, this species has only been recorded on two occasions, indicating intermittent visitation which aligns with the habits of this nomadic species. The banks of some Drainage Lines support *Eucalyptus victrix* trees that have the potential to be used for nesting if they possess previously built nests. The Grey Falcon recorded by *ecologia* (2021b) was in close proximity to a drainage line in the Mulga East portion of the Development Envelope. The Proposal impacts a total of 71.26 ha of this habitat type, which is 3.3% of the mapped extent in the Development Envelope. Mapped nests which have the potential to be used by this species within the Development Envelope will be retained. The remainder of the habitat types within the Development Envelope are unlikely to provide suitable nesting habitat for the Grey Falcon however, 5,595.18 ha of potential foraging habitat is present, of which 921.37 has will be cleared 16.47%). A targeted survey undertaken in 2023 assessed 54 survey sites within suitable habitat for the Grey Falcon. A total of 46 nests across 27 trees were recoded and assessed as suitable for use by the Grey Falcon. However, none were observed during the survey and no secondary evidence of this species was found within the assessed nest sites. The majority of the nests were associated with *Eucalyptus vitrix*. Based on the results of surveys to date, is likely that the Development Envelope is used by this species on an occasional basis for foraging and potential breeding. **Changes to surface and groundwater** An ecohydrological study (AQ2 2024b**;**) was completed to investigate the claypan flats and associated stands of mesic trees comprising *Eucalyptus victrix*. Sensitivity analyses reaffirmed the overriding importance of the timing and magnitude of soil water replenishment events, rather than total annual rainfall per se, for sustaining the woodland trees.The assessment found no GDEs within the Development Envelope. Water balance modelling supported by on-ground vegetation measurements, used to estimate tree water use relative to water availability estimated that surface water inputs are sufficient to support the density of trees occurring in the Fortescue Valley *E. victrix* woodland communities. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be about 2.0 mbgl. If water levels rise above this threshold for prolonged periods, vegetation stress is predicted. Although the predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LoM, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time (AQ2 2024b). Impacts to fauna habitat resulting from changes in hydrology are further discussed in **Section 10.4**. Overall, the potential impacts to the vegetation are likely to be spatially restricted and transient. A Water Management Plan has been prepared to allow for the identification and management of impacts to vegetation health and vegetation resulting from hydrological changes associated with implementation of the Proposal (**Appendix 6**). Given the likely intermittent visitation of this species and the extent of habitat that will remain within the Development Envelope, impacts to this species are unlikely to be significant. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Stony Spinifex Plains and Hillslopes		813.97		
		Cracking Clay		28.10		
		Snakewood		8.04		
Pilbara Olive Python	The Conservation Advice for the Pilbara Olive Python does not define which habitat is considered critical for the survival of this species (DCCEEW 2008a).	Rocky Hills	NA	520.80	1,406.03	**Loss of Habitat** The Pilbara Olive Python has a medium to low likelihood of occurrence within the Development Envelope. Within the Development Envelope, suitable habitat for the Pilbara Olive Python is
		Drainage line/Floodplain	NA	71.26		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
	Defining habitat critical for the survival of the Pilbara Olive Python is acknowledged as being difficult due to a lack of research on habitat use. Likewise, sites that are important for reproduction in adults are poorly understood as only two nesting sites have ever been located in rocky hills away from river systems. DBCA have provided a default definition based on the description of common habitat characteristics where the species have been encountered (refer to Northover et al 2023). It is also known that habitat quality for this species is strongly influenced by the presence of waterholes and billabongs (Pearson 2006, DCCEEW 2008a). Based on survey information available to date, the Development Envelope does not contain deep gorges or permanent sources of water considered preferred habitat for this species (DCCEEW 2008a). As such, denning is considered to be less likely within the Development Envelope, given the absence of persistent of watering holes. Within the Development Envelope, suitable habitat for the Pilbara Olive Python is associated with the Rocky Hills (rocky outcrops, breakaways and small gorges) although it has also been known to inhabit spinifex grasslands and travel large distances. There is a record of one Pilbara Olive Python which was found at a mine camp within the Mulga Downs Iron Ore Project. This camp was located within the Stony Spinifex Plains and Hillslopes habitat type. However, this is not habitat which has been defined as habitat for the species in the most recent work by DBCA. While the Rocky Hills habitat may support the Pilbara Olive Python, it cannot be considered high value habitat this species given the absence of permanent water holes. Drainage Line habitat also provides suitable foraging habitat (*ecologia* 2021a). Rocky Hills habitat is considered common and widespread throughout the Pilbara (*ecologia* 2021a). No deep gorges or permanent sources of water considered preferred habitat for this species, have been recorded within the Development Envelope.	Stony Spinifex Plains and Hillslope	NA	813.97		associated with the Rocky Hills (rocky outcrops, breakaways and small gorges) although it has also been known to inhabit spinifex grasslands and travel large distances. Defining habitat critical for the survival of the Pilbara Olive Python is acknowledged as being difficult due to a lack of research on habitat use. Likewise, sites that are important for reproduction in adults are poorly understood as only two nesting sites have ever been located in rocky hills away from river systems. DBCA have provided a default definition based on the description of common habitat characteristics where the species have been encountered (refer to Northover et al 2023). It is also known that habitat quality for this species is strongly influenced by the presence of waterholes and billabongs (Pearson 2006, DCCEEW 2008a). Based on survey information available to date, the Development Envelope does not contain deep gorges or permanent sources of water considered preferred habitat for this species (DCCEEW 2008a). As such, denning is considered to be less likely within the Development Envelope, given the absence of persistent of watering holes. The Proposal will result in the loss of a total of 520.80 ha of Rocky Hills habitat, which represents 19.59% of available habitat within the Development Envelope. As such, significant areas (about 80%) of mapped potential suitable habitat for this species will remain within the Development Envelope. The Development Envelope comprises 5,280.79 ha of suitable foraging habitat (Drainage line/Floodplain and Stony Spinifex Plains and Hillslope) for the Pilbara Olive Python, of which 885.97 ha (16.78%) will be impacted by the Proposal. Significant areas of foraging habitat will therefore remain within the Development Envelope (greater than 80%). The FHEZ is 1320.82 ha in total, including 950.81ha of high value Rocky Hills fauna habitat type. The FHEZ also includes 107.62 ha of Drainage Line, and 262.39 ha of Stony Spinifex Plains and Hillslopes habitat types which provide other suitable foraging and denning habitat. The FHEZ Corridor supports 548.14 ha of Rocky Hills habitat, 331.16 ha of Stony Spinifex Plains and Hillslopes and 75 ha of Drainage Lines/Floodplains habitat which will be retained. None of these habitats are restricted to the Development Envelope and are considered common on a local and regional scale. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2,** respectively.
Night Parrot	No high value habitat critical to the survival of the Night Parrot was identified within the Development Envelope. The area does not support large stands of old clumps of old, unburnt spinifex. Distribution of the spinifex stands was patchy. Water bodies, permanent or temporary, were not found in proximity to any vegetation which could be considered as potential nesting areas (Biologic 2022a). Based on the above, habitat considered suitable for the Night Parrot within the Development Envelope includes Drainage Line/Floodplain and Stony Spinifex Plains and Hillslopes (*ecologia* 2021a). In the absence of long unburned spinifex, this habitat is considered as supporting only. Potential supporting (foraging) habitat for the Night Parrot is also found in Chenopod/Cracking Clay Floodplains (*ecologia* 2021a).	Stony Spinifex Plains and Hillslopes	NA	813.97	900.95	**Loss of habitat** Habitat considered potentially suitable for the Night Parrot within the Development Envelope includes Drainage Line/Floodplain and Stony Spinifex Plains and Hillslopes, both of which are considered common and widespread throughout the Pilbara. However, in the Development Envelope these lack large clumps of unburnt spinifex. Long unburnt spinifex, preferred by the Night Parrot, is patchily distributed in the Development Envelope and restricted to the Stony Spinifex Plains and Hillslopes in the northeast of the Development Envelope. The Development Envelope includes 71.26 ha Drainage Line/Floodplain and 813.97 ha Stony Spinifex Plains and Hillslopes, both of which are considered common and widespread throughout the Pilbara (*ecologia* 2021a). The Rocky Hills habitat includes vegetation complexes of sparse hummock grasslands of *Triodia* spp. and sparse chenopod – both which have been identified as suitable for the Night Parrot. The Stony Spinifex Plains and Hillslopes occur interspersed between the Rocky Hills habitat. These areas were targeted during surveys as they were considered to contain habitat which may be critical or supporting. Potential supporting (foraging) habitat for the Night Parrot is found in Chenopod/Cracking Clay Floodplains; however, it is unlikely that this habitat is utilised by the Night Parrot due to degradation from long-term overgrazing and trampling by cattle (*ecologia* 2021a). **Changes to surface water and groundwater** Changes to surface water and groundwater conditions in the Development Envelope are not expected to impact the Night Parrot. This species is known to occupy chenopod shrublands near paleo drainages such as the Fortescue Valley. Night Parrot records have primarily been from near salt lakes in the arid
		Drainage lines/Floodplains	NA	71.26		
		Chenopod/Cracking Clay Floodplains	NA	15.72		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
						zone. Changes to the water balance of the Gnalka Gnoona and Koodjeepindarranna Claypans is considered minimal (AQ2 2024b). Impacts to fauna habitat resulting from changes in hydrology are further discussed in **Section 10.6.2**. Dense thickets of lignum are stated as critical habitat for the Night Parrot. Lignum is well adapted to a periodic flooding regime and has strong drought and waterlogging tolerance. The predicted hydrological change to the Development Envelope is unlikely to significantly affect lignum; except that lignum recruitment could be enhanced. The Fortescue Valley vegetation types can be regarded as supporting habitat for the Night Parrot. The key structural and floristic elements of these vegetation types that are relevant for Night Parrot habitat values (e.g. perching, nesting, provision of food resources) are unlikely to be affected by the predicted hydrological change. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in Section **10.4.1** and Section **10.4.2**, respectively.
Greater Bilby	Habitat considered to be suitable for the Bilby was identified during the database searches for each of fauna surveys. Database search results indicated that Drainage Line/ Floodplain and Mulga Woodland habitats could provide suitable supporting habitat for Bilbies. Habitat which may be considered critical for the survival of the Bilby has also been defined as habitat along palaeo drainages near salt lake systems such as the Fortescue Valley (Northover et al 2023). The Drainage Line/ Floodplain and Mulga Woodland habitats in the Development Envelope can be considered habitat within the home range of paleo drainage systems for the Bilby, along with the Chenopod/ Cracking Clay Floodplain habitat. These all exist within the Fortescue Valley paleo drainage system and also includes habitat such as Mixed Eucalypt/Mulga Floodplain. Systematic fauna surveys were undertaken within these habitats. Targeted searches were undertaken using UAV. No Bilby dens or burrows were identified in any targeted surveys or systematic surveys sites undertaken within the Fortescue Valley paleodrainage system within and south of the Development Envelope. The presence of soil substrate suitable for burrow construction is critical (Dziminski and Carpenter 2016). The Mulga Woodland was found to have compacted alluvial loamy clay soils with occasional surface stones, not suitable for burrowing. The Drainage Line/Floodplain habitat is considered suitable for the Bilby and contains spinifex, samphires and Mulga complexes.	Drainage lines/Floodplains	NA	71.26	2,911.72	**Loss of habitat** Approximately 522.64 ha of Drainage Line/Floodplain, 8,202.96 ha of Mulga Woodland habitat and 92.78 ha of Chenopod/Cracking Clay Floodplain is present within the Development Envelope. Drainage Line/ Floodplain habitat and Mulga Woodland is considered common and widespread throughout the Pilbara (*ecologia* 2021a). No dens or burrows were found during surveys and therefore the home ranges for the Bilby are likely to be outside the area. The Proposal will result in clearing of up to 2,911.72 ha of habitat which has the potential to support foraging and/or dispersal activities for the Bilby, which represents a loss of 33.02% of available habitat within the Development Envelope. As such, about 66.98% of mapped potential foraging and/or dispersal habitat for this species will remain within the Development Envelope. Clearance of this habitat is not expected to have a significant impact on the survival of the Greater Bilby as no dens or primary or secondary activity has been found in this habitat. Records of the Bilby are outside the Development Envelope primarily in the north and further east. Further, Drainage Line/ Floodplain habitat and Mulga Woodland is considered common and widespread throughout the Pilbara (*ecologia* 2021a; Biologic 2022 a, b; Spectrum 2023a). This species is considered to be a visitor rather than a resident. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Mulga Woodland	NA	2,824.74		
		Chenopod/ Cracking Clay Floodplain	NA	15.72		
Peregrine Falcon	This species occupies extremely diverse habitats and has the potential to occur in all the habitats present, for foraging. No suitable nesting habitat was recorded within the Development Envelope.	Rocky Hills	NA	520.80	648.75	Approximately 2,790.02 ha (18.86%) suitable habitat for this species will remain in the Development Envelope. Given the diverse range of habitats utilised by this species and the extent of preferred habitats for this species that will remain in the Development Envelope, impacts to this species are unlikely to be significant. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Drainage Line/Floodplain	NA	71.26		
		Gibber Cracking Clay	NA	56.48		
Gane's Blind Snake	Gane's Blind Snake is found throughout the Pilbara bioregion, with records in conservation state, such as the Millstream Chichester National Park and Karijini National Park (noting that the location of these data points is an estimated location).	Mulga Woodland	NA	2,824.74	2,896.00	Given the retention of approximately 5,829.60 ha (66.81%) of suitable habitat for this species within the Development Envelope and the regional extent of these habitat types, the Proposal is unlikely to significantly impact the regional population or the conservation status of the species. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2**, respectively.
		Drainage Area/Floodplain	NA	71.26		

Conservation Significant Fauna	Habitat Overview	Habitat Type		Extent in Indicative Footprint (ha)	Total (ha)	Assessment of Significance of Impact
		Foraging	Denning/ Roosting			
Western Pebble-mound Mouse	The Western Pebble-mound Mouse almost exclusively occurs on gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs The species most likely occurs within habitats that provide suitable material for the construction of mounds, such as stony slopes of Hillcrest/Hillslope habitats.	Stony Spinifex Plains and Hillslopes	NA	813.97	813.97	Approximately 3,944.18 ha (82.90%) of this fauna habitat type will remain in the Development Envelope. This species is widespread and common in the region, and the Proposal is unlikely to significantly impact the regional population or the conservation status of the species. Suitable habitat for this species is preserved in the FHEZ Corridor and numerous mounds were recorded in this area. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in Section **10.4.1** and Section **10.4.2**, respectively.
Migratory Species Red-necked Stint Wood Sandpiper Common Greenshank	Important habitats in Australia for migratory shorebirds include those recognised as nationally or internationally important. The widely accepted and applied approach to identifying internationally important shorebird habitat has been through the use of criteria adopted under the Ramsar Convention on Wetlands (DoEE, 2017). According to this approach, wetland habitat should be considered internationally important if it regularly supports: • 1% of the individuals in a population of one species or subspecies of waterbird; OR • a total abundance of at least 20 000 waterbirds. Nationally important habitat for migratory shorebirds can be defined using a similar approach to these international criteria, i.e. if it regularly supports: • 0.1% of the flyway population of a single species of migratory shorebird; OR • 2000 migratory shorebirds; OR • 15 migratory shorebird species.	Mixed Eucalypt/Mulga Floodplain	NA	0.00	0.00	The Proposal will not impact this habitat type within the Development Envelope. This habitat type is considered widespread within the Fortescue valley and does not provide significant refugia to sustain any permanent populations. Migratory species have the potential to utilise this habitat type as foraging habitat only when inundated. **Changes to surface water and groundwater** Impacts to fauna habitat resulting from changes in hydrology are further discussed in **Section10.6.2.2**. Where changes in flood depth are predicted, in the majority of cases, the dominant species in the impacted vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change. Vegetation types dominated by mulga (*Acacia aneura* complex) are susceptible to increased waterlogging, which could cause a decline in tree health. Such areas are relatively small (circa tens of hectares) in the overall affected area. An assessment of the potential for vegetation in and around claypans to be impacted by altered hydrology is provided in **Section 10.6.2.2**. Other potential direct and indirect impacts to this species as a result of the Proposal are discussed in **Section 10.4.1** and **Section 10.4.2,** respectively.

10.6.1.3 Loss of Habitat for Short Range Endemics

Clearing, earthworks and excavation activities will unavoidably result in the loss of individual potential SRE taxa recorded within the Development Envelope. Of the 10 potential SREs identified within the Development Envelope, the majority are likely to be widespread or have distributions extending beyond the clearing boundaries.

The habitats with the greatest diversity were found to be the Rocky Hills and Drainage Lines/Floodplain. Across all SRE surveys, only one species of isopod was identified as confirmed SRE species – *Buddelundia* 56. This species were recorded from the *ecologia* Phase 2 survey within the Mulga West Borefield which has now been excluded from the Proposal.

The Proposal will remove a combined total of 592.06 ha of these high value SRE habitat types, representing 18.61% of the total extent within the Development Envelope. Mulga Woodland was also a favourable SRE habitat type. The Proposal will remove 2,824.74 ha of Mulga Woodland, representing 34.44% of the total extent within the Development Envelope. Overall, the loss of potential SRE habitat within the Development Envelope is 30.01%. Significant areas of habitat suitable for SRE's will therefore remain in the Development Envelope. The habitats within the Development Envelope are also not restricted, which indicates SRE species that occur within the Development Envelope, could also occur within the surrounding area. Extensive areas of suitable habitat for these species will therefore remain within the Development Envelope. These habitat types are also widespread in the Pilbara.

One Confirmed SRE – *Buddelundia* 56 was recorded in the Development Envelope. This species was not recorded in the Indicative Footprint and was found outside the Development Envelope.

Up to 31 possible SREs were recorded in the Development Envelope. Four were only recorded in the Indicative Footprint. These four are the isopods *Buddelundia* indet. 1 and Buddelundiinae 'Nyi01'; the Arachnid *Missulena* sp. indet.; and the Arthropod *Dampetrus* OPI001 and they were collected from Rocky Hills Habitat. Over 90% of potential habitat for SREs will be retained and the habitats are widespread.

Isopod and scorpion specimens from SRE target groups were collected from all habitat types surveyed. Habitat preferences for target SRE groups were highly variable, with different invertebrate groups exhibiting habitat preferences likely to be associated with variations in microhabitat requirements. Drainage Lines/Floodplains were found to support the greatest diversity of scorpions. Rocky Hills provided the greatest diversity of pseudoscorpions and millipedes, and the Mulga Woodland habitat supported isopods and harvestmen. Survey effort demonstrates all of the mapped habitats within the Development Envelope extend beyond the Development Envelope. Significant areas of suitable habitat will therefore remain both within and outside the Development Envelope. Habitat suitable for SREs will be retained within the FHEZ and FHEZ Corridor.

The FHEZ will protect 1,320.82 ha of fauna habitat comprising of Rocky Hills (950.81 ha), Drainage Line/Floodplain (107.62 ha) and Stony Spinifex Plains and Hillslopes (262.39 ha). The FHEZ Corridor will retain 991.45 ha of suitable habitat. This includes 75 ha of Drainage Lines/Floodplains, 548.14 ha of Rocky Hills and 331.16 h of Stony Spinifex Plains and Hillslopes. Exclusion of the FHEZ and restricted development within the FHEZ Corridor therefore reduces impacts on habitat which is known to support SREs.

10.6.2 Indirect Impacts

10.6.2.1 A decline or change in health/composition of fauna habitat

Dust and Use of Saline Water for Dust Suppression

Construction and operation activities may result in an increase in dust. Dust emissions during construction can be generated through vegetation clearing and earthwork activities, including vehicle and machinery movements. Dust emissions during operations may arise from the handling of ore and movement of machinery. Dust has the potential to impact on the health of fauna habitat resulting from deposition onto the surfaces of leaves. There is also the potential of impacts to the health of fauna habitat from the use of saline water for dust suppression during the construction and operation of the Proposal. This can result in vegetation mortality or an increase in soil salinity leading to a decline in vegetation and flora health.

Matsuki et al. (2016) conducted a study examining the impacts of dust on plant health in semi-arid environments. The results of the study indicated no evidence of negative impacts on plant health as a result of dust deposition. Plants in semi-arid environments are exposed to dust within the natural environment and are less likely to suffer from short-term impacts of dust.

Clearing will be undertaken progressively. In addition, temporarily cleared areas will be progressively rehabilitated upon completion of construction. Dust emissions are expected to be minimal and localised to immediately adjacent vegetation.

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope and throughout the life of mine. The Proposal may result in a minor, temporary increase in localised dust deposition on vegetation but this is not expected to significantly impact vegetation, noting that the Pilbara is a naturally dusty environment.

Dewatered mine water will be used to suppress dust. This water will be limited to use in mine areas where vegetation has been cleared. The water will be a blend of brackish water from dewatering bores.

Even with potential elevated dust levels as a result of the Proposal, the fauna species within the Development Envelope are adapted to the dusty climate of the Pilbara, and dust emissions will not result in permanent changes to fauna habitat.

A Water Management Plan has been prepared to allow for the identification and management of impacts to vegetation health and vegetation resulting from (amongst other things) the use of saline water for dust suppression associated with implementation of the Proposal.

10.6.2.2 Altered Hydrological and Hydrogeological Regimes

Changes to surface water flows

The predicted impacts of alterations to the hydrological regime are described further in **Section 7**.

The potential impacts of hydrological change on mapped vegetation types and associated habitat attributes for MNES fauna species was qualitatively assessed, based on the key areas where predicted groundwater and surface water change may impact vegetation.

A total area of approximately 25 ha is predicted to be subject to increased flood levels comprising a mix of Mulga dominated vegetation at the base of alluvial fans and *Eucalyptus victrix* woodlands near the valley fringe. The magnitude of predicted change however is modest and the dominant species in these vegetation types are well adapted to periodic flooding and drying and are unlikely to be significantly affected by the predicted hydrological change of increased surface water inputs. Vegetation types dominated by mulga (*Acacia aneura* complex) are susceptible to increased waterlogging, which could cause a decline in tree health. Such areas are relatively small (circa tens of hectares) in the overall affected area. Although this area has also been identified as being at risk of exposure to shallow groundwater levels (from MAR), prolonged periods of groundwater mounding can be avoided with a programme of ongoing monitoring and adaptive management. Given this, the health and condition of vegetation and the fauna species these areas support are not anticipated to be significantly affected.

An additional area of approximately 310 ha is expected to experience a reduction in flood levels (>5 cm decrease maximum flood height) within the Fortescue Valley to the south of the Development Envelope. The magnitude of predicted change is modest. Water shadowing downstream of linear infrastructure (i.e., roads) is minimal due to the preliminary locations selected for the proposed culverts as captured in the model, which allow flows to continue downstream of the infrastructure. The areas likely to be affected largely comprise areas of patchy vegetation dominated by Mulga and scattered *Eucalyptus victrix*. Denser patches with high percentage cover of *Eucalyptus victrix* (vegetation type AdEvWL), have the greatest potential to experience soil water depletion and drought stress during prolonged interfloods.

The vegetation types predicted to be exposed to hydrological change are widespread across the Fortescue Valley and do not contain critical habitat for listed fauna species. Some instances of dense lignum thickets (relevant for the Night Parrot) occur further into the Fortescue Valley in association with *Eucalyptus victrix* woodland communities, but these are distant from the areas potentially exposed to hydrological change.

Given this, it is unlikely that the value of these fauna habitats to fauna species that utilise them will be significantly impacted as a result of altered hydrological regimes. Ongoing monitoring and adaptive management (i.e., redistribution of MAR) will avoid the impact of groundwater mounding on vegetation.

Cave microclimates may be influenced by proximity to surface water features, such as permanent pools which may increase humidity of the surrounding environment (Bat Call 2021b). However, as no surface water fed permanent pools were found within the Development Envelope during the surveys (*ecologia* 2023a; Biologic 2022b, Spectrum, 2023a, b), it is more likely that the microclimate of caves within the Development Envelope are influenced by factors such as cave depth and structural ability to retain humidity, and water infiltration during rainfall events through the rock above (Bat Call 2021b). Therefore, it is not anticipated that the Proposal will impact cave microclimates as a result of changes to surface water regimes. Notwithstanding, baseline and ongoing monitoring of cave humidity is included in the CSFMP (**Appendix 12**).

The Gnalka Gnoona Claypan and the Koodjeepindarranna Claypan are located immediately to the south of the Development Envelope. The claypans support a diverse and highly unique aquatic invertebrate assemblage. This includes a high richness of aquatic crustacean and rotifer taxa, which are considered sensitive receptors for the claypan systems. In total, five significant invertebrate taxa were recorded during the database search and literature review. The significant invertebrates were new to science and therefore potentially restricted to claypans in the Biologic (2023) Desktop Assessment Area. Changes to groundwater and surface water levels, extent and quality have the potential to impact aquatic habitat within the freshwater claypans, that support regionally significant aquatic invertebrate communities, particularly during the initial filling phase of the claypans, when sensitive juvenile life-stages are likely to be present. Changes to water quality and hydrological regime may also adversely affect hatching / emergence rates of dormant invertebrate resting stages.

The claypans also provide important foraging areas for waterbirds. A number of threatened and listed migratory species have been identified as potentially utilising the claypans and habitats within the Development Envelope.

As discussed in Section 7.5, a water balance for the claypans was created to quantify the impact due to the potential loss in catchment due to the proposed mine development. The claypan water balance assessment concluded the predicted changes to inundation depths, ponding duration (hydroperiod) and water quality (TDS) of ponded water associated with the claypans are anticipated to be marginal and within the range of tolerance for associated vegetation and aquatic invertebrates (AQ2 2024b; Biologic 2023).

Monitoring and management of salinity, nutrient and metals inputs into the claypans, as well as the aquatic invertebrate communities, will be undertaken as outlined in the WMP (**Appendix 6**).

Changes to groundwater levels

Given that the vegetation is inferred to be disconnected from the groundwater system under baseline conditions, a reduction in groundwater levels is not predicted to impact the terrestrial environment. Therefore, changes to groundwater as a result of drawdown is not expected to impact terrestrial fauna. An assessment of potential impacts to vegetation from groundwater level change is provided in Section 9.4.2.4.

Changes to the groundwater level from mine pit dewatering may impact cave microclimates through a reduction in humidity in cases where cave roosts are connected to the water table (Bat Call 2021). However, the depth to groundwater within the FHEZ (which contains 36 Category 4 Nocturnal Roosts) ranges from a minimum of 20 m to greater than 50 m (AQ2 2024a). Despite considerable survey effort within the Development Envelope and FHEZ, no permanent pools which are groundwater fed have been found (*ecologia* 2023a; Biologic 2022b, Spectrum, 2023a, b) and ecohydrological studies to date have found that the vegetation is disconnected from the groundwater system, meaning a reduction in groundwater is not predicted to impact the terrestrial environment (AQ2 2024b). As there are no known direct connections with the water table and as groundwater is found, at its closest, approximately 20 m below surface level, groundwater is unlikely to influence cave microclimates within the Development Envelope and the FHEZ.

As shown in **Figure 10-22**: , the maximum modelled groundwater drawdown contour (2 m) extends outside of the Development Envelope, primarily in a south-westerly direction. Of the habitat in the drawdown area, 74.77% has been mapped, with the majority of the area mapped outside of the Development Envelope occurring to the south/south-west mapped as Mixed Eucalypt/Mulga Floodplain (16.47%). This habitat type is associated with

the Fortescue River floodplain (Spectrum 2023a). It is assumed, based on mapping undertaken to date and broad vegetation mapping, that unmapped areas south/south-west of the Development Envelope that intersect the maximum modelled groundwater drawdown contour (2m) are likely to be a continuation of the mapped Mixed Eucalypt/Mulga Floodplain and Mulga Woodlands habitat types. Neither of these habitat types are associated with fauna microhabitats, such as caves, that support bat roosting and therefore, groundwater drawdown in this area is unlikely to impact on cave microclimates. One additional area north-west of the mapped extent, seen on **Figure 10-22**: , sits within an area that may be subject to groundwater drawdown. This area is adjacent to a mapped area of Rocky Hills habitat that has been extensively searched for caves, with one cave recorded (MEC023 ~ 2.2 km east of unsurveyed area). Based on an analysis of aerial imagery, the unmapped area is likely to be a continuation of the Mulga Woodland and Drainage Line habitat types which occur directly south of the unmapped area. Based on this inference, it is highly unlikely that any caves would occur within this area of groundwater drawdown extent as all known caves sit within the Rocky Hills habitat type. Subsequently, based on groundwater drawdown impact modelling and extensive fauna surveying, the likelihood of impacts to cave microclimates from groundwater drawdown associated with the Proposal, within and outside of the Development Envelope, are negligible. Notwithstanding, baseline and ongoing monitoring of cave humidity is included in the CSFMP (**Appendix 12**). Following cessation of operations and closure of the mine, groundwater levels are predicted to recover to within 0.1 m of baseline levels, meaning negligible impacts are also temporary.

Groundwater level rise (i.e., mounding) will occur as a result of MAR. Based on the ecohydrological conceptual model and measured baseline conditions, the threshold groundwater depth above which interaction with vegetation may occur is estimated to be 2.0 mbgl. The predicted depth to groundwater remains below 2.5 mbgl (i.e., below this threshold) in the immediate MAR areas throughout the LoM; however, areas to the south of both the Murray's Hill / Anticline Hill and Fridge / Horseshoe South MAR areas, at the break of slope, have been identified as areas at risk of exposure to shallow groundwater levels for periods of time.

Groundwater salinity will also change as a result of dewatering and MAR activities. The TDS of the combined dewatering discharge for all dewatering bores over LoM is predicted to range between 1,800 and 3,000 mg/L. The modelling indicates that changes in groundwater quality resulting from the proposed dewatering and MAR activities is anticipated to be fairly localised (i.e., <2 km in extent). Predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM. As the intent is to avoid any water logging of the root zones, the salinity of the mounded groundwater and the tolerance of vegetation to salinity changes does not require further consideration.

In overall terms, potential impacts from groundwater mounding are likely to be spatially restricted and transient over the life of the Proposal. However, given the level of uncertainty associated with predictive modelling of groundwater levels and noting that the tolerance of vegetation to groundwater level change is site specific and not easily determined, a program of ongoing monitoring of groundwater levels and vegetation health will be undertaken. A detailed discussion of the proposed management and monitoring measures is provided in the Water Management Plan (**Appendix 6**). The key management measures are:

- Surplus water will be managed via MAR to:
  - limit the extent of drawdown from the immediate mining area (accepting recirculation of groundwater) and

- limit the potential for the saline interface to rise as a result of hydrostatic changes in the broader cone of depression.

- Comprehensive baseline and operational monitoring of groundwater levels and groundwater quality will be undertaken to monitor impacts relating to dewatering and MAR; inclusive of on-going monitoring outside of the area of impact to provide further baseline data, thereby allowing differentiation between seasonal and mining-related changes. As the tolerance of vegetation to groundwater level change is site specific and not easily determined, baseline and operational monitoring of both groundwater levels and vegetation health is of particular importance for the areas identified as being at risk of exposure to shallow groundwater levels.
- Operation of multiple MAR areas to allow flexibility of injection and periods of recovery (i.e., reduced injection in one area and increased in another) if required due to groundwater level or groundwater quality triggers being observed.
- Review of dewatering rates if groundwater level or groundwater quality triggers are observed and cannot be managed by modifying the distribution of MAR.
- Backfilling of the pits at closure to allow groundwater levels to return to near pre-development conditions and eliminate further changes to groundwater salinity resulting from evaporation from pit lakes. The modelling indicates a rapid recovery of groundwater levels post-mining, with predicted groundwater levels reported to recover to within 0.1 m of pre-mining levels within 10 years of the cessation of mining, at all mining areas, MAR areas and regional simulated observation points.

In addition to the above management measures, monitoring data will be regularly compared to model predictions and, as necessary, the numerical model can be re-calibrated to recorded responses and used to re-assess integrated groundwater management and mining scenarios.

As such there is a low likelihood of impacts to fauna habitat resulting from groundwater mounding of changes in groundwater quality.

Figure 10-22: Maximum extent of groundwater drawdown across mapped fauna habitat extent

646000 648000 650000 652000 654000 656000 658000 660000 662000 664000 666000 668000 670000 672000 674000 676000 678000 680000 682000 684000 686000

7570000 7568000 7566000 7564000 7562000 7560000 7558000 7556000 7554000 7552000 7550000 7548000 7546000 7544000 7542000 7540000

GREAT NORTHERN HWY

Legend

- Development Envelope
- Fauna Habitat Exclusion Zone (FHEZ)
- FHEZ Corridor

Fauna habitat

- Boulder Piles
- Calcrete Stony Plain
- Chenopod/ Cracking Clay Floodplain
- Claypan
- Cracking Clay
- Drainage Lines/Floodplains
- Gibber Cracking Clay
- Hilltops, Mesas & Outcrops
- Mixed Eucalypt/ Mulga Floodplain
- Mulga Woodland
- Rocky Hills
- Rocky Plains & Footslopes
- Snakewood
- Stony Spinifex Plains and Hillslopes
- Cleared/Disturbed
- Category 4 nocturnal refuges
- Max 2m Drawdown Extent
- Max 5m Drawdown Extent
- Max 10m Drawdown Extent
- Highway
- Minor Road

JBS&G

Job No: 67751

Client: Hancock Prospecting Pty Ltd

Version: A	Date: 01-Apr-2025
Drawn By: dmills	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometres

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

GROUNDWATER DRAWDOWN

FIGURE 10.22

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Image Reference: World Imagery: Earthstar Geographics

10.6.2.3 Impacts (i.e. cave collapse) from blasting/vibrations

Any bats utilising suitable caves recorded in the Development Envelope or FHEZ at the time of mining may be impacted indirectly through noise and vibration and it is possible that the bats would avoid these caves during construction and mining. However, if the structural integrity and suitable microclimate of the caves remain unchanged post mining, the caves can be considered suitable for use by the Pilbara Leaf-nosed Bat and / or Ghost Bat.

PSM (2024) was engaged to undertake geotechnical assessments of caves located in close proximity to the Proposal to understand potential impacts of the Proposal to caves that will be retained in the FHEZ as a result of blasting and operational vibration. The geotechnical assessment is provided as **Appendix 28.**

The caves to be retained within the FHEZ located closest to pits were selected for the assessment as these are considered most susceptible to vibration impacts. Caves located further away from the pits, in the FHEZ Corridor, would be expected to experience reduced vibration levels.

The assessed caves are hosted within outcropping bedrock escarpment of the Marra Mamba Iron Formation. The flat-lying orientation of these lithologies at Mulga Downs results in cave profiles that are generally relatively low and wide. They are commonly highly weathered and hydrated, with pervasive overprinting of the original rock fabric. The exposed escarpments themselves are typically 10-15 m in height.

The purpose of the geotechnical assessment was to assess the geotechnical stability of the caves in consideration of impacts from blasting and operational vibration, and to recommend maximum blast and operational vibration limits that should be achieved at the cave entrances to reduce the likelihood of collapse.

To assist in assessing appropriate blasting limits for the caves, each site was assigned a qualitative susceptibility rating based on key geotechnical features observed in the cave and/or escarpment around the cave entrance during the infield assessments:

- Identified specific potential rockfall hazard sources.
- Open/dilated defects.
- Structural controls on cave formation or stability (e.g. major joints, bedding).
- Interpreted potential for significant roof collapse events, including observations of:
  - Wide spans;
  - Flat roof profiles;
  - Persistent sub-horizontal bedding partings; and
  - Highly jointed and dilated rock mass (PSM, 2024).

Based on the assessment undertaken across 19 caves, four were considered low risk, 11 were considered medium risk and four were considered high risk. The assessment assigned to each cave is outlined in PSM (2024).

There is limited public information available in relation to the impact of mining activities on nearby caves and rock shelters, or any published vibration limits or guidelines. Based on the literature review undertaken by

PSM and its experience at other Pilbara mine sites, the recommended vibration limits to reduce the likelihood of significant damage above the natural background level of degradation that may result in changes to climatic conditions within the cave, or reduced access for fauna are:

- 75 mm/s for low to medium susceptibility caves (MEC007; MEC012; MEC013; MEC016; MEC025; MEC033; MEC049; MEC060; MEC062; MEC074); and
- 25 mm/s for high susceptibility caves (MEC003; MEC061; MEC063; MEC065) (PSM, 2024).

PSM also recommends that where blasting is within 500 m of a cave site, continued geotechnical monitoring is to be undertaken to assess the impact of the mining operations on rock mass, including:

- PPV monitoring at the cave sites;
- Geotechnical monitoring (such as crack-meters, tilt-meters, regular inspections)

The recommended vibration limits may be revised following assessment of initial monitoring data recorded during blasting.

HPPL will use the outcomes from the PSM baseline assessment to complete a blast impact assessment to determine blast design targets (both measured as PPV) that will safeguard caves from structural damage to these caves. A set of drill and blast parameters (including bench heights, hole diameters and stemming heights) will be developed to demonstrate that blasting can be conducted close to caves without causing structural damage.

To ensure that blast vibrations are managed below thresholds where structural damage to caves would be experienced, ground vibration trigger and threshold values have been set in the CSFMP (**Appendix 12**). Beyond structural monitoring and as described in the CSFMP, humidity of caves will be monitored to ensure blasting and vibrations are not impacting on cave humidity which has an impact on conservation significant fauna that utilise this microclimate. Monitoring of blasting vibration and cave integrity will be undertaken during and following construction and operations to confirm the caves can be considered suitable for use by the Pilbara Leaf-nosed Bat and / or Ghost Bat. With the development and implementation of an appropriate blasting design, aiming to ensure that ground vibration levels remain well below the limits recommended to ensure no damage, it is expected that the structural integrity of all caves will be maintained.

Monitoring of blasting vibration and cave integrity will be undertaken during and following construction and operations to confirm the long-term viability of these features for ongoing usage by bats.

10.6.2.4 Introduction and Spread of Weeds

The Development Envelope has a high number of weeds particularly along previously disturbed areas such drill lines. Increase in the spread of these weeds may result indirectly in the loss of foraging habitat. HPPL will implement established weed and hygiene management measures to reduce the risk of spreading existing weeds, or new weeds being introduced, into the Development Envelope. Any impacts are predicted to be localised to disturbed areas and will not impact the habitat of fauna in the local area**.**

The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes measures to minimise decline in habitat condition as a result of weed invasion.

As a result, no significant residual impacts on fauna habitat from spread of weeds are anticipated.

10.6.2.5 Altered Fire Regimes

Fire prevention measures (and control measures, should a fire break out) will be in place. This will also increase the capacity for fire management in the wider area through fire-fighting equipment, trained personnel and fire access. If a fire does occur as a result of the Proposal, fire response procedures and equipment will ensure that the fire outbreak is kept to a minimum and effectively controlled. Therefore, the Proposal is not considered likely to increase fire regimes.

The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes measures to minimise decline in habitat condition as a result of altered fire regimes. Several mitigation measures will be implemented in relation to minimising bushfire risk (**Table 10-13**), which are expected to effectively mitigate fire risks during construction and operation of the Proposal.

10.6.2.6 Disruption of Natural Foraging and Breeding Patterns

Fragmentation

Clearing for the Proposal has the potential to result in habitat fragmentation, which may lead to altered movement patterns, genetic isolation, increased competition for resources in remaining connected habitats and reduced species richness.

Fragmentation within the Indicative Footprint is most likely to occur in the mine pit area where Rocky Hill and Stony Spinifex Plains and Hillslopes habitats will be lost as a result of orebody extraction. The creation of the FHEZ to the north-west of the Fridge Hill and Horseshoe West pits aligns with an area of the Development Envelope which will not be cleared. These areas are intersected by Drainage Line habitat through the centre of the FHEZ and to the west (Figure 10-20). Northern Quolls, SREs, Gane's Blind Snake and the Pilbara Olive Python are known to use Drainages line to disperse. The northern most section of the Development Envelope occurs along the flanks of the Fortescue Valley where it connects to the Chichester Ranges. The Drainage Lines continue from the valley through to the Chichester Ranges. Further mitigation of impacts from fragmentation have been reduced by excluding an area of moderate to high value habitat which connects the FHEZ to habitat outside the Development Envelope. This corridor allows for the dispersion of fauna across Rocky Hills Habitat and includes a number of caves providing refuge. Fragmentation of the FHEZ, which contains fauna habitats considered moderate and high value, is avoided with the establishment of this exclusion area which is 991.45 ha.

Fauna habitat mapping was conducted over a larger area than the Development Envelope (refer to **Figure 10-2**). Habitat such as the Mulga Floodplain occur along the Fortescue Valley, an area that provides ecological connectivity. Since the Development Envelope does not intersect the Fortescue River, the Proposal will not create a barrier that would fragment the Fortescue Valley.

The FHEZ and FHEZ Corridor have been identified as areas that represent increased fauna habitat value and play a key role in maintaining fauna values within the wider region. As described in Section 2.2.3.10, The FHEZ will be an area within which no activities associated with the Proposal will occur. The FHEZ Corridor will accommodate minor, low impact activities including an un-sealed light vehicle access road to support infrequent light vehicle access to a communications tower (which will be located approximately 200 m south of the FHEZ Corridor) and monitoring activities. Impacts to the viability of the FHEZ corridor from such activities are considered negligible as there will be no physical barrier to movement for fauna species and vehicles on the access road will be infrequent, incur speed restrictions and almost exclusively moving during day-light hours (reducing the likelihood of interaction).

The purpose of the FHEZ and FHEZ Corridor is to mitigate, through avoidance, impacts to conservation significant fauna. The value of the FHEZ is enhanced and maintained by the inclusion of the FHEZ Corridor which comprises similar and supporting habitats. The purpose of the FHEZ Corridor is to ensure connection of the habitat within the FHEZ to habitat outside of the Development Envelope, to allow for the dispersal of fauna from the FHEZ to the Chichester Ranges and preventing fragmentation of terrestrial fauna habitat which supports species such as the Northern Quoll.

An infrastructure corridor is proposed within the FHEZ Corridor however this will only be developed if the Mulga Downs Hub and Rail Spur Proposal (Assessment No. 2358) is approved. Disturbance within the FHEZ Corridor would be linear (north-south) and limited to no more than 5 ha of direct disturbance and key components include:

- A raised ore conveyor with services (electricity, water etc.) attached;
- Un-sealed service road for maintenance of the conveyor; and
- Surface water management to divert water under/around infrastructure.

It is acknowledged that any significant disturbance and activities within the FHEZ corridor would be a detriment to the FHEZ corridors intended purpose (connection of the habitat within the FHEZ to habitat outside of the Development Envelope). HPPL will look to reduce impacts from the FHEZ infrastructure corridor by minimising its potential as a barrier to fauna movement. Measures may include:

- Raising the conveyor off the ground where possible;
- Use of fauna friendly culverts;
- Limits to the number and speed for vehicles using the maintenance track during operations;
- No over-head powerlines or barbwire fences; and
- Consideration for impacts from noise, light and vibration on fauna movement.

To ensure potential activities within the FHEZ corridor are managed appropriately, HPPL is committed to updating the CSFMP (Appendix 12) to include the details for approval by the EPA prior to the commencement of construction.

10.6.2.7 Noise, Light and Vibration

Construction and operation activities which result in an increase in light, noise and vibrations can affect the foraging and breeding behaviours of native species, resulting in a decline in local populations.

Noise and vibration can potentially impact fauna species within proximity of the construction and operation activities. The increased noise and vibration during construction and operation can disturb fauna behaviour such that fauna may avoid areas of suitable habitat and reduce their foraging area. While noise impacts on people are commonly regulated, there are no state policies or other widely accepted guidelines relating to noise levels or thresholds at which there would be an adverse effect on fauna. As with humans, an animal's response to noise can depend on a variety of factors, including noise level, frequency distribution, duration, number of events, variation over time, rate of onset, noise type, existence and level of ambient noise, time of year, and time of day. The animal's location, age, sex, and past experience may also affect their response to noise.

Despite the difficulties associated with assessing noise impacts on animals, studies have been done that can assist in drawing some general conclusions (SLR 2021b):

- In mammals, sound levels above about 90 dB are likely to be aversive to mammals and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Sound levels below about 90 dB usually cause much less aversive behaviour.
- Noise may be of more adaptive significance for nocturnal species because full use cannot be made of vision.
- Anthropogenic noise can also trigger flight and alert responses in birds and altered behaviour after the noise disturbance, which can lead to reduced breeding success, at noise levels ranging from 65-85 dB(A).
- Some studies indicate hearing damage to some lizard species after exposure to steady noise levels above LAeq 95 dB

Noise and vibration activities conducted at night may result in impacts to the Category 4 nocturnal roosts and bat foraging activities in nearby habitat. A study undertaken by Bullen and Creese (2014) indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost and this can be transferred to the Pilbara Leaf-nosed Bat feeding habitat. LGA conducted an Environmental Noise Assessment (LGA, 2024) to determine the likely impacts of noise created by the Proposal on bats. As there are no legislated noise criteria, the noise levels were assessed based on relevant studies on the impact of noise on the Ghost Bat, specifically a study undertaken by Bullen and Creese (2014) that indicated that sound levels of up to 70 dB are unlikely to result in Ghost Bats leaving their roost. Applying this criterion, the noise modelling undertaken for the Proposal indicates that noise from operations to nearby caves is predicted to be below the 70 dB threshold, and it would be unlikely for the bats to cease utilising the caves (LGA, 2024). It is therefore unlikely that noise emissions from the Proposal will have a significant impact on bats utilising nearby caves.

Blast vibrations have the potential to temporarily interfere with the ability of some species to detect prey or predators; however, blasts are expected to be brief and sporadic and are not expected to result in long-term or continuous disturbance. In the event that individuals are disturbed, it is likely only to be temporary and individuals are expected to return following cessation of blasting.

Light emissions can disorient flying birds, particularly during migration, and cause them to divert from efficient migratory routes or collide with infrastructure. The Fortescue Marsh is approximately 38 km upstream of the Development Envelope and the Fortescue Valley is frequented by a number of migratory bird species when the wetlands of the Fortescue Marshes (categorised within the national Directory of Important Wetlands (DIWA) as

WA066) are inundated. Migratory shorebirds may use less preferable roosting sites to avoid lights and may be exposed to increased predation where the lighting makes them visible at night (DoEE 2015).

Artificial lights may interrupt nocturnal foraging for migratory birds and mammals (i.e., attracting invertebrates), which may increase nocturnal species (Northern Quoll and Bats) and possible interactions with vehicles or machinery. No known bat roosts (caves) are present in the Development Envelope that could be susceptible to impacts from artificial lighting. Lighting used during nighttime activities may affect bats leaving roots at night to forage.

Lighting from the Proposed Action will have a minor impact on the foraging behaviour of bats within the Indicative Footprint and immediately adjacent, as excessive lighting is known to affect foraging behaviour (Bat Call 2021a). However, Ghost Bat has persisted at Cattle Gorge, 500 metres from mining operations (Bat Call 2021a) and at other Pilbara projects, indicating impacts are likely to be minor. Atlas Iron Pty Ltd (2021) also reported that while the Pilbara Leaf-nosed Bat is thought to be attracted to light sources (Cramer et al. 2016a), long-term studies at Atlas's Mt Dove Project have, however, shown that Pilbara Leaf-nosed Bat activity is not impacted by artificial illumination). The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes minimising disturbance to native fauna from noise, vibration and lighting during Proposal implementation.

10.6.2.8 Feral Animals

Construction of infrastructure is known to increase the movement of feral predators such as cats, foxes and wild dogs, all which have been recorded in the Development Envelope. Along with habitat fragmentation, construction of infrastructure can force native fauna into areas where they are at greater risk of predation.

The Proposal is in open terrain and therefore is unlikely to change the access of feral predators significantly. Feral cats have been recorded in the Development Envelope and are considered one of the most damaging feral fauna species. Predation by the feral cat is a threatening process for several conservation significant fauna species, including the Northern Quoll and Pilbara Olive Python (DAWE 2021b). Feral cats have been recorded within the Rocky Hills habitat.

Inappropriate waste management can also attract feral predators. HPPL commits to implement appropriate waste management to prevent feral fauna attraction and to undertake feral fauna control in response to sightings within the Development Envelope to minimise the risk of increased predation.

The CSFMP (**Appendix 12**) also outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes feral animal control during Proposal implementation.

On this basis, the Proposal is not predicted to result in a significant impact to conservation significant fauna species from feral predators.

10.7 Significant Residual Impact

The significant residual impact of the Proposal to Terrestrial Fauna, after the application of the mitigation hierarchy, is:

- Loss of up to 1,406.03 ha of high value habitat for conservation significant fauna species, comprising:
  - Rocky Hills;
  - Stony Spinifex Plains and Slopes; and
  - Drainage Lines / Floodplain.

Environmental offsets are proposed for the clearing of native vegetation and for high value fauna habitat and are discussed in **Section 16**. Therefore, HPPL considers the Proposal can be managed to meet the EPA's objective for terrestrial fauna.

10.8 Environmental Outcome

The proposed environmental outcome, including consideration of the proposed mitigation measures to protect environmental values associated with terrestrial fauna, are expected to meet the EPA's objective for this factor. The predicted environmental outcomes for terrestrial fauna associated with the Proposal are summarised in **Table 10-16**.

Table 10-16: Terrestrial Fauna Environmental Outcomes

Potential impact	Environmental Outcome
Direct impacts	
Loss of conservation significant fauna	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.

Loss of fauna habitat	• Clearing of up to 4,339.16 ha of fauna habitat within two Pilbara IBRA bio-subregions and across nine fauna habitat types, including:
	  o Clearing of up to 4,095.65 ha of Fortescue Valley subregion;
	  o Clearing of up to 243.51 ha of Chichester subregions;
	• Loss of up to:
	  o 520.80 ha of Rocky Hills habitat;
	  o Loss of up to 2,824.74 ha of Mulga Woodland habitat;
	  o Loss of up to 813.97 ha of Stony Spinifex Plains and Hillslopes habitat;
	  o Loss of up to 71.26 ha of Drainage Line/Floodplain habitat;
	  o Loss of up to 15.27 ha of Chenopod/Cracking Clay Floodplain habitat;
	  o Loss of up to 56.69 ha of Gibber Cracking Clay habitat
	  o Loss of up to 28.10 ha of Cracking Clay habitat; and
	  o Loss of up to 8.04 ha of Snakewood habitat.
	• Loss of up to 520.80 ha of Rocky Hills habitat which is the habitat where four possible SREs taxa were only recorded.

	Potential impacts to the conservation significant fauna recorded from within the Development Envelope include the loss of up to: • 1,462.72 ha of Ghost Bat (*Macroderma gigas*) (Vulnerable BC Act) foraging habitat;

Potential impact	Environmental Outcome
	• 1,406.03 ha of Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) (Vulnerable BC Act) foraging habitat; • 1,406.03 ha of Northern Quoll (*Dasyurus hallucatus*) (Endangered BC Act) habitat of which 520.80 ha is potential denning habitat; • 1,406.03 ha of Pilbara Olive Python (*Liasis olivaceus*) (Vulnerable BC Act) foraging habitat; • 813.97 ha of Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4, DBCA) foraging and breeding habitat. • 2,896.00 ha Gane's Blind Snake (*Anilios ganei*) (Priority 1, DBCA) habitat; • 921.37 ha of Grey Falcon (*Falco hypoleaucos*) (Vulnerable, BC Act) habitat; • 648.75 ha of Peregrine Falcon (*Falco peregrinus*) (OS, specially protected BC Act); • 900.95 ha of potential habitat for Night Parrot (*Pezoporus occidentalis);* • 2,911.72 ha of potential habitat for Greater Bilby *(Macrotis lagotis);* • There will be no loss of Category 1, 2 or 3 roosts for Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) or Ghost Bat (Macroderma gigas). Up to 8 Category 4 roosts will be removed. • Up to 31 possible SREs and one confirmed SRE (*Buddelundia* 56) were recorded within various habitats in the Development Envelope, primarily Rocky Hills, Drainage Line/Floodplain, and Stony Spinifex Plains and Hillslopes habitats.
Indirect impacts	
A decline or change in health/composition of fauna habitat	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna.
Disruption of natural foraging and breeding patterns of terrestrial fauna	• Impacts of the Proposal are not expected to result in outcomes which would be inconsistent with the EPA objectives and guidance for terrestrial fauna. • To ensure potential activities within the FHEZ infrastructure corridor are managed appropriately, HPPL is committed to updating the CSFMP (Appendix 12) to include the details for approval by the EPA prior to the commencement of construction.

11 Terrestrial Environmental Quality

11.1 EPA Objective

The EPA's objective for the environmental factor Terrestrial Environmental Quality is:

"To maintain the quality of land and soils so that environmental values are protected" (EPA 2016).

For the purposes of EIA, the EPA defines terrestrial environmental quality as "*the chemical, physical, biological and aesthetic characteristics of soils*" (EPA 2016).

11.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to the Terrestrial Environmental Quality environmental factor, which have informed the planning for the Proposal, are listed in **Table 11-1**.

HPPL has specifically considered these guidance documents in the following ways:

- Surveys and analyses undertaken to describe the receiving environment and its significance;
- Identification of activities which may lead to impacts to terrestrial environmental quality; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 11-1:Policy and Guidance

Reference	Title	How Policy has been considered
EP Act		
EPA 2016h	Environmental Factor Guideline: Terrestrial Environmental Quality, EPA, Western Australia.	The information provided in this chapter addresses the 'considerations for environmental impact assessment' listed in this document.
DMIRS 2020b	Environmental Objectives Policy for Mining	The information provided in this chapter acknowledges DEMIRS' regulatory framework under the *Mining Act 1978* establishes key environmental factors and objectives that can adequately regulate potential impacts to Terrestrial Environmental Quality.

Specific additional work required for assessment of the Proposal, relating to Terrestrial Environmental Quality, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered within this assessment.

11.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to the Terrestrial Environmental Quality factor, including details of the surveys and studies undertaken to support the Proposal.

11.3.1 Relevant Studies

HPPL has conducted numerous studies to inform the description of the receiving environment for the Proposal. **Table 11-2** lists the technical studies undertaken. Key studies are provided in **Appendix 16.**

Table 11-2: Completed Baseline TEQ Surveys and Studies

Author and Title	Description	Guidance/Methodology
Landloch 2009 Soil and Overburden Assessment of Murrays Hill	Baseline information on the soils within Murrays Hill and assessment of overburden materials.24 sites were inspected for soil classification with 5 test pits and 27 drill samples were sent for pH, salinity and cation exchange capacity. Landform determination, soil morphology and vegetation mapping was also conducted.	• Guidelines for mining Proposals in Western Australia February 2006 • Department of Industry, Tourism, and Resources (DITR), 2006, Leading Practice Sustainable Development for the Mining Industry: Mine Rehabilitation • McKenzie N.J., Gundy M.J., Webster R., and Ringrose-Voase A.J. 2008, Guidelines for surveying soil and land resources. 2nd edition, Volume 2 Australian Soil and Land Survey Handbook Series • Schoknecht, N., Tille, P. and Purdie, B., 2004, Soil landscape mapping in south-western Australia. An overview of methodology and outputs. • Standards Association of Australia, 2006, Australian standard: Methods of testing soils for engineering purposes. Method 3.8.1: Soil classification tests – Dispersion – Determination of Emerson class number • Van Vreeswyk A.M.E., Payne A.L., Leighton K.A. and Hennig P., 2004. An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No 92. Department of Agriculture
MWH 2013	The aim of this assessment of the Murrays Hill area at was to evaluate the potential for overburden, waste rock, and ore to produce acid rock drainage and metal leaching The study collected 44 samples for acid-base accounting (ABA) and leach testing from the Murrays Hill area.	
Mine Earth 2019a Mulga East iron Ore Project. Stage 1: Soil and Mine Waste Sampling and Analysis Plan	Sampling and Analysis Plan for soils and mine waste material.	Not applicable

Author and Title	Description	Guidance/Methodology
Mine Earth 2021 Mulga Downs Iron Ore Project. Baseline Soil and Landform Assessment **Appendix 15**	The aim of the assessment was to characterise the existing surface soil materials within the study area, to identify available soil resources and potentially problematic materials, and to develop associated recommendations for the recovery and stockpiling soil resources and for their use in rehabilitation and mine closure activities.	Australian Soil and Land Survey Guidelines (CSIRO, 2009)
Mine Earth 2023 Waste Characterisation for Mulga Downs **Appendix 16a**	The aim was to determine the environmental geochemical and erosional stability properties of key waste rock units from the Project, to develop a preliminary inventory and to provide associated recommendations for waste rock management. The study conducted a desktop review of the geological database to provide context for the geochemical assessment. • 68 Samples were analysed for ABA and 26 for leach testing, total metals, and mineralogy.	• Global Acid Rock Drainage Guide (INAP 2009) • Acid Rock Drainage Test Handbook (AMIRA 2002) • Prediction Manual for Drainage Chemistry for Sulphidic Geological Materials (Price 2009).
SRK Consulting 2024 Mulga Downs Iron Ore Project: Geochemical Assessment **Appendix 16b**	This report documents extensive additional geochemical characterisation and advanced leach testing. The study reviewed and included all drill hole assays and previous geochemical assessments completed by MWH (2013) and Mine Earth (2023). 167 samples were analysed ABA, 131 for total metals, 167 for leach testing, 25 for minerology, 5 samples had LEAF1313, 6 samples for LEAF 1314, 5 samples for LEAF1316, 7 samples were leached with synthetic groundwater, 4 samples for AMIRA long-term column leaching (1 year completed). The study assesses material properties and criteria for assessing the potential for acid and metalliferous drainage/neutral mine drainage (AMD/NMD) and contaminant leaching, as well the homogeneity of waste material across site.	Not applicable
4DG 2023 Mulga Hub and Spur Project – SP2 Ground Breaking Investigation - Hub Factual Geotechnical Report **Appendix 16c**	Along with geotechnical investigations test pits in the northern portion of the site were investigated for Potential Acid Sulfate Soils (PASS). No high water table or evidence of PASS was observed.	
JBS&G (2024) Mulga Downs Iron Ore Mine and Borefield. Asbestiform Minerals and Asbestos Containing Material, Preliminary	A Preliminary Environmental Site Assessment (PESA) relating to the potential for natural asbestiform minerals and/or anthropogenic asbestos containing material (ACM) to be present within the Development Envelope and Indicative Footprint of the proposed Mulga Downs Iron Ore Mine and groundwater borefield.	• JBS&G's Environmental Site Assessment was undertaken in accordance with the following technical guidance and methodologies:

Author and Title	Description	Guidance/Methodology
Environmental Site Assessment. **Appendix 13**	The specific objectives of the ESA were to: • Identify areas within the Development Envelope where natural asbestiform minerals may accumulate, as a result of erosion/deposition (wind, water) of natural asbestiform minerals and/or anthropogenic activity; • Identify areas within the Development Envelope where asbestos may have been imported and used based on anthropogenic activity; • Assess the potential risks relating to actual and potential asbestiform minerals and ACM within the identified areas; and • Provide information/data to allow development of an appropriate Asbestos Management Plan (AMP) to minimise the asbestos disturbance, possible distribution or spreading of asbestiform minerals and ACM throughout the implementation of the Proposal.	• "Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia" (Department of Health [DoH], 2021); • National Environmental Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 • WA Department of Water and Environmental Regulation (DWER) • Contaminated Sites Guidelines, as amended 2021 • Relevant Australian Standards (AS4482.1- Guide to the investigation and sampling of sites with potentially contaminated soil (non-volatile and semi-volatile compounds) and AS4482.2 – Guide to the sampling and investigation of potentially contaminated soil (Part 2: volatile substances).
Senversa (2023) **Appendix 14**	Senversa (2023) Voluntary Auditors Report (VAR)	Senversa (2023)

11.3.2 Soil and Landforms

Soil and landform assessments were undertaken over the majority of the Development Envelope by Landloch, 2009 and Mine Earth, 2021. Four soil-landform associations were identified within the Development Envelope namely 'Low hills / rises', 'Alluvial plains, 'Floodplains' and 'Calcareous flats' (**Table 11-3; Figure 11-1**).

Table 11-3 Soil and Landform Associations across the Development Envelope.

Landform	Soil Association
Low Hill / rises	• Shallow, skeletal soils over fractured / weathered and competent rock. • High percentage of competent rock fragments through the surface soil profile. • Non-saline, non-sodic, not dispersive (in natural state), low nutrient status, moderately slow drainage class and low to moderate water holding capacity.
Alluvial plains	• Deep alluvial soils, well structured topsoils over massive subsoil horizons. • Moderate percentage of competent rock fragments through the surface soil profile. • Non-saline, topsoils classified as sodic, with highly sodic subsoils, minor dispersion of clay fraction upon saturation of some samples, low to moderate nutrient status, moderate drainage class and low to moderate water holding capacity.
Floodplains	• Deep alluvial soils, well structured topsoils over massive subsoil horizons.

	• Relatively low percentage of competent rock fragments through the surface soil profile. • Moderately saline, topsoil and subsoils classified as highly sodic, with minor dispersion of clay fraction upon saturation of some samples, low to moderate nutrient status, moderately slow drainage class and moderate water holding capacity.
Calcareous flats:	• Moderate percentage of competent rock fragments through the surface soil profile, increasing with depth. Some outcropping calcrete present in some areas. • Classed as alkaline and slightly saline, topsoil and subsoils classified as sodic, however soil in natural state is not dispersive, with only minor dispersion of clay fraction upon severe disturbance of some samples, low to moderate nutrient status, moderately slow drainage class and high water holding capacity.

11.3.3 Acid Sulfate Soils

Acid sulfate soils (ASS) are naturally occurring soils and sediments that contain iron sulphides, predominantly in the form of pyrite. The disturbance of ASS and exposure to oxygen results in sulfuric acid being formed, which can lead to the release of metals, nutrients and acidity into the soil and groundwater system (DER 2015).

Acid sulfate soils includes potential acid sulfate soils (PASS) and actual acid sulfate soils (AASS). PASS are soils or sediments which contain sulphides that have not been oxidised, and AASS are soils or sediments which contain sulphides that have undergone some oxidation (DER 2015).

Acid sulfate soils risk mapping has been developed by DWER and is available for the Pilbara coastline and other limited areas within the Pilbara. The Proposal is not located within an area that is delineated as having ASS risk from this DWER mapping dataset (**Figure 11-2**). It is noted however, that this risk mapping provides a broad scale desktop overview of the potential ASS risk, rather than a site-based sampling and analysis approach.

Additional ASS probability mapping is available from the CSIRO Atlas of Australian Acid Sulfate Soils (Fitzpatrick, Powell and Marvanek 2011). This mapping is a provisional ASS classification inferred from national and state soils, hydrography, vegetation and landscape coverages, mapped at a base scale of 1:2.5 million. The CSIRO mapping is very broad scale and has not involved any ground-truthing. This mapping indicates there is a Low (Class B) to Extremely Low (Class C) probability of ASS in the area of the Proposal (Fitzpatrick, Powell, & Marvanek, 2011). An area to the southwest, outside of the Development Envelope, in the Fortescue Valley is classified as High probability but it will not be subject to direct disturbance by the Proposal (**Figure 11-3**).

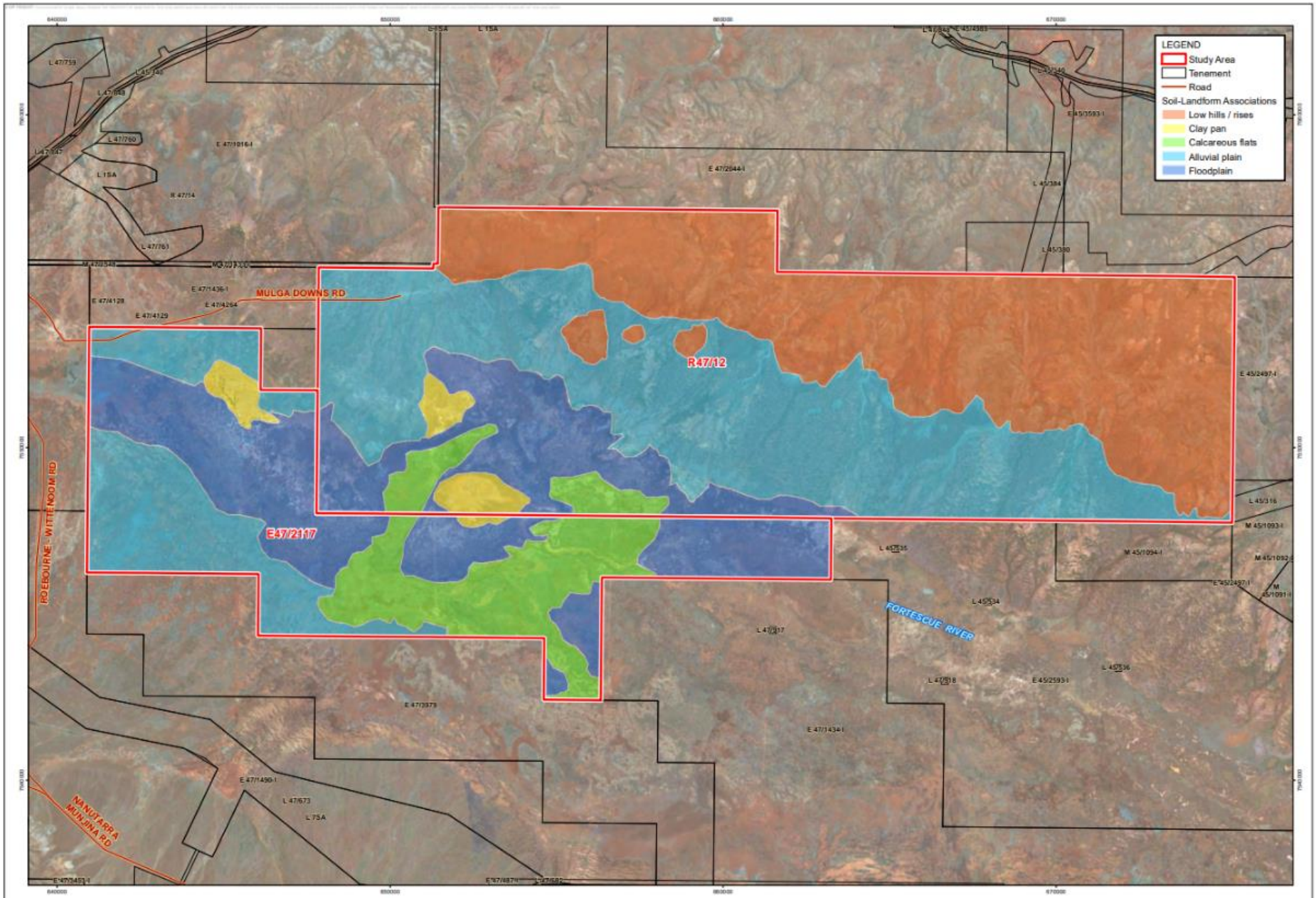
There are certain landform conditions that increase the risk of ASS occurring generally (DER 2015). Of those areas, the following are present within the Development Envelope (Mine Earth, 2023):

- Floodplains;
- Wetland-dependent vegetation such as reeds and paperbarks;
- Areas where the highest known watertable level is within three metres of the surface;
- Any areas where a combination of all the following pre-disposing factors exist:
  - Organic matter;
  - Iron minerals;
  - Waterlogged conditions or a high watertable; and

- Sulphidic minerals.

Test pitting undertaken in the northern portion of the Development Envelope included observations for PASS and found none of the above evidence that would be indicative of PASS (4DG 2023). Further in-field testing is planned during geotechnical works, with the results utilised within the Mining Proposal which will be prepared for the Proposal.

Figure 11-1: Soil-landform Mapping across the Development Envelope



MINE EARTH

Soil-Landform Associations

Figure 14

Figure 11-2: ASS Risk Mapping (DWER) (Source: Mine Earth, 2023).

*Note the Disturbance Envelope reflected in this figure is consistent with the Proposal as referred to DCCEEW under the EPBC Act and excludes Murray's Hill (LoA – do not assess 2013). This difference is explained in Section 1044.3.

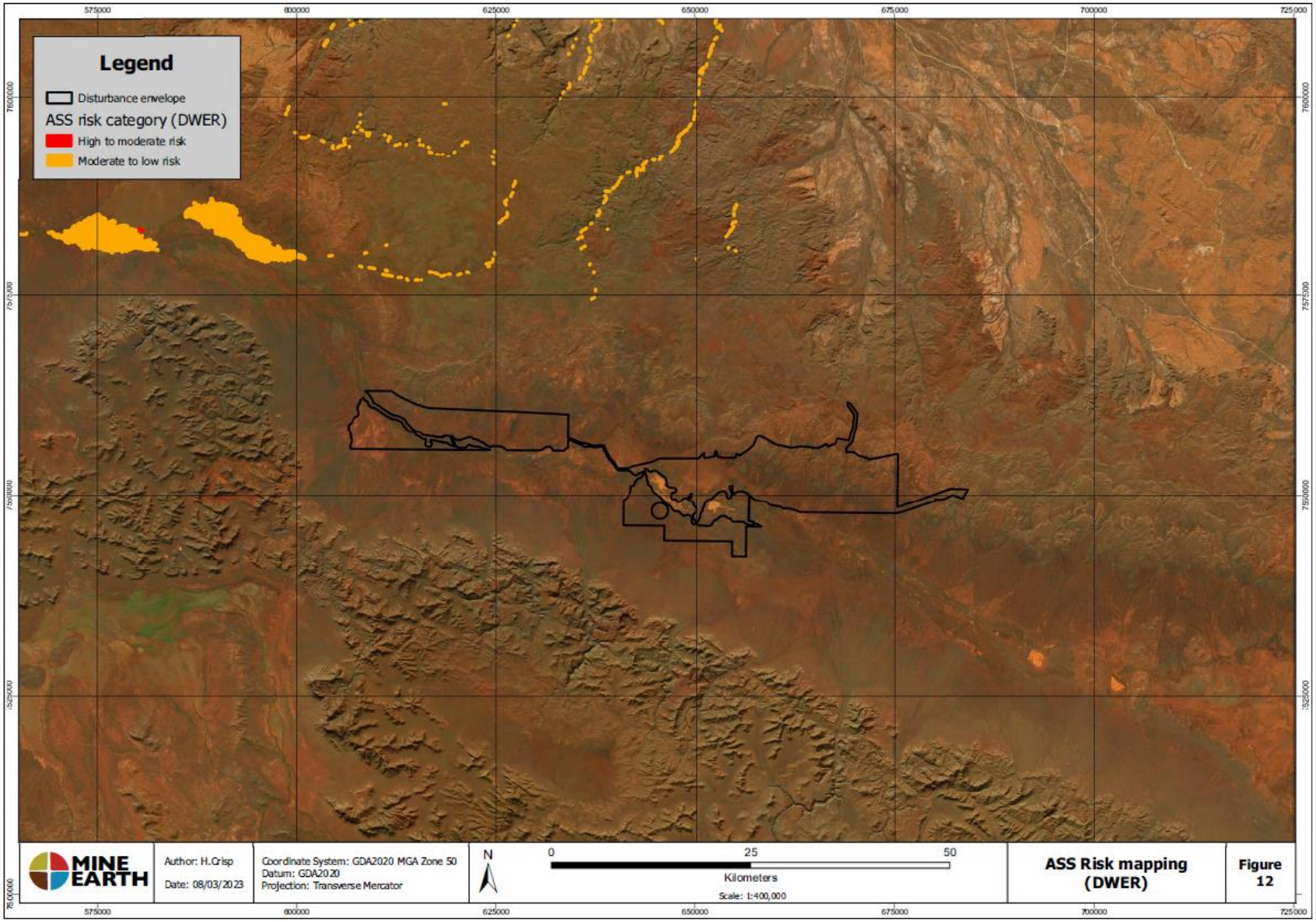
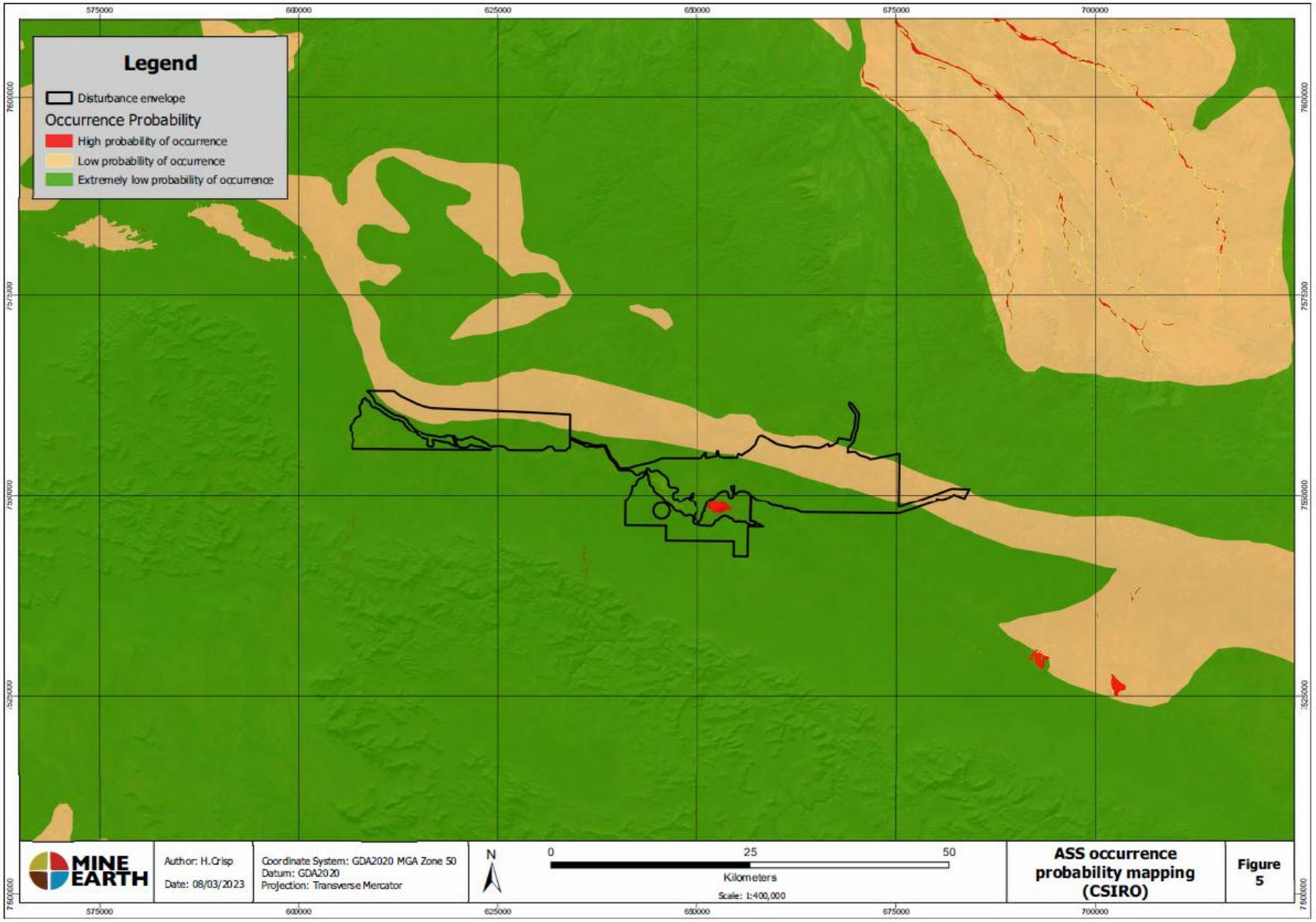

Legend
Disturbance envelope
ASS risk category (DWER)
High to moderate risk
Moderate to low risk
575000
600000
625000
650000
675000
700000
725000
7600000
7575000
7550000
7525000
7500000
MINE EARTH
Author: H.Crisp
Date: 08/03/2023
Coordinate System: GDA2020 MGA Zone 50
Datum: GDA2020
Projection: Transverse Mercator
N
0
25
50
Kilometers
Scale: 1:400,000
ASS Risk mapping (DWER)
Figure 12

Figure 11-3: ASS occurrence Probability Mapping (CSIRO) (Source: Mine Earth, 2023)

*Note the Disturbance Envelope reflected in this figure is consistent with the Proposal as referred to the Commonwealth under the EPBC Act. The Proposal being assessed by the EPA does not include the Murray's Hill Project which forms part of the Proposal under assessment by DCCEEW. This difference is explained in Section 1044.3.


Legend
Disturbance envelope
Occurrence Probability
High probability of occurrence
Low probability of occurrence
Extremely low probability of occurrence
575000
600000
625000
650000
675000
700000
7600000
7575000
7550000
7525000
7500000
MINE EARTH
Author: H.Crisp
Date: 08/03/2023
Coordinate System: GDA2020 MGA Zone 50
Datum: GDA2020
Projection: Transverse Mercator
N
0
25
50
Kilometers
Scale: 1:400,000
ASS occurrence probability mapping (CSIRO)
Figure 5

11.3.4 Characterisation of Waste Rock Material

A number of geochemical assessments have been completed for the Proposal (MWH 2013 and Mine Earth 2023; refer to (**Table 11-2**). These assessments have and continue to follow a staged approach in accordance with DEMIRS guidance:

- Phase 0: Geological interpretation;
- Phase 1: Acid Base accounting;
- Phase 2: Leach Testing;
- Phase 3 – Water balance and modelling; and
- Phase 4 – Kinetic testing.

This staged process is followed for every new batch of samples collected and the database of geochemical information is built on previous studies.

11.3.4.1 Geochemical Characterisation

Initial assessments focussed on geological interpretations combined with total element assays performed on samples obtained from early exploration and resource evaluation programs (Phase 0 and 1). The key geochemical characterisation findings of Mine Earth (2023) Waste Characterisation study of the Proposal are summarised below.

The geological assay database across the regional area, which is not only confined to the mining pits, comprises almost 230,000 analyses for sulfur and calcium. An assessment of this database indicates that only 10% of the sulfur assays are greater than 0.1% sulfur, while approximately 4.4% contain greater than 0.3% sulfur and 3.2% are greater than 0.5% sulfur (**Table 11-4**).

Table 11-4: Distribution of sulfur percentage for entire assay database

Stratigraphy	Percentage of all assays in regional database			Number of samples for geochemical analyses
	>0.1%Sulfur	>0.3% Sulfur	>0.5% Sulfur	
Alluvium (CzD3)	3.5%	0.7%	0.1%	112
Channel Iron Deposits (CzD2)	0.3%	<0.03%	<0.03%	36
Marra Mamba – Newman Member	0.1%	<0.03%	<0.03%	5
Marra Mamba – Macleod Member	0.3%	0.1%	0.1%	43
Marra Mamba – Nammuldi Member	3.4%	1.7%	1.3%	127
Jeerinah Formation – Roy Hill Shale Member	2.0%	1.7%	1.5%	11
Other	0.6%	0.1%	0.1%	11
Upcoming analyses (2025)				100
Total	**10.2%**	**7.6%**	**3.2%**	**445**

The mass of waste rock has been reduced by 80% through the redesign of the pits mine and no potentially acid-forming Jeerinah Formation material is present. The majority of waste material is represented by alluvium and surficial Nammuldi member units, with the Fridge Hill and Fridge West areas generating the majority of the material.

The 125 drill holes sampled for geochemical analysis during all waste characterisation studies across the mine development area are displayed in **Figure 11-4.**

Figure 11-4: Distribution of all sampled drillholes across the Proposal

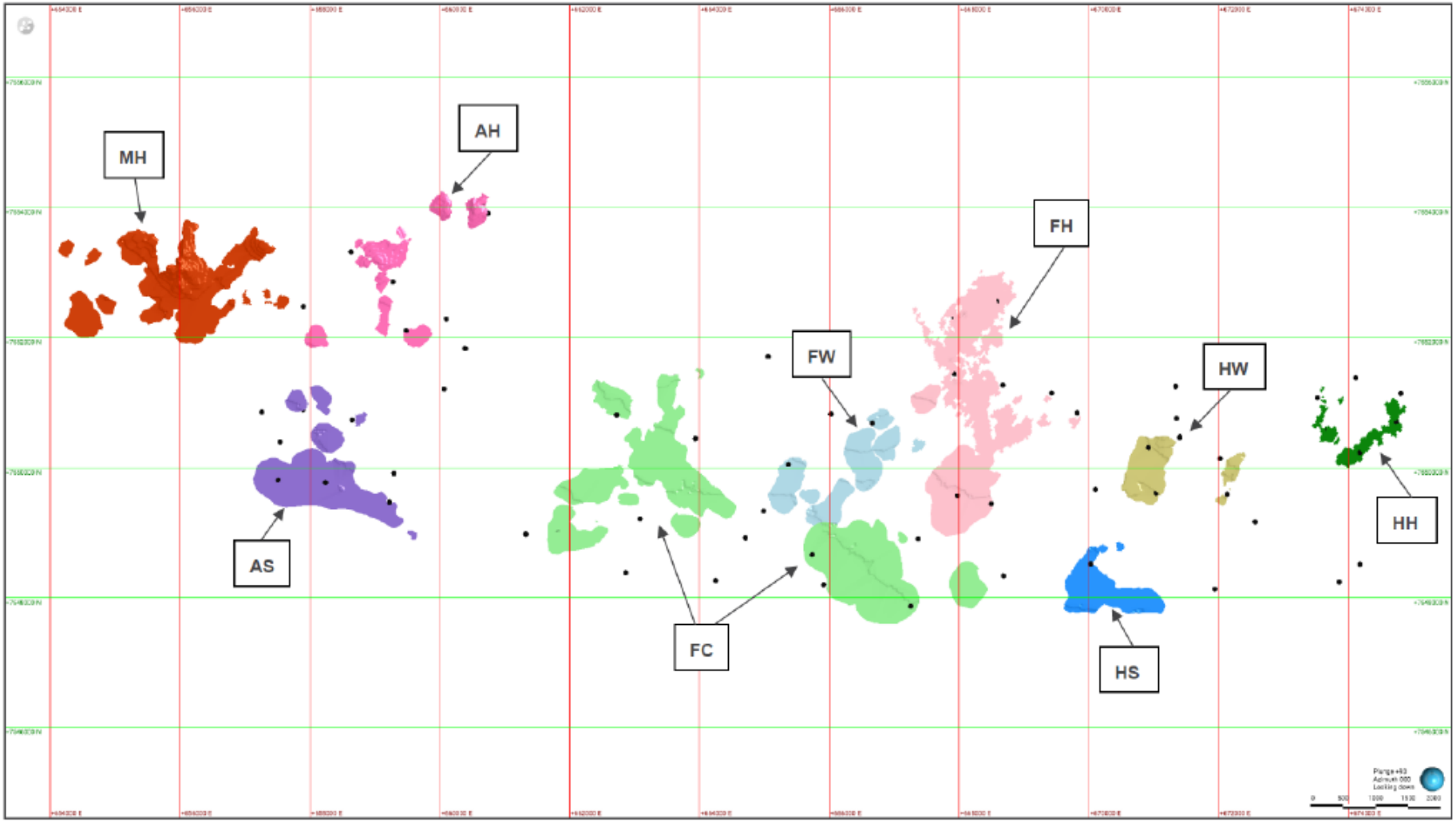

MH
AH
AS
FH
FW
HW
HH
FC
HS

Table 11-5: Stratigraphy of waste per pit (Mt)

Pit	Alluvium	Detrital	Mt Newman Member	Macleod Member	Nammuldi Member	Jeerinah Formation	Total Mass (Mt)	%
Murrays Hill	5.9	0.095	1.6	6.5	9.1	0	23	15
Anticline Hill	1.0	-	0.31	5.0	3.5	0	9.8	6.6
Fridge Central	0.9	-	1.5	1.2	-	0	3.6	2.4
Fridge Hill	10	1.0	0.22	4.8	39	0	55	37
Fridge West	18	-	12	4.9	0.003	0	35	24
Horseshoe Hill	-	-	0.01	2.3	1.0	0	3.4	2.3
Horseshoe West	6.2	3.5	1.3	5.4	2.6	0	19	13
Total mass (Mt)	42	4.6	17	30	56	0	150	100
%	28	3	11	20	37	0	100	

The SRK (2024) study extensively details the classification options and acid-base accounting results for all samples and determined the conservative classification given in **Table 11-6**. This table indicates that 95% of the waste material is non-acid forming and the remainder may be easily managed as it is distributed in small volumes across pits. The risk of acidic mine drainage is low.

Table 11-6: Acid potential classification of waste by acid-base by pit (Mt)

Pit	Non-Acid Forming (NAF)	Uncertain- (UC)	Potentially Acid Forming (PAF)	Total Mass (Mt)	%
Murrays Hill	21	1.9	0.29	23	15
Anticline Hill	8.8	0.68	0.37	9.8	6.6
Fridge Central	3.6	0.039	-	3.6	2.4
Fridge Hill	55	0.61	-	55	37
Fridge West	35	0.56	-	35	24
Horseshoe Hill	3.4	0.015	-	3.4	2.2
Horseshoe West	16	2.1	0.65	19	13
Total mass (Mt)	143	6.0	1.3	150	100%
%	95	4.0	0.87	100%	
Classification: NAF=<0.1 %, UC=0.1 % ≤ S <0.25 %, PAF S ≥ 0.25%					

Potential contaminant leaching was determined by deionised water leach extracts by a range of contact ratios, saline leach tests, 'synthetic' groundwater leach tests and LEAF testing (1313, 1314 and 1316): where a series of batch tests to determine leachability as a function of pH or volume are conducted. Additionally, AMIRA column testing has been conducted over 12 months to determine the long-term leaching potential of waste.

Leachate pH is a primary control on contaminant solubility. Under the neutral pH conditions expected for most of the waste rock, leaching is expected be limited and the risk of metalliferous drainage is low.

11.3.4.2 Physical Characterisation

Landloch (2009) and Mine Earth (2023) tested material for cation exchange capacity (CEC) exchangeable sodium percentage (ESP) and sodicity adsorption ratio (SAR), as well as potential for dispersion. The erosional stability of lithologies were estimated based on mineralogy and a visual assessment of the competency of core. Calcrete, mineralised waste, dolomite displayed moderate to high erosional stability, while oxide and shale material on the surface was estimated to have low erosional stability.

The majority of lithologies tested were non-sodic with calcrete, hematitic CID and mangniferous alluvium showing minor sodicity. All material was Emerson[3] Class 5 which has no potential for dispersion (Mine Earth, 2023).

11.3.5 Asbestiform Minerals and Asbestos Containing Materials

Asbestiform minerals are widely distributed in Western Australia. Amphibole and serpentine minerals are major components of mafic and ultramafic rocks found in Western Australia's "greenstone belts". In the Pilbara, amphibole minerals may be encountered in the BIF of the Hamersley Basin (DMP 2015). More specifically crocidolite (the source of "blue" asbestos) is typically associated with the Dales Gorge Member of the Brockman Iron Formation (Grubb 1971). A thin (5 mm) band of crocidolite has also previously been identified in the Marra Mamba Iron Formation in the western Fortescue Valley (Barnett & Commander 1986).

On the basis the ore body is located within the Marra Mamba Iron Formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, intersection of natural asbestiform minerals onsite (i.e. within the Brockman Iron Formation) during mining operation is considered to be low.

Review of the DWER Contaminated Sites Database under CS Act identified the previous Development Envelope for the Proposal included areas classified as '*Contaminated – Remediation Required'.* (JBS&G 2022; **Appendix 13**). Following the s43A application to amend the Proposal in September 2024, no classified contaminated site is located within the amended Development Envelope for the Proposal.

Planning for the Proposal identified the potential for natural asbestiform minerals and anthropogenic Asbestos Containing Materials (ACM) to be present within the Development Envelope, based on the proximity of the Development Envelope to the Wittenoom Asbestos Management Area (WAMA) (**Figure 13-1**).

In a meeting with HPPL on 13 July 2022, DWER indicated that the boundary of the WAMA should not be considered a 'hard' boundary, as it was based on cadastral boundaries, and that ACM could be present on the Mulga Downs Pastoral Station due to known and suspected use of asbestos material sourced from historical mining locations in the Wittenoom, Yampire and other gorges in the vicinity of the Development Envelope.

In addition to the potential presence of ACM, DWER indicated an assessment of asbestiform minerals was also required due to the possibility of natural erosion/dispersion (e.g., water dispersal in drainage lines and air

[3] The Emmerson Aggregate test (Emmerson, 1967) classifies the structural stability of soil aggregates under rainfall to inform management of dispersion.

dispersal downwind of historical mine and tailing facilities) of material from the Wittenoom, Yampire and other gorges.

Section 3.9 and **Section 3.11** summarises the geology and hydrology of the Development Envelope with respect to potential deposition of natural asbestiform within and surrounding the Development Envelope.

A registered asbestos-contaminated site listed on the DWER Contaminated Sites Database is located to the south of the Development Envelope and is associated with abandoned infrastructure of the Mulga Downs Pastoral Station (Parcel ID 73903). The Mulga Downs Homestead (Parcel ID 20175) is also listed as an asbestos-contaminated site, which is located outside of, but immediately north of, the Development Envelope (**Figure 11-5** and **Figure 13-1**).

Primary sources of ACM are from the known registered contaminated areas located outside of the Development Envelope and surrounds. Secondary sources are from anthropogenic activities within the Development Envelope, including use of ACM within anthropogenic built forms (other than those already recorded as registered contaminated sites), and from miscellaneous historical dumping of ACM tailings.

Primary sources of natural asbestiform within the Development Envelope include unintended surfacing resulting from on-site exploration drilling program and deposition of natural asbestiform within the Lower Fortescue River Valley via surface water runoff from the Hamersley Ranges. Secondary sources of natural asbestiform within the Development Envelope include deposition of natural asbestiform via airborne migration. As the ore body is located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, intersection of natural asbestiform minerals onsite during mining operation is considered to be low.

Following consultation, DWER confirmed with HPPL that the presence of ACM on the Mulga Downs Pastoral Station is the result of known and suspected anthropogenic utilisation of asbestos material sourced from historical mining locations in the Wittenoom, Yampire and other gorges in the vicinity of the Development Envelope. In addition, DWER indicated an assessment of asbestiform minerals was required, due to the possibility of natural erosion/dispersion (e.g., water dispersal in drainage lines and air dispersal downwind of historical mine and tailing facilities) from the gorges, as well as from potential miscellaneous dumping of tailings.

The WAMA covers an area of 46,840 ha of land and includes the former townsite, mining areas, Wittenoom Gorge and Joffre Floodplain. This entire area has been classified by DWER in 2008 as a contaminated site under the CS Act. The area was declared by DWER and the Department of Health to be not suitable for any form of human occupation or land use (DPLH, 2022).

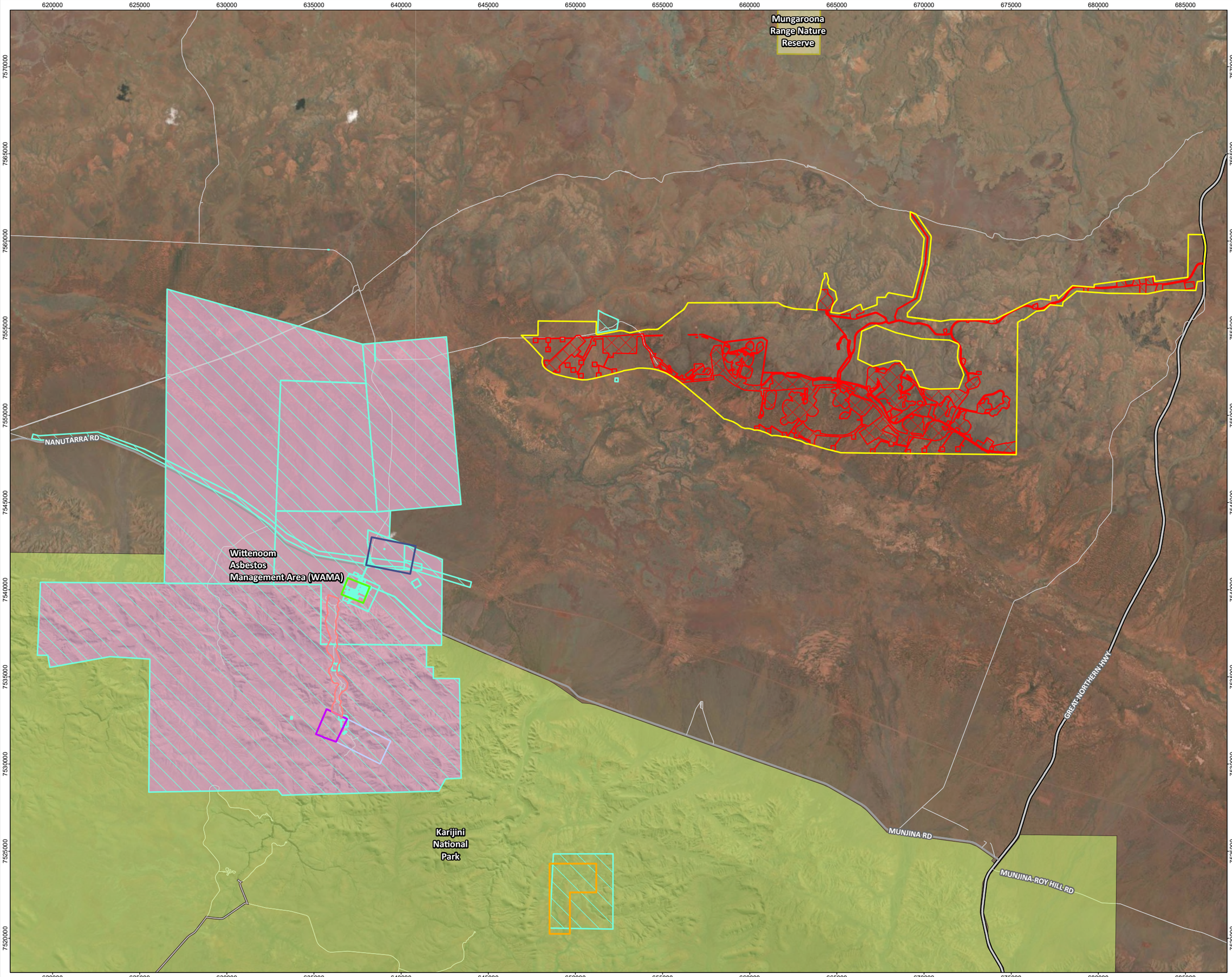
The location of the Development Envelope and Indicative Footprint relative to the WAMA and DWER registered contaminated sites is detailed in **Table 11-7** and shown in **Figure 11-6.**

Table 11-7: DWER Online Contaminated Sites Database Search

Property Description	Location and Address	Classification	Distance from Development Envelope	Reason for Classification
Located within, or immediately adjacent to, the Development Envelope				
Portion of Lot 5418 on DP404418 as shown on certificate of title LR3165/155	Mulga Downs Homestead Mulga Downs Pastoral Station, Mulga Downs Road	Contaminated – remediation required (01/08/2018) (ID 20175)	Immediately north of the Development Envelope	The site was first classified under section 13 of the *Contaminated Site Act 2003* based on information submitted to DWER in October 2008. The site was originally reported as a result of the identification of free asbestos fibres and asbestos fibre bundles in surface soils around the station homestead and buildings. The asbestos was brought to the site in asbestos contaminated tailings material sourced from the former Wittenoom mine site area. Some remediation of the site was undertaken including the removal of 120 tonnes of asbestos contaminated soil from various areas at the site and the off-site disposal of the impacted soil. The resultant excavation voids were backfilled with soils excavated from a "borrow pit" located 2km from the site. Further investigations in 2018 noted additional contamination present and remediation required. The DWER records do not detail where the asbestos contaminated soil was taken to. Identified concentrations of contaminants exceed adopted assessment levels. The site is therefore not suitable for occupation until further remedial measures have been undertaken. Remediation is required to mitigate the potentially unacceptable risk to human health. This area is fenced and signposted to prevent any unauthorised access. An exclusion fence line managed by Hancock is located around the homestead. The fence was installed by Hancock and is still in place with signage identifying the potential risk of asbestos at the entry points.
Portion of Lot 5418 on DP404418 as shown on certificate of title LR3165/155	Abandoned Infrastructure Area. Mulga Downs Homestead Mulga Downs Pastoral Station, Mulga Downs Road	Contaminated – remediation required (01/08/2018) (ID 73903)	250m south of the Development Envelope	This site comprises an area approximately 2.5 km south of the Mulga Downs Homestead station (ID 73903) which is detailed above. The site is used for the storage of old infrastructure has also been included in the classification of the larger Mulga Downs parcel. In April 2018 DWER were informed that exposed asbestos fibre bundles were again visible on the surface of the soils around the abandoned infrastructure to the south of the Homestead station. Identified concentrations of contaminants exceed adopted assessment levels. The site is therefore not suitable for occupation until further remedial measures have been undertaken. Remediation is required to mitigate the potentially unacceptable risk to human health. This area is fenced and signposted to prevent any unauthorised access.
Not located within the Development Envelope				
Portion of Lot 5418 on DP404418 (Subject M1 and M2)	External extent of the WAMA, extending west into Mt Florance and Mt Hooley Pastoral Stations. Mulga Downs, WA, 6751	Contaminated – remediation required (28/01/2008) (ID 80831 and 80832)	Outside of the Development Envelope to the west and south (Parcel ID 80831; Parcel ID 80832)	These two sites relate to the eastern and northern extent of the WAMA. The Development Envelope no longer intersects the WAMA.
Unallocated Crown Land and numerous discrete parcels of land	Southern extent of the WAMA, including Wittenoom and surrounding areas Wittenoom, WA, 6751	Contaminated – remediation required (28/01/2008) Numerous	Various	The WAMA comprises the Wittenoom Town site, Wittenoom Airfield, Wittenoom Gorge, Yampire Gorge and the Joffre Creek flood plain between the Wittenoom Townsite and the Fortescue River. The site was reported due to the presence of Free Crocidolite (blue asbestos) fibres in soils across the town and in mine tailings which were used extensively to replace sand in the construction of housing, airfield, roads and infrastructure and facilities at Wittenoom. In addition, mine tailings containing free asbestos fibres are present near the Colonial, Eastern Gorge and Yampire mines. Free asbestos fibres are present in the Joffre Creek and floodplain and in the Fortescue River near its confluence with Joffre Creek. The site was reported to the Department of Environment and Conservation (DEC) as per reporting obligations under section 11 of the Contaminated Sites Act 2003, in March 2008. The report identified the presence of free asbestos fibres within the asbestos processing waste tailings dumps near the Colonial, Eastern Gorge and Yampire mines. It was found that subsequent erosion of the tailings dumps by wind and water have transported free asbestos fibres to Wittenoom Gorge, Joffre Creek and across the floodplain to the Fortescue River. Free asbestos fibres were also detected in the airstrip and in all developed areas of the Wittenoom town site. The report documents the findings of a semi-quantitative human health Risk Assessment. The risk assessment concluded that based on the current levels and types of occupation and land use and the concentrations of asbestos contamination, the Colonial, Eastern Gorge and Yampire mines (including their respective tailings dumps), the Wittenoom Gorge (Joffre Creek) and floodplain, and the Wittenoom town site are of "high risk" to human health. The report further concluded that the Wittenoom Airstrip was of "medium risk" to human health. The report was the subject of a non-statutory independent review by a Contaminated Sites Auditor which was submitted to DEC on 31 March 2008. Based on the information provided, and as the Site is known to have free asbestos fibre contamination in soils that present an unacceptable risk to human health, the Site including the Wittenoom town site and surrounding gorges and floodplain area are classified as 'Contaminated - remediation required'. A memorial stating the Site's classification has been placed on the Certificates of Title.
Section of Rail Maintenance Track within part of Lot 116 on	Koodaideri Railway Wittenoom, WA, 6751	Contaminated – remediation required (25/05/2021)	13 km	The site consists of a portion of a rail maintenance track that intersects the WAMA. The site was reported in 2020 due to the identification of asbestos fibres in soils of the rail corridor during construction of the maintenance track, including bags of asbestos material, and diffuse contamination found in stream channels. Asbestos contaminated fill is also known to have been used for construction projects in the local area.

Property Description	Location and Address	Classification	Distance from Development Envelope	Reason for Classification
DP220191 and part of Lot 5418 on DP404418		(ID 78799)		The site is currently managed under the environmental conditions required by Ministerial Statement 999. Further investigations and remediation are required.

Figure 11-5: Location of Site with Asbestos in relation to the Proposal



Legend

- Development Envelope
- Indicative Footprint

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve

Asbestos mine locations (JBS&G, 2022)

- Colonial mine, mill & tailings
- Conceptual layout
- Development envelope
- Floodplain
- Wittenoom Asbestos Management Area
- Yampire mine & mill

DWER registered contaminated sites (DWER-059)

- Contaminated - remediation required
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 07-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:200,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LOCATION OF SITES WITH ASBESTOS IN RELATION TO THE PROPOSAL

FIGURE 11.5

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

HPPL commissioned JBS&G Australia Pty Ltd (JBS&G) to prepare a Sampling and Analysis Quality Plan (SAQP) and Preliminary Environmental Site Assessment (PESA) to assess the asbestos contamination status of the Proposal (JBS&G 2023a and 2023b; **Appendix 13**).

The overarching objectives of the SAQP and PESA were to assess the potential presence or absence of natural asbestiform minerals resulting from both natural erosion and deposition and imported asbestos (e.g., ACM) from anthropogenic activity within the Development Envelope. The results of the assessment will enable appropriate management throughout construction and operational activities.

The specific objectives of the PESA were to:

- Identify areas within the Development Envelope where natural asbestiform minerals could accumulate because of erosion, deposition and anthropogenic activity;
- Identify areas within the Development Envelope where asbestos may have been imported and used based on anthropogenic activity;
- Assess the potential risks relating to actual and potential asbestiform minerals and ACM within the identified areas; and
- Provide information to allow the development of an appropriate Asbestos Management Plan to minimise the asbestos disturbance and possible distribution or spreading of asbestiform minerals and ACM throughout the implementation of the Proposal.

The PESA involved a site inspection, sampling of building material suspected of containing asbestos, a detailed desktop assessment designed to identify areas where the erosional deposition may have occurred, and sampling selected areas where the deposition was considered most likely. The site inspection did not include an assessment of the classified asbestos-impacted area outside the Development Envelope, however HPPL supplied photographs of this area and some additional details.

The PESA identified asbestos impacts were likely limited to:

- Building materials within ancillary structures in the Development Envelope, such as tank stands and bore infrastructure;
- The existing and classified asbestos-contaminated area (registered ID 73903) associated with the former Mulga Downs homestead;
- The possible deposition of asbestos from the Wittenoom mine area because of erosion; and
- The potential importation of asbestos into the Development Envelope (including as a construction base for infrastructure or as dumped waste).

The PESA investigation found that:

- A single loose fibre bundle of crocidolite in the soil was detected in a single sample (sample ID 10_0.1); however, the asbestos concentration in the sample, and every other sample, was below the laboratory Limits of Reporting (LOR) and adopted assessment criteria; and
- Limited site structures contained ACM.

ACM is understood to have been dumped deliberately or as an accident within locations close to the Development Envelope. No ACM (including bags of tailings) or other consolidated waste storage areas were observed during the site investigation.

It is unlikely the area is impacted by asbestos from erosional deposition, and the selected sampling did not identify evidence of this to the extent that represented a potential risk.

The PESA concluded that there is a low risk of asbestos from existing structures, ground contamination (in-situ or from erosional deposition) or unexpected finds causing human health impacts at receptors through an inhalation pathway, as follows:

- On the basis that the Proposal ore body is located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley where the Brockman Iron Formation is absent, the intersection of natural asbestiform minerals (i.e., within the Brockman Iron Formation) during construction and operation of the Proposal is low;
- The potential for erosion and deposition of natural asbestiform minerals from the Wittenoom, Yampire and other gorges north of the Lower Fortescue River is considered low;
- Given the relatively small size and scale of the observed infrastructure, the amount of asbestos that could be released in the event of disturbance is likely to be minor. The potentially unacceptable risk to site receptors from ACM within site structures is low; and
- While the potential for unidentified historical dumping couldn't be discounted, the currently available information indicates that the unacceptable risk receptors from miscellaneous dumping of ACM is low.

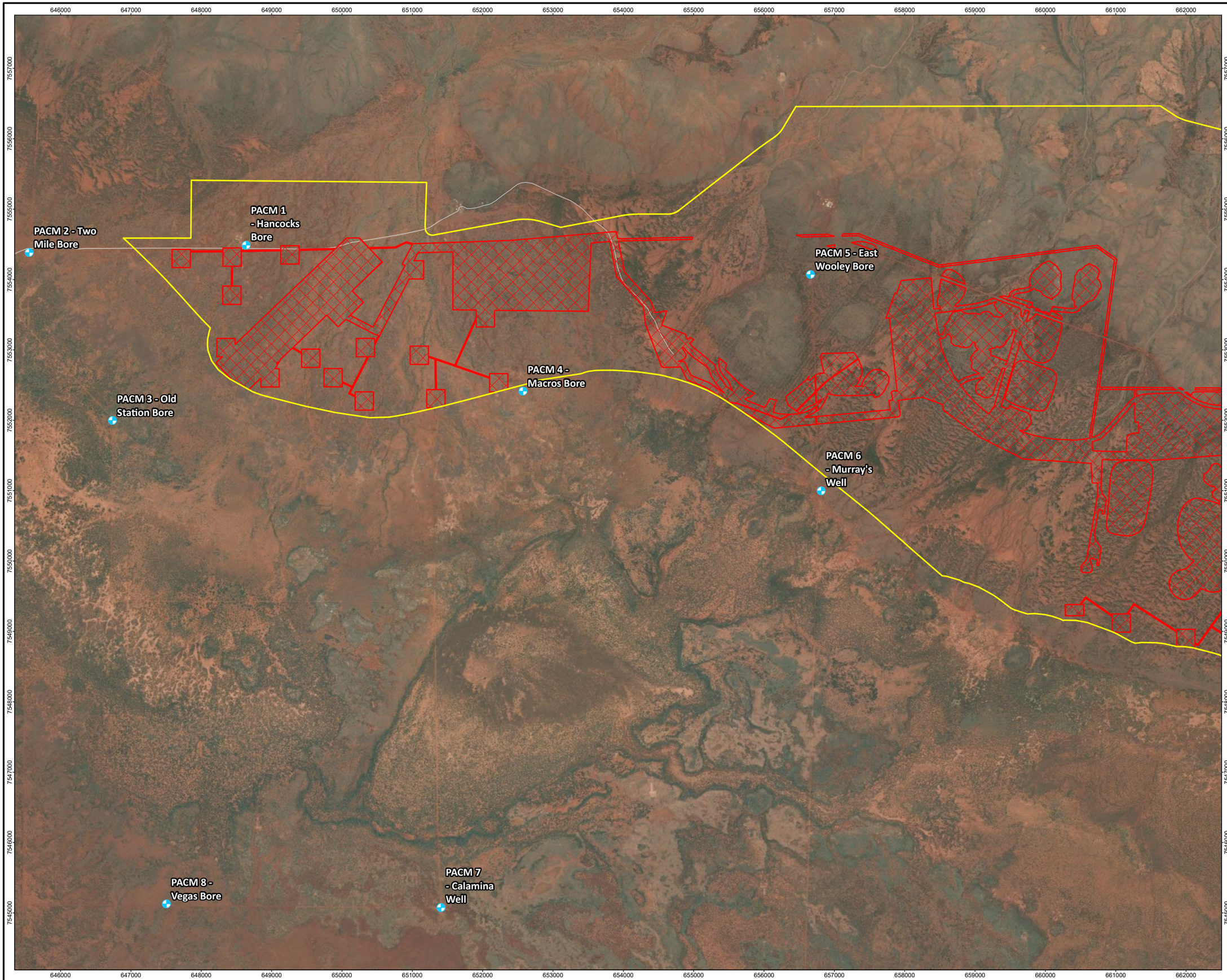
The SAQP and PESA were subject to independent audit, including producing a Voluntary Auditor's Report (VAR) (**Appendix 14**), which was prepared in accordance with the CS Act and relevant DWER guidance. The auditor concluded that the SAQP and PESA provided adequate characterisation of the forms of asbestos previously identified and suspected within the Development Envelope

In summary, potential impacts due to inhalation of fibres from asbestiform minerals and ACM in structures, the ground or air is limited to people in the Development Envelope, such as HPPL construction and operations workers, contractors and visitors. Given the large separation distances to residential receptors (the closest is the Wirrilimarra Community 12.2 km east of the Development Envelope), it is unlikely that these communities would be at risk.

An Asbestos Management Plan (**Appendix 17**) has been prepared to prevent the release of fibres from site structures during operation and detail the appropriate procedures for decommissioning and removal of the structures from the site. The management plan is intended to apply to areas outside of the identified contaminated sites within the Development Envelope, noting that the areas within the registered contaminated sites are managed under specific management plans. An unexpected finds procedure is included in the Asbestos Management Plan, detailing the management measures to be implemented if tailings or other asbestos containing waste materials are observed in the Development Envelope.

HPPL considers that the residual impacts can be managed by implementing industry-standard dust control measures and the Asbestos Management Plan.

Figure 11-6: Anthropogenic Sample Locations (JBSG 2024 – Asbestos Management Plan)



Legend

- Development Envelope
- Indicative Footprint
- Anthropogenic sample

Roads (LGATE-195)

- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 31-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:49,152 at A3

0 1 2
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

ANTHROPOGENIC SAMPLE LOCATIONS (SOURCE JBSG ASBESTOS MP)

FIGURE 11.6

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Image Reference: World Imagery: Maxar www.nearmap.com© - Imagery Date: 28. May 2022.

11.4 Potential Impacts

A preliminary assessment of the potential direct and indirect impacts of the Proposal to Terrestrial Environmental Quality values in consideration of the EPA objectives is provided below. There are no identified direct impacts relating to Terrestrial Environmental Quality.

11.4.1 Indirect Impacts

The potential indirect impacts to Terrestrial Environmental Quality from implementation of the Proposal, prior to mitigation, include:

- Contamination of soils, surface water and groundwater.
- Redistribution of ACM that is present from historical anthropogenic activities.

Contamination of Soils, Surface Water and Groundwater

Contamination of soils, surface water and groundwater is a potential indirect impact associated with the following:

- Generation of Acid and/ or Metalliferous Drainage (AMD) from mine voids during operation, waste rock dumps, waste rock material backfilled in pits below the water table, run-of mine pads and/or low-grade ore stockpiles;
- Acidification of groundwater, wetlands and drainage lines from oxidation of ASS, particularly if ASS material is used for construction of surface water levees or drainage lines;
- Erosion from waste rock dumps increasing sediment volume to downstream soils and drainage lines;
- Failure, leaks or seepage from saline water pipelines and/or water storage dams;
- Spillage of chemicals and hydrocarbons;and
- Seepage of landfill leachate.

11.4.1.1 Generation of Acid and/ or Metalliferous Drainage

AMD is formed by the oxidation of sulfide minerals when exposed to air and water. Activities that involve the excavation of rock with sulfide minerals, such as mining, accelerate the process. The drainage produced from the oxidation process may be neutral to acidic, and contain elevated concentrations of heavy metals or metalloids, but always contains sulfate. AMD results from a series of reactions and stages that typically proceed from near neutral to more acidic pH conditions (INAP, 2009).

AMD may lead to contamination of soil, surface water and groundwater with metals or metalloids and low pH conditions, potentially leading to adverse impacts to ecosystem services and other land and water users.

11.4.1.2 Acidification from ASS

Acid sulfate soils contain iron sulfides similarly to acid rocks. Iron sulfides are micro-crystalline minerals such as pyrite that have formed by biological processes reducing dissolved sulfates in shallow groundwaters under low oxidation conditions usually in soils where long-term water-logged conditions occur such as estuaries, wetlands and shallow groundwater in deep sands.

When exposed to air by drainage, lowering of water-tables or excavation, oxidation of the sulfides creates sulfuric acid which can trigger a range of flow-on effects, including acidification of groundwater, wetlands and waterways (DWER, 2015). In contrast to acid rock oxidation this process can occur very quickly, however ASS volumes are much lower.

The Proposal has the potential to result in acidification of groundwater, wetlands and drainage lines from the oxidation of ASS via excavation or mine dewatering activities lowering the natural water table.

11.4.1.3 Erosion from Waste Rock Dumps

Erosion of WRDs may occur where wind and/or water come into contact with soil and rock material on WRD slopes, surfaces and embankments. Without adequate management, eroded material from WRDs has potential indirect impacts to Terrestrial Environmental Quality by increasing sediment volume to the environment downstream of these waste structures.

The presence of potentially dispersive clay minerals may additionally lead to increased turbidity of surface water and breakdown of soil aggregates and structure.

11.4.1.4 Failure, leaks or seepage from saline water pipelines and/or water storage dams

The Proposal will include saline water storage dams and saline water pipelines as part of mineral processing and dewatering operations. Without adequate management, saline water and water storage dams have the potential to indirectly impact Terrestrial Environmental Quality through failure, leaks or seepage releasing saline water to the environment. Release of this material may lead to changes in surface water and/or groundwater quality.

11.4.1.5 Spillage of chemicals and hydrocarbons

The Proposal will involve the use a range chemicals and hydrocarbons that have the potential to adversely impact Terrestrial Environmental Quality if spills of these substances aren't adequately managed. Potential indirect impacts of spillages include localised contamination of soil, surface water and groundwater.

11.4.1.6 Seepage of landfill leachate

The Proposal will include a landfill facility that has the potential to generate leachate (water generated from decomposition of organic matter within landfills and external water sources that have come into contact with landfills). If landfill leachate is not managed, there is a potential for indirect impacts such as localised contamination of soil, surface water and groundwater.

11.4.1.7 Redistribution of Asbestos Containing Material that is present from historical anthropogenic activities

As outlined in **Section 11.3.5**, ACM is known from, and suspected to be present in parts of the Development Envelope from historical anthropogenic activities associated with the nearby Wittenoom asbestos mining area. Clearing, earthworks, construction and mining activities have the potential to inadvertently redistribute ACM that is present in the Development Envelope.

11.4.2 Cumulative Impact

The Proposal and other projects in the region including the Mulga Downs Hub and Rail and Murray's Hill, may have a cumulative impact on Terrestrial Environmental Quality through:

- Contamination of soils, surface water and groundwater; and
- Redistribution of ACM that is present from historical anthropogenic activities.

The cumulative impacts associated with the construction and operation of the Proposal and other projects are discussed in more detail in the Cumulative Impact Assessment in **Section 17.**

11.5 Mitigation

HPPL has applied the mitigation hierarchy (avoid, minimise and rehabilitate) during Proposal design to reduce the potential impacts to Terrestrial Environmental Quality.

Avoidance measures include designing the Proposal to avoid mining stratigraphic units that pose the greatest AMD risk, avoiding impacts to areas prone to ASS where practicable, and avoiding ground disturbance in areas known or suspected to contain ACM, where practicable. The

will also be implemented which outlines management of potential contamination areas and procedures to be applied if asbestos or suspected asbestos materials are located.

A summary of mitigation measures applied to address the key potential impacts on Terrestrial Environmental Quality is provided in **Table 11-8**.

Table 11-8: Mitigation Measures for Terrestrial Environmental Quality

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
Indirect impacts:			
Contamination of soils, surface water and groundwater	• As a result of the AMD risk posed by elevated sulfur material at depth, HPPL purposely designed the pits to exclude basal Nammuldi Member subunits and Jeerinah Formation (Roy Hill Shale).	• The Proposal has been designed to avoid direct impacts to areas prone to ASS, such as wetlands. • Surface water diversions have been designed to ensure surface water flows avoid contact with waste rock dumps. • Storage of contaminating materials in Australian Standard (AS) compliant locations with bunding, spill controls and leak prevention. • Appropriate siting of landfill facilities to avoid interaction with surface drainage. • If PAF is encountered during mining, PAF material will be managed according to the Waste Management Plan to ensure final landform is non-acid forming. • Ongoing waste characterisation studies. • Ongoing waste characterisation during mining. • Waste rock material will be used as pit backfill to minimise the need for surface waste rock landforms. • Low stability or material the Uncertain or PAF classification waste rock material will not be placed on waste rock landform surfaces.	• If unexpected PASS is encountered, disturbed soils or low pH waters will be neutralised prior to discharge. • Excavation or dewatering will cease until suitable management measures are employed. • If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria. • Monitoring of surface and groundwater quality in accordance with a Water Management Plan to detect any adverse changes in water quality between the mine and sensitive receptors, with 'early response' criteria, 'trigger' criteria and 'threshold' criteria. • Progressive rehabilitation to be undertaken in accordance with a Mine Closure Plan assessed and approved by DEMIRS, as per requirements under the Mining Act. • Spills and leaks of reagents, chemicals and hydrocarbons will be cleaned up in accordance with HPPL procedures. • Pipelines, water storage dams and landfills will be appropriately decommissioned and

Potential Impact	Mitigation		
	Avoid	**Minimise**	**Rehabilitate / Monitor**
		• Competent waste rock material will be used to armour waste rock dump surfaces. • Waste rock landform design, including heights, slope lengths, batter angles and surface water control structures account for physical and chemical properties of waste rock. • Design landforms and infrastructure to contain sedimentation where possible. Toe bunds and sediment basins will direct and contain sediment runoff to prevent excessive scour and increased sediment volumes to the downstream environment. • Adherence to Dangerous Goods licence conditions and Australian Standards. • Adherence to EP Act Part V licence conditions with respect to bulk chemical storage and landfill management. • Disposal of waste to landfill will be a last resort. Materials will be repurposed or recycled where practicable.	disturbed areas rehabilitated, unless there is a specific agreement in place with a third party to take ownership and responsibility of the infrastructure post mining. The requirements will be regulated as per a Mine Closure Plan to be assessed and approved by DEMIRS, in accordance with the Mining Act. • All chemical and hydrocarbon storage areas will be appropriately decommissioned and closed as per DEMIRS requirements of the MCP, in accordance with the Mining Act.
Redistribution of ACM that is present from historical anthropogenic activities	• The Development Envelope avoids the WAMA. • The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access.	• Adherence to the Asbestos Management Plan. • The Proposal has been designed to avoid impacts to areas where ACM has been confirmed or is suspected, where practicable.	• ACM-contaminated areas will be rehabilitated where appropriate, and asbestos management will be subject to monitoring through the AMP.

11.6 Assessment and Significance of Residual Impacts

11.6.1 Indirect Impacts

Contamination of Soils, Surface Water and Groundwater

To mitigate the risk of AMD impacts to soil, surface water and groundwater, HPPL has purposely designed the mining pits to exclude basal Nammuldi Member subunits and Roy Hill Shale. Waste material characterisation conducted to date shows elevated sulfur material at depth within these units, posing the highest AMD generation risk. Excluding these material types notably lowers the risk of AMD from waste rock dumps, in-pit backfill, exposed mine pit walls, ore on RoM pads and low-grade ore stockpiles.

The majority of waste material 95% (**Table 11-6**) is classified as NAF with less than 1% being classified as PAF by a very conservative measure. Any probability that significantly acid generating material will occur in waste material stored in landforms or backfilled below water table has been almost completely avoided.

Broad-scale mapping indicates the Proposal has a generally low ASS risk and site-based observations have not identified any areas of PASS.. In the event that unexpected ASS is encountered, mitigation measures will be employed. If ASS has been disturbed or dewatered, monitoring of surface and groundwater quality in accordance with a Water Management Plan will continue until water return to below 'trigger' criteria.

Physical waste rock characterisation work undertaken by Mine Earth (2023) has identified the erosional stability of the key lithologies within the various stratigraphic units summarised as follows:

- Fresh chert, BIF and mineralised waste rock should display moderate-high erosional stability and should be suitable for placement on final landform slopes. Moderate-high stability waste rock may provide a useful source of durable rock armour.
- Calcrete and silcrete waste rock should display moderate to moderate-high erosional stability and should be suitable for placement on final landform slopes.
- Fresh dolomite and transitional chert, BIF and mineralised waste rock should display moderate erosional stability. These rock types may not be suitable for placement on final landform slopes (to be verified during mining).
- Fresh shale and transitional dolomite and shale waste rock should display low-moderate to low erosional stability and should not be placed on final landform slopes.
- The oxide component of all rock types can be expected to low erosional stability and should not be placed on final landform slopes.

The findings of this work will be used to inform more detailed test work and waste rock handling and placement procedures that will ensure low erosional stability waste rock is not placed on final waste rock landform slopes, and high erosional stability rock armouring materials is used. Based on projected waste rock volumes by stratigraphic unit, there will be sufficient quantities of competent material to cover less stable material. The nature of the geology also results in the less competent oxide waste rock being mined first, with more competent material encountered at depth to encapsulate low stability waste rock.

Whilst WRDs are active and prior to progressive rehabilitation, standard mitigation measures will be used to manage sediment dispersal from waste dump slopes at angle of repose. Measures include sediment basins to direct and contain any sediment runoff, preventing dispersion to the downstream environment.

The risk of high sediment load from WRDs impacting downstream soils and drainage lines can be adequately managed to meet the EPA's objectives for Terrestrial Environmental Quality. HPPL notes that risks to Terrestrial Environmental Quality associated with high sediment volumes from waste rock dumps can be adequately regulated by DEMIRS, under the provisions of the Mining Act. Through the Mining Proposal and Mine Closure Plan assessment and approval process, environmental objectives and performance criteria will be established to ensure mining operations meet DEMIRS environmental objectives for mining, which include land and soil and water resources as key environmental factors.

Any impacts to Terrestrial Environmental Quality arising from spillage of reagents, chemicals and hydrocarbons and pipeline failures, leaks/seepage from saline water storage facilities are likely to be localised and minor, and unlikely to result in significant environmental impacts. The Proposal will be subject to regulation under the Mining Act, which will also regulate impacts to the environment arising from spillage of reagents, chemicals and hydrocarbons and pipeline failures, leaks/seepage from saline water storage facilities via setting appropriate environmental outcomes and performance criteria relating to land and soils and water resources.

The DG Act reduces the risk to the environment from dangerous goods (transport, storage, use and disposal) by regulating the user and ensuring correct use and adherence to standards.

The provisions of the DG Act allows DEMIRS, through the licencing process, to regulate mining activities and meet the EPA's objectives for Terrestrial Environmental Quality.

Adherence to Dangerous Goods licence conditions, EP Act Part V licence conditions with respect to bulk chemical storage, relevant Australian Standards and the use of industry-standard mitigation measures for the transport, storage use and disposal of dangerous goods will ensure there are no significant residual impacts to Terrestrial Environmental Quality from the Proposal.

The EP Act Part V process, through the completion of the works approval, associated commissioning works and licence, will provide adequate regulation of emissions and discharges from the Proposal. The provisions of Part V of the EP Act will meet the EPA's objectives for Terrestrial Environmental Quality.

Redistribution of asbestos containing material

Based on the findings of the SAQP completed by JBS&G (2023), it is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM.

As part of the SAQP, soil sampling was targeted towards areas where the potential for the deposition of asbestiform minerals was considered to be highest. A single loose fibre bundle of crocidolite in the soil was detected in a single sample, however, the asbestos concentration in the sample, and every other sample, was below the laboratory LOR and adopted assessment criteria. In the absence of any asbestos detections or exceedances, the potential risk to site receptors is considered to be low (JBS&G, 2024).

Limited historical site structures at Mulga Downs have confirmed the presence of ACM, however given the relatively small size and scale of the observed infrastructure, the amount of asbestos release in the event of disturbance is likely to be minor. Other unidentified site structures within the Development Envelope could potentially contain ACM. However, the potential for unacceptable risk to Terrestrial Environmental Quality from ACM within site structures is considered to be low and can be managed via the implementation of an Asbestos Management Plan (AMP), including procedures for the safe decommissioning and removal of these structures from site (JBS&G, 2024).

ACM is known to have been historically dumped near the Development Envelope. However, no ACM (including bags of tailings) or other consolidated waste storage areas were observed during the site investigation. While the potential for unidentified dumping can't be completely discounted, the current available information indicates that the unacceptable risk to site receptors from miscellaneous dumping of ACM tailings is low and can be managed via the preparation and implementation of an unexpected finds procedure within the AMP (JBS&G, 2024).

Prior to implementing the above-stated management plans and procedures, HPPL has implemented a number of avoidance measures to minimise risks of encountering anthropogenic ACM. These include:

- The Development Envelope avoids the WAMA.
- The Mulga Homestead, which is a registered contaminated site, is excluded from the Development Envelope and has been fenced off with appropriate signage provided to prevent unauthorised access.

Based on the above, the risk of ACM to Terrestrial Environmental Quality is considered low and manageable.

11.7 Significant Residual Impact

The residual impacts of the Proposal to Terrestrial Environmental Quality are not considered significant. Based on the studies and investigations undertaken to date, the outcomes of the assessment of potential impacts and proposed mitigation measures to protect environmental values associated with Terrestrial Environmental Quality meet the EPA's objective for this factor.

11.8 Environmental Outcome

The predicted environmental outcomes for Terrestrial Environmental Quality are summarised in **Table 11-9**.

Table 11-9: Terrestrial Environmental Quality Environmental Outcomes

Potential impact	Environmental Outcome
Indirect impacts	
Contamination of soils, surface water and groundwater	• The risk of contamination of soils, surface water and groundwater from AMD is significantly reduced from HPPL's strategy of purposely designing pits not to intersect basal Nammuldi and Roy Hill Shale/ Member of the Jerrinah Formation stratigraphic units, as these have been shown to have the highest sulfur levels and are most likely to lead to the generation of AMD. • SRK (2024) confirms that the AMD potential is, in general, low. • The potential for leaching is expected to be limited given the neutral pH conditions expected for the majority of waste rock.

Potential impact	Environmental Outcome
Indirect impacts	
	• Other regulatory processes such as DEMIRS' Mining Proposal and MCP will ensure waste structures such as waste rock dumps are designed, operated, decommissioned and closed to meet the EPA's objectives for Terrestrial Environmental Quality. • Any contamination of soils, surface water and/or groundwater arising from failure, leaks or seepage from saline water pipelines, or water storage dams is likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts. • Similarly, impacts associated with spillage of chemicals and hydrocarbons and landfill leachate or also are likely to be localised and minor, able to be managed by other regulatory processes and unlikely to result in significant environmental impacts.
Redistribution of asbestos containing material (ACM) that is present from historical anthropogenic activities	• It is considered unlikely that significant risk will be posed to Terrestrial Environmental Quality from clearing, earthworks, construction and/or mining activities redistributing historical, anthropogenic ACM. • The implementation of, and adherence to, an Asbestos Management Plan, including procedures for the safe decommissioning and removal of ACM structures and an unexpected finds procedure can adequately manage ACM risks to Terrestrial Environmental Quality to ensure the EPA's objective for this environmental factor can be met.

12 Greenhouse Gas Emissions

12.1 EPA Objective

The EPA's objective for the environmental factor Greenhouse Gas (GHG) Emissions is:

"To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable." (EPA 2024).

12.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1,** specific policy and guidance relevant to the key environmental factor Greenhouse Gas Emissions that have informed the planning for the Proposal are listed in **Table 12-1**.

Table 12-1: Greenhouse gas policy and guidance

Reference	Title	How policy and guidance has been considered
State		
EPA, 2024	Environmental Factor Guideline: Greenhouse Gas Emissions (the GHG Guideline)	The information provided in this chapter addresses the considerations for environmental impact assessment' listed in this document.
GoWA, 2019a	Greenhouse Gas (GHG) Emissions Policy for Major Projects	Considered in the assessment of GHG emissions. In particular: *"Where the greenhouse gas emissions of a major Proposal assessed under Part IV of the Environmental Protection Act 1986 (WA) (EP Act) will be subjected to alternative regulatory measures, the State will no longer apply conditions to reduce net greenhouse gas emissions."* *"The EP Act requires the EPA to identify and consider key environmental factors as part of its statutory assessment functions. Acknowledging the EPA's duties to assess Proposals lawfully and in a manner it considers appropriate, the State Government expects that in line with this policy, there is no need to assess emissions dealt with by other regulatory measures."*
GoWA, 2020	Western Australian Climate Change Policy	Sets out the WA Government's plan for a climate-resilient community and a prosperous low-carbon future; also underscores the commitment to adapting to climate change and working with all sectors of the economy to achieve net zero greenhouse gas emissions by 2050.
Commonwealth		
Commonwealth Government, 2007	National Greenhouse and Energy Reporting Act 2007 (NGER Act)	Under the NGER Act, companies are obligated to report on their GHG emissions in accordance with statutory requirements (CER 2021). The NGER Act provides a single national framework for the reporting and dissemination of information relating to GHG emissions, energy production and energy consumption in Australia governed by the Clean Energy Regulator (CER).
Commonwealth Government, 2008	National Greenhouse and Energy Reporting (Measurement) Determination 2008	Considered in the GHG emissions assessment.

Reference	Title	How policy and guidance has been considered
Commonwealth Government, 2022	Climate Change Act 2022	Requires the Commonwealth Government to consider the advice regarding the Net Zero Plan and 2035 target.
Commonwealth Government, 2023	National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (as amended 2023)	The objectives of the Act as set out in are: (1) To establish a unified national reporting framework for greenhouse gas emissions, projects, energy consumption, and production by corporations, aimed at informing government policy, the public, meeting international obligations, supporting government programs, and avoiding redundant state and territory reporting requirements. (2) To help achieve Australia's greenhouse gas emissions reduction targets by ensuring that emissions from large facilities do not exceed set baselines, total net safeguard emissions remain within specified limits from 2020 to 2030, and decline to zero by 2050, while providing incentives for facilities to reduce their emissions. Pursuant to the Australian Government's Safeguard Mechanism Rule, if a facility is anticipated to emit more than 100,000 t CO2-e of Scope 1 emissions per financial year (i.e., the 'safeguard threshold'), it qualifies as a safeguard facility and is required to keep its net emissions levels at or below its emissions baseline set by the CER. The reforms are intended to put facilities on a broad trajectory to meet net zero in 2050, consistent with EPA requirements. Together with the reporting obligations under the NGER Act, the safeguard mechanism provides a National framework for Australia's largest emitters to measure, report and manage their emissions. Whilst the Proposal is not currently expected to be a safeguard facility, there some factors, which are not yet finalised, that may impact this position: The emissions are an estimate only, these estimates may change as the project and operational conditions develop.

HPPL acknowledges the Commonwealth Government's commitment has been updated (June 2022). The former commitment to an interim GHG reduction target of 26% to 28% below 2005 levels by 2030 has been superseded by a more ambitious target of 43%; incorporated through legislation via the Commonwealth Climate Change Bill 2022, which was passed in September 2022 and formalised as the target for the updated Nationally Determined Contribution under the Paris Agreement (Commonwealth Government 2023).

Information required for the assessment of impacts from GHG emissions in accordance with the EPA, 2024 GHG Guideline is included in this section.

12.3 Safeguard Mechanism Confirmation

The Proponent is unlikely to be a Safeguard Facility. In addition, the Proponent will not exceed 100,000 t CO2-e of overall project emissions due to the application of the mitigation hierarchy.

12.3.1 Application of Mitigation Hierarchy

Application of the mitigation hierarchy for greenhouse gas (EPA 2023d) is as follows:

- Avoid – avoid emissions through best-practice design;
- Reduce – reduce emissions over the project life; and
- Offset – offset some or all residual emissions.

A summary of mitigation measures applied to address the key potential impacts of GHG emissions against the mitigation hierarchy for greenhouse gas (EPA 2023d) of avoid, reduce and offset is described below and provided in Table 12 2.

12.3.1.1 Avoided emissions

The EPA's mitigation hierarchy has been considered throughout the planning of the anticipated construction and operational periods of the Proposal. HPPL has incorporated best practice measures to minimise and avoid GHG emissions at Proposal implementation with subsequent long-term reduction strategies outlined.

The power network for the Proposal has been designed to avoid employing diesel generators wherever practicable. Electrical loads will be connected to the electricity distribution network and supplied from the central power station. The central power station incorporates LNG engines, a battery and solar PV. Exceptions include the reinjection and dewatering bores and the gate house. For these use cases, hybrid solar microgrids will be considered. The difference in emissions intensity between diesel generators (as are typically deployed in a mine of this size and type) and the LNG battery and solar power station is 572,761 t-CO2-e over the life of the Project.

The commitment to implementation and scale up of the use of solar power as a renewable energy source is based on forecasts of what is achievable during the lifetime the Proposal. It is possible that technology associated with PV solar, BESS and associated management systems will evolve beyond current expectations during the Proposal lifetime. Should this occur, HPPL will consider the feasibility of implementing a larger percentage of renewable energy sooner.

Further, the proposed transport solution (hauling ore via road train to Hillside siding to be loaded onto the train) compared to the alternative (hauling ore via road train to Utah Point) avoids another 607,756 t-CO2-e over the life of the Project.

12.3.1.2 Potential Reduction Projects

Other GHG avoidance and minimisation initiatives, to be implemented at Proposal commencement, include optimisation of mine layout to minimise haulage distances, gradients and use of multiple ROM pads. This mine layout has meant the litres per total material movement (TMM) is equivalent to that of Roy Hill, which is the fourth best mine in the Pilbara from an emissions intensity perspective (from a total of 19 mines) (refer to data from the CER: https://cer.gov.au/markets/reports-and-data/emissions-intensity-determination-data-safeguard-facilities). This ensures that best practice mining operational practices are incorporated from the commencement of Mulga Downs.

During operations, HPPL will look to introduce a number of energy efficiency initiatives if they are feasible and beneficial to do so, this will be informed by learnings from those initiatives deployed at other group operations, such as:

- Specifying fuel efficient HME.
- Use of diesel fuel additive such as the Caltex Active Tec product. This has been shown to reduce fuel consumption by 3.9% across the operations.
- Engine tuning optimisation, which have shown to have improved emissions by up to 7% for single HME.
- Use of lighter trays in the HME. The associated diesel efficiency improvement is yet to be quantified in other operations, but is estimated to reduce the diesel L per TMM by up to 10% for a single HME using that tray.
- The Anti-Idle technology has been trailed and is being further developed in consultation with OEM partners. This technology targets periods of the HME operations where the vehicle is at stationary idle by turning off the engine but maintaining the power to the aircon and other systems the operator requires. The amount of addressable idle time varies due to asset class and operational factors however HPPL are targeting a 1-2% annual fuel saving.
- Renewable and/or Hybrid Diesel stationary power system used in place of small field generators, communication trailers and lighting trailers. These have been trialled and deployed where suitable in operations a predicted fuel saving of 40 to 60%.
- Fuel Active is a product that prevents contaminants in the fuel tanks from entering HME engines. This allows the engine to achieve a cleaner burn and could offer approximately a 1.5% fuel saving per asset, but this is yet to be validated.
- Smaller electric equipment, investigate the deployment of smaller and commercially available electric equipment where it is economically and operationally feasible to do so.

Subsequent emission reductions, via hydrocarbon displacement, can only be realised by gradual electrification of the mining fleet and progressive increased renewable penetration into the power network. The timing of increasing of both electrification and renewable penetration are dependent on technology maturity and availability. HPPL have allocated land to enable the solar field and electrical assets to be expanded to support increased electrification.

12.3.1.3 Offset Projects

The Proponent will apply the mitigation hierarchy to ensure that total or net emissions stay within the limits shown in Figure 12-1. This includes using offsets as a last resort in the event that other mitigations are not successful. Should the Proponent need to use offsets, they will be offsets that are issued under recognised carbon offset programs. Such programs include:

- Australian Carbon Credit Units issued under the Carbon Credits (Carbon Farming Initiative) Act 2011 (Cth).
- Safeguard Mechanism Credits issued under the Safeguard Mechanism (Crediting) Amendment Act 2023.
- Verified Emission Reductions issued under the Gold Standard program.

- Verified Carbon Units issued under the Verified Carbon Standard program.
- Carbon offsets issued under the Climate Action Reserve program.
- Carbon offsets issued under the American Carbon Registry program.
- Other offset units that are issued under similarly recognised programs.

The EPA's mitigation hierarchy has been considered throughout the planning of the anticipated construction and operational periods of the Proposal. HPPL has incorporated best practice measures to minimise and avoid GHG emissions at Proposal implementation with subsequent long-term reduction strategies outlined.

The power network for the Proposal has been designed to avoid employing diesel generators wherever practicable. Electrical loads will be connected to the electricity distribution network and supplied from the central power station. Exceptions include the reinjection bores, which run intermittently so can prioritise periods of solar generation from a local photovoltaic (PV) system, and the gate house which will also use electricity from a local solar PV system equipped with a diesel generator for periods when solar generated electricity is not available. The difference in emissions intensity between diesel generators (as are typically deployed in a mine of this size and type) and the current solution is ~62%.

Implementation of a hybrid central power station, integrating power generation from gas rather than diesel, and a solar panel farm, will provide the primary GHG reductions. Initially the solar generation capacity will provide 38% of the mine base load requirements, resulting in a reduction in emissions of 25,507 t CO_2-e per annum compared to servicing the base load requirements from a 100% gas fired power station.

Other GHG avoidance and minimisation initiatives, to be implemented at Proposal commencement, include optimisation of mine layout to minimise haulage distances, gradients and use of multiple ROM pads. This mine layout has meant the litres per total material movement (TMM) is equivalent to that of Roy Hill, which is the fourth best mine in the Pilbara from an emissions intensity perspective (from a total of 19 mines) (refer to data from the CER: https://cer.gov.au/markets/reports-and-data/emissions-intensity-determination-data-safeguard-facilities). This ensures that best practice mining operational practices are incorporated from the commencement of Mulga Downs.

During operations, HPPL will look to introduce a number of energy efficiency initiatives if they are feasible and beneficial to do so, this will be informed by learnings from those initiatives deployed at other group operations, such as:

- Specifying fuel efficient HME
- Use of diesel fuel additive such as the Caltex Active Tec product. This has been shown to reduce fuel consumption by 3.9% across the operations.
- Engine tuning optimisation, which have shown to have improved emissions by up to 7% for single HME.
- Use of lighter trays in the HME. The associated diesel efficiency improvement is yet to be quantified in other operations, but is estimated to reduce the diesel L per TMM by up to 10% for a single HME using that tray.
- The Anti-Idle technology has been trailled and is being further developed in consultation with OEM partners. This technology targets periods of the HME operations where the vehicle is at stationary

idle by turning off the engine but maintaining the power to the aircon and other systems the operator requires. The amount of addressable idle time varies due to asset class and operational factors however HPPL are targeting a 1-2% annual fuel saving.

- Renewable and/or Hybrid Diesel stationary power system used in place of small field generators, communication trailers and lighting trailers. These have been trialled and deployed where suitable in operations a predicted fuel saving of 40 to 60%.
- Fuel Active is a product that prevents contaminants in the fuel tanks from entering HME engines. This allows the engine to achieve a cleaner burn and could offer approximately a 1.5% fuel saving per asset, but this is yet to be validated.
- Smaller electric equipment, investigate the deployment of smaller and commercially available electric equipment where it is economically and operationally feasible to do so.

Subsequent emission reductions, via hydrocarbon displacement, can only be realised by gradual electrification of the mining fleet and progressive increased renewable penetration into the power network. The timing of increasing of both electrification and renewable penetration are dependent on technology maturity and availability. HPPL have allocated land to enable the solar field and electrical assets to be expanded to support increased electrification.

The commitment to implementation and scale up of the use of solar power as a renewable energy source is based on forecasts of what is achievable during the lifetime the Proposal. It is possible that technology associated with PV solar, BESS and associated management systems will evolve beyond current expectations during the Proposal lifetime. Should this occur, HPPL will consider the feasibility of implementing a larger percentage of renewable energy sooner.

Application of the mitigation hierarchy for greenhouse gas (EPA 2023d) is as follows:

- Avoid – avoid emissions through best-practice design;
- Reduce – reduce emissions over the project life; and
- Offset – offset some or all residual emissions.

A summary of mitigation measures applied to address the key potential impacts of GHG emissions against the mitigation hierarchy for greenhouse gas (EPA 2023d) of avoid, reduce and offset is provided in **Table 12-2**.

Table 12-2: Summary of Mitigation Measures for Greenhouse Gas Emissions

Mitigation			
Potential impact	**Avoid**	**Reduce**	**Offset**
Direct contribution to climate change from Scope 1 emissions generated by the Proposal	Vegetation clearing minimised to no more than 4,339.16 ha of clearing within a Development Envelope of 16,848.53 ha. Power provided by hybrid power station with natural gas fired generators, avoiding diesel-fired generators. Hybrid power station installed with solar and BESS to provide 38% of power demand, avoiding gas fired generation. Power remote infrastructure and equipment with solar and BESS where possible, avoiding need for diesel fired generators. Adopt energy efficient infrastructure and equipment. Location of infrastructure and haul roads designed to minimise haul distances. Haul roads designed to minimise gradients and stop/start points. Transport of ore by rail (subject to approvals) in place of road transport.	Where economic and possible to do so incrementally increase renewable penetration through increased sourcing of electricity from solar and other sources. Incremental electrification of equipment as technology becomes economically and commercially available. Regular planned equipment maintenance to ensure fuel efficiency is optimised. Implement fuel reduction strategies such as changes in modes of operation, duration of engine idle time, type of fuel used, engine management system optimisation and other initiatives as listed in section 12.3.1.2. Connect infrastructure and equipment to distributed electricity network where possible, avoiding need for diesel fired generators.	Carbon offsets will be used where emissions exceed emission reduction commitments and target as listed in section 12.3.1.3.
Indirect contribution to climate change from Scope 2 emissions generated by the Proposal	Scope 2 emissions, associated with electricity or other energy commodities sourced from a third party, have been avoided where possible. Electricity will be source	NA	NA

Mitigation			
Potential impact	**Avoid**	**Reduce**	**Offset**
	from on-site infrastructure (hybrid gas/solar power station or diesel generators).		
Indirect contribution to climate change from Scope 3 emissions generated by the Proposal	Replace transport of ore by road with rail (subject to approvals).	Replace diesel locomotives with electric ones	Define and refine scope 3 emissions estimates through the life of the Proposal to identify mitigation measures.

12.4 Estimate of Emissions

Three distinct classes (Scopes) of GHG emissions are described in various national and international GHG reporting standards that delineate sources and associated responsibilities. The Scopes of GHG emission classes are defined (EPA, 2023a) as:

- Scope 1 emissions are those released to the atmosphere as a direct result of an activity, or a series of activities, which are part of a Proposal being considered by the EPA;
- Scope 2 emissions are those from the independent consumption of an energy product by the Proposal; and
- Scope 3 emissions are indirect GHG emissions other than Scope 2 emissions that are generated in the wider community. Scope 3 emissions (both upstream and downstream) occur as a consequence of the activities of a Proposal, but from sources not owned or controlled by HPPL as part of the Proposal.

12.4.1 Scope 1 (as defined by the EPA)

12.4.1.1 Mine Emissions

Fuel consumption forecasts were informed by data from existing operations and detailed Proposal specific studies. Emission estimates are based on construction commencing in FY 2027 with operations commencing during FY 2028. Forecasting is based on mining operations ceasing by the end of FY 2041 (ore will be stockpiled for transportation to Port Hedland). From FY 2042, trucks and excavators are forecast to be largely employed for closure activities, including backfilling and rehabilitation.

Emissions estimates, as tonnes carbon dioxide equivalent (t CO2-e), have been made using “Method 1” from the National Greenhouse and Energy Reporting (Measurement) Determination 2008, incorporating the National Greenhouse and Energy Reporting (Measurement) Amendment (2023) Determination 2023, which employs default emission factors in the estimation of emissions.

Scope 1 emissions associated with the Proposal will occur from/are associated with:

- Combustion of diesel fuel during construction phase for:
  - Vegetation removal (mobile equipment);
  - Earthmoving, heavy haulage vehicles and other related equipment
  - Mine pits and tailings storage facilities;
  - Installation of mine infrastructure including processing plant, mine roads, culverts, airport, accommodation camp, fuel corridor, power station and power lines, solar farm, and ancillary infrastructure (e.g., water management infrastructure, explosives storage, offices, landfill etc.);
  - Vehicles for transporting construction workers and ancillary vehicles including light vehicles (LV), goods vehicles; and
  - Diesel generators to meet electricity requirements for construction of the Proposal infrastructure, power station and accommodation camp.

- Combustion of fuel during the operational phase for:
  - Mining of ore;
  - On-site ore transport, crushing, screening, wet processing and stacking;
  - Mineral waste management (WRDs);
  - Electricity generation for operational activities and infrastructure (through the use of a gas, battery and solar farm);
  - Haul truck operation (the use of multiple ROM pads has reduced haul distances and increased fuel efficiency);
  - Haulage of ore to the Proposal Boundary via road trains;
  - Water carts;
  - Ancillary vehicles (e.g., LVs, goods vehicles, buses); and
  - Water abstraction.

12.4.1.2 Transport Emissions

The emissions associated with transport include:

- The emissions associated with road haulage to Hillside Siding.
- The emissions associated with the operation of Hillside Siding.
- The emissions associated with rail haulage from Hillside Siding to Utah Point.

12.4.1.3 Land Clearing Emissions

Emissions associated with vegetation clearing are not covered emissions for the purposes of safeguard.

Carbon sequestration loss due to biomass disturbance has been calculated using the generic methodology from Intergovernmental Panel on Climate Change (IPCC) (IPCC 2003). The calculation of GHG emissions resulting from loss of biomass associated with the Proposal is based on the following conservative assumptions and exclusions:

- Vegetation was mature without any disturbance;
- Above and below ground biomass in the Development Envelope will be cleared progressively;
- The above ground biomass estimate derived from the average biomass density inside the Proposal area to be cleared in the Maximum Above Ground Biomass (also known as M) spatial layer developed for the Full Carbon Accounting Model (FullCAM) is representative of vegetation, including all plants and debris, in the Development Envelope;
- A root to shoot ratio of 2.8 derived from Intergovernmental Panel on Climate Change (IPCC guidance) for shrubland [4] is representative of the vegetation in the Development Envelope;
- The default IPCC value of carbon fraction of biomass dry matter of 0.5 is representative;
- All carbon in biomass removed conservatively assigned as if will be released as CO_2 in the year of clearing;

[4] Table 3A.1.8 shrubland IPCC 2003 https://www.ipcc- nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

- Soil carbon loss was not accounted for; and
- Restoration of carbon sequestration via progressive revegetation, where practicable, is not accounted for.
- The carbon loss from vegetation clearing ($\Sigma E_v \text{t CO}_2 - e$) was estimated from the following formula[5]:

$$\Sigma E_v \text{t CO}_2 - \text{e} = \text{A} \times \text{AGB x } (1 + \text{R}) \text{ x CF x CD}$$

Proposal specific parameters are described in **Table 12-3**.

Table 12-3: Parameters for calculation of carbon sequestration loss due to biomass disturbance

Parameter	Description	Value	Source
A	area to be cleared in hectares	Up to 4,339.16 ha	Project team
AGB	above ground biomass	6.9 t dry matter/ha	Maximum Above Ground Biomass (also known as M) spatial layer 2019
R	root to shoot ratio to estimate below ground vegetation biomass	2.83	Table 3A.1.8 shrubland IPCC 2003 Good Practice Guide for Land Use, Land Use Change and Forestry
CF	IPCC default carbon fraction of biomass	0.5	IPCC Guidelines for National Greenhouse Gas Inventories
CD	ratio of the molecular weight of carbon dioxide to carbon	3.67	Molecular weight CO_2 (44) / Molecular weight C (14)

It is anticipated there will be 210,421 t CO_2-e as a result of carbon sequestration loss due to biomass disturbance from the Proposal.

[5] IPCC 2006 equation 2.14

12.4.1.4 Scope 1 Emissions Profile

The emission profile is shown below in Figure 12-1. To note:

- Total Unmitigated Emissions - This represents what the emissions of the Proposal would have been without the application of the mitigation hierarchy.
- Total Mitigated Emissions - This represents the total Proposal emissions after application of the mitigation hierarchy, which do not exceed 100,000 t CO_2-e.
- Vegetation Clearing - This portion of the clustered column represents the emissions that are not measured under the Safeguard facility, namely vegetation clearing which results in loss of biosequestration.
- Emissions – Mine Facility - This portion of the clustered column represents the emissions associated with the mine facility and includes emission from diesel associated with mining and the emissions associated with the power generation.
- Emissions – Transport - This portion of the clustered column represents the emissions associated with transporting the ore to the port (road haulage and rail haulage).
- Avoided Emissions - This portion of the clustered column represents the avoided emissions achieved through the use of a hybrid renewable/LNG power station and using a rail system (described in further detail below).
- Emissions abated through Reduction/Offsets - This portion of the clustered column represents a reduction or offsetting of emissions that the Proponent commits to achieving.

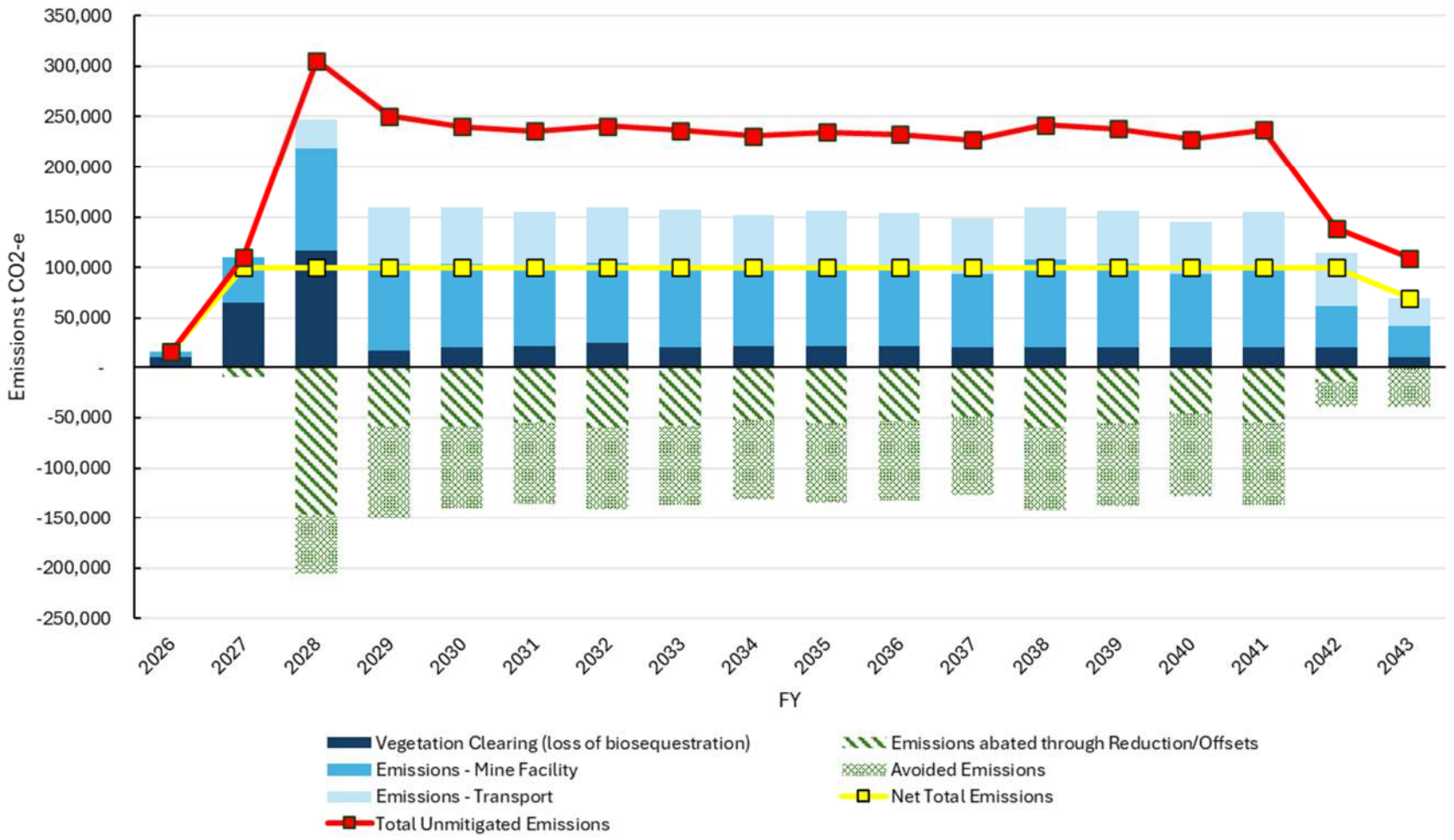

Figure 12-1: Scope 1 emissions profile for the Proposal

12.4.2 Scope 2

Scope 2 emissions, associated with electricity or other energy commodities sourced from a third party, are not currently anticipated. Electricity will be source via on-site infrastructure (hybrid gas/solar power station or diesel generators).

12.4.3 Scope 3

The Scope 3 emissions associated with the Proposal will be greater than 100,000 t CO_2-e. The following information has been provided in this section:

- The estimate of scope 3 emissions.
- Activities to reduce scope 3 emissions.
- Where scope 3 emissions will be emitted.

Estimate of Scope 3 emissions

Scope 3 (indirect) emissions associated with the Proposal include GHG emissions associated with the supply of materials for construction of infrastructure and ongoing maintenance, fuel and energy related activities, transport and handling of ore through to the port, onward international transport via sea, and emissions associated with steel production.

Scope 3 emissions associated with the mining of ore have been considered against the 15 Scope 3 categories defined by the World Resources Institute (WRI 2013) in **Table 12-4**. Where requirements and logistics are uncertain at the current stage of Proposal development, emissions cannot be reasonably estimated at this time (detailed as "Not estimated" in the table below).

Table 12-4: Description and Boundaries of Scope 3 Categories

Category	Description	Relevance to Proposal	Emission Estimate (t CO_2--e)
1. Purchased goods and services	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year	Upstream emissions associated with goods and services relevant to the operation and maintenance of the mine – requirements not yet fully determined.	Not estimated.
2. Capital goods	Extraction, production, and transportation of capital goods purchased or acquired by the reporting company in the reporting year	Upstream emissions associated with the supply of materials, plant and equipment for mine construction and operation– not determined in sufficient detail to derive and estimate.	Not estimated.
3. Fuel- and energy related activities (not included in scope 1 or scope 2)	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the	Extraction, production and transportation of purchased gas and diesel to site – logistics not yet determined.	Not estimated

Category	Description	Relevance to Proposal	Emission Estimate (t CO_2--e)
	reporting year, not already accounted for in scope 1 or scope 2, including: a. Upstream emissions of purchased fuels (extraction, production, and transportation of fuels consumed by the reporting company)		
4. Upstream transportation and distribution	Transportation and distribution of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers and its own operations (in vehicles and facilities not owned or controlled by the reporting company). Transportation and distribution services purchased by the reporting company in the reporting year, including inbound logistics, outbound logistics (e.g., of sold products), and transportation and distribution between a company's own facilities (in vehicles and facilities not owned or controlled by the reporting company).	Transportation of purchased goods to site – logistics not yet determined. Emissions associated with ore handling at the port.	Not estimated. 12,000 t CO2-e/annum
5. Waste generated in operations	Disposal and treatment of waste generated in the reporting company's operations in the reporting year (in facilities not owned or controlled by the reporting company)	Disposal of mixed solid waste and wastewater will be limited to that generated by the administration and accommodation camp to be disposed of at facilities within the Proposal boundary. Third party waste disposal would be limited to disposal of speciality wastes such as hydrocarbons and are not expected to lead to significant quantities of Scope 3 emissions.	Not estimated
6. Business travel	Transportation of employees for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company)	Not reasonably quantifiable at this time.	Not estimated

Category	Description	Relevance to Proposal	Emission Estimate (t CO_2--e)
7. Employee commuting	Transportation of employees between their homes and their worksites during the reporting year (in vehicles not owned or operated by the reporting company)	Not reasonably quantifiable at this time.	Not estimated
8. Upstream leased assets	Operation of assets leased by the reporting company (lessee) in the reporting year and not included in scope 1 and scope 2 – reported by lessee	No upstream leasing of assets expected at this time.	-
9. Downstream transportation and distribution	Transportation and distribution of products sold by the reporting company in the reporting year between the reporting company's operations and the end consumer (if not paid for by the reporting company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company)	Shipping of 12 Mtpa at an intensity of 0.017 t CO_2-e/t iron ore (assuming a distance of 3,154 km and using the production variable default of 0.00000539 t CO_2-e/ net tonne km).	Sea freight: 204 000 t CO_2-e/annum
10. Processing of sold products	Processing of intermediate products sold in the reporting year by downstream companies (e.g., manufacturers)	Emissions from the use of 12 Mtpa of iron ore for steel production have been estimated assuming 1.6 t of iron ore are required to yield 1.0 t of steel[6], with an associated CO_2 emissions of 1.89 t CO_2-e[7].	14.38 Mt CO_2-e/annum
11. Use of sold products	End use of goods and services sold by the reporting company in the reporting year	Beyond the scope of current knowledge.	-
12. End-of-life treatment of sold products	Waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life	Beyond the scope of current knowledge.	-
13. Downstream leased assets	Operation of assets owned by the reporting company (lessor) and leased to other entities in the reporting year, not included in scope 1 and scope 2 – reported by lessor	No downstream leasing of assets expected at this time.	-
14. Franchises	Operation of franchises in the reporting year, not included in	Not applicable.	-

[6] https://worldsteel.org/steel-topics/raw-materials/

[7] https://worldsteel.org/publications/policy-papers/climate-change-policy-paper/

Category	Description	Relevance to Proposal	Emission Estimate (t CO_2--e)
	scope 1 and scope 2 – reported by franchisor		
15. Investments	Operation of investments (including equity and debt investments and project finance) in the reporting year, not included in scope 1 or scope 2	Not applicable.	-

Reduction of scope 3 emissions

Steelmaking

HPPL is exploring opportunities to collaborate to reduce upstream scope 3 emissions and partnering with key customers, collaborating with industry and engaging in research. This includes:

- A partnership with the Heavy Industry Low Carbon Transition (HILT) Cooperative Research Centre (CRC) (HILT CRC). By participating in collaborative research, we can expect to achieve better results than if we were acting independently. The HILT CRC brings together some of Australia's best and brightest researchers and like-minded industry partners to explore innovative new technology concepts. Roy Hill (a related party) has joined HILT CRC as a Core Partner, which means not only have we made a financial commitment to support the CRC, but we're also lending some of our expertise.
- HPPL has partnered with the University of Melbourne regarding development of a new technology called Carbelec TM. CarbelecTM is an innovative technology that utilises electrolysis at low temperature to convert carbon dioxide (CO2) into reusable carbon and oxygen. The technology is applicable to existing blast furnaces, cement plants, other applications (e.g. Direct Air Capture).

Other initiatives:

HPPL has put in place the following initiatives with respect to their Scope 3 emissions

- Transport of ore via rail (from Hillside siding to Port Hedland) rather than the rail (subject to approvals) will lead to avoidance of Scope 3 emissions.
- Recycling materials and equipment from other site, including:
    - The crushing circuit is recycled from another site, meaning that no new steel had to be smelted for the construction of the plant.
    - Depending on the timing of construction of Mulga and decommissioning of other projects, the Proponent is considering the recycling equipment and material from other projects such as the electrical equipment associated with remote generation (transformers and switch gear).

Where scope 3 emissions will be emitted

As shown above, the majority of emissions are incurred the smelting of iron ore into steel. HPPL have yet to engage customers for the product from the Proposal. However, all the product will be exported to overseas market. A list of likely countries that would import the product and whether or not the party has signed up to the Paris Agreement or legislated carbon reduction (Table 12-5). If a party has done either, we are assuming it is reasonably likely that the scope 3 emissions will be subject to scope 1 or 2 emission reduction requirements.

Table 12-5: List of likely countries that would import the product

Country	Paris Agreement or legislated carbon reduction
Japan	Paris Agreement Signatory
China	Paris Agreement Signatory
Vietnam	Paris Agreement Signatory
India	Paris Agreement Signatory
Taiwan	Non party to Paris agreement Implemented Greenhouse Gases Emission Reduction and Management Act in July 2015 which has greenhouse gas reduction targets.
Korea	Paris Agreement Signatory
Malaysia	Paris Agreement Signatory

13 Air Quality

13.1 EPA Objective

The EPA's objective for the environmental factor Air Quality is:

"To maintain air quality and minimise emissions so that environmental values are protected" (EPA 2023a).

For this assessment, air quality is defined as *"the chemical, physical, biological and aesthetic characteristics of air"* (EPA 2020d).

13.2 Policy and Guidance

In addition to the policy and guidance outlined in **Section 4.1**, specific policy and guidance relevant to this environmental factor that have informed the assessment of the Proposal are summarised in **Table 13-1**.

HPPL has specifically considered this guidance in the following ways:

- Completion of analyses to describe the receiving environment and its significance;
- Identification of activities that may lead to impacts on Air Quality; and
- Application of the mitigation hierarchy in elements of Proposal design.

Table 13-1: Relevant Policy and Guidance

Reference	Title	How policy and guidance has been considered
State		
Department of Environment and Conservation (DEC) (now DWER), 2011	Guideline for managing the impacts of dust and associated contaminants from land development sites remediation and other related activities.	This guideline has been used to develop the Asbestos Management Plan (**Appendix 17**) to mitigate potential impacts.
Department of Health, 2021	Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia.	This guideline has been used in the assessment of potentially asbestos-contaminated land within the Development Envelope and for the management of the potential impacts.
Department of Mines and Petroleum (now DMIRS), 2015	Management of Fibrous Minerals in Western Australian Mining Operations.	This document was used to develop the Asbestos Management Plan (**Appendix 17**) to mitigate potential impacts.
DWER, 2021a	Guideline: Managing asbestos at construction and demolition waste recycling facilities.	This guideline has been used to develop the Asbestos Management Plan to mitigate potential impacts.
DWER 2021c	Guideline: Assessment and management of contaminated sites.	This guideline informed the appropriate assessment methodology for potential asbestos impacts.
DWER, 2024b	Western Australian Contaminated Sites Auditor Scheme.	The Preliminary Environmental Site Assessment (**Appendix 13**) was subject to audit by an accredited auditor in accordance with this scheme.

Reference	Title	How policy and guidance has been considered
DWER, 2024a	Requirements for Mandatory Auditors' Reports.	The Preliminary Environmental Site Assessment **Appendix 13** was subject to a Voluntary Audit Report (**Appendix 14**)prepared following this guide.
EPA, 2020d	Environmental Factor Guideline: Air Quality	The potential impacts of the Proposal have been assessed against the EPA objective for this factor.
Work Health and Safety Commission, July 2022		
Commonwealth, 1998	National Environment Protection Measure for Ambient Air Quality (Air NEPM).	The Ambient Air Quality NEPM contains relevant criteria against which potential impacts to air can be assessed.
National Environment Protection Council (NEPC), 2013	National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM).	The ASC NEPM has been followed to assess potentially asbestos-contaminated land within the Development Envelope.
EPA (NSW), 2022	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.	The document contains relevant criteria against which potential impacts of dust deposition can be assessed.
Work Health and Safety Commission (DMIRS 2022b)	How to Safely Remove Asbestos: Code of Practice.	This document was used to develop the Asbestos Management Plan to mitigate potential impacts.
Safe Work Australia, 2020	How to manage and control asbestos in the workplace: Code of Practice.	This document was used to develop the Asbestos Management Plan (**Appendix 17)** to mitigate potential impacts.

Specific additional work required for assessment of the Proposal relating to the environmental factor Air Quality, was provided in the ESD, which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this chapter.

13.3 Receiving Environment

The following sections describe the key features of the receiving environment in relation to the Air Quality factor, including details of the surveys and studies undertaken to support the Proposal.

13.3.1 Relevant Studies

A summary of the studies relevant to air quality, undertaken for the Proposal and surrounding area is provided in **Table 13-2**. The assessment of potential impacts on air quality as a result of the Proposal uses information from these reports. The studies completed to inform the Proposal have been conducted in accordance with the relevant policy and guidance.

Table 13-2: Air Quality Studies

Reference	Title	Description	Guidance / Methodology
Ambient Air Quality (Particulates)			
SLR 2021a **Appendix 18**	Phase 2 Mulga East Iron Ore Project Ambient Air Quality Monitoring Program	SLR was engaged to undertake baseline ambient air quality monitoring around the Development Envelope, including continuous monitoring of PM_{10} concentrations at one location using a beta attenuation monitor (BAM) and monthly monitoring of dust deposition rates at three locations using dust deposition gauges.	The ambient monitoring was conducted in general accordance with *AS/NZS 3580.10.1:2016 Methods for sampling and analysis of ambient air: Determination of particulate matter - Deposited matter - Gravimetric method* and *AS/NZS 3580.9.11 Methods for sampling and analysis of ambient air: Determination of suspended particulate matter - PM10 beta attenuation monitors*, as amended by Amdt 1:2009).
Asbestiform Minerals and Asbestos Containing Material			
JBS&G, 2023a	Sampling and Analysis Quality Plan (SAQP)	The SAQP and PESA were designed to assess the potential presence or absence of natural asbestiform minerals resulting from both natural erosion and deposition and imported asbestos from anthropogenic activity within the Development Envelope.	The SAQP and PESA have been prepared in accordance with: • Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia (Department of Health [DoH], 2021); • National Environmental Protection (Assessment of Site Contamination) Measure 1999, as amended 2013; • With respect to WA Department of Water and Environmental Regulation (DWER) Contaminated Sites Guidelines, as amended 2021; and • Relevant Australian Standards (AS4482.1- Guide to the investigation and sampling of sites with potentially contaminated soil (non-volatile and semi-volatile compounds) and AS4482.2 – Guide to the sampling and investigation of potentially contaminated soil (Part 2: volatile substances)).
JBS&G, 2023b **Appendix 13**	Preliminary Environmental Site Assessment (PESA)		
Senversa, 2023 **Appendix 14**	Voluntary Auditors Report (VAR)	The audit was undertaken to independently assess the quality and veracity of the SAQP and PESA.	The VAR has been prepared in accordance with the Contaminated Sites Act, 2003 relevant DWER [formerly Department Environment Regulation (DER)] guidance including The Western Australian Contaminated Sites Auditor Scheme and Requirements for Mandatory Auditors' Reports.

13.3.2 Climate

A detailed description of the climate of the region is provided in **Section 3.4**; however, a summary of key climate information relevant to this factor is provided below.

The mean annual maximum temperature recorded at Karijini North is 34.3˚C and the mean annual minimum temperature is 20.3˚C. The mean maximum daytime temperature is highest in December, at 41.3˚C, and the mean minimum winter temperature is lowest in July at 12.1˚C (BoM 2023b).

Rainfall across the Pilbara region is seasonal and highly variable. It is possible for significant rainfall events to be recorded in one location with minimal rainfall being recorded at the nearest alternative weather station. The region may often experience up to 12 months of dry weather, with hot dry summers and mild winters. Rainfall is typically associated with cyclonic and storm weather systems (van Vreeswyk et al 2004).

Wind roses compiled from data recorded by the Karijini North automatic weather station (AWS) during the baseline air quality monitoring program (2019-2021) (SLR 2021a) are presented in **Figure 3-6**. The highest frequency of winds is from the eastern and south-southwestern quadrants. There is minimal change in the wind distribution between the wet and dry seasons.

Wind speeds during the SLR (2021a) baseline air quality monitoring program were above 5 m/s (the speed above which wind erosion of exposed surfaces generally occurs) for approximately 35% of the time. The corresponding long-term wet and dry season windspeeds indicate a similar distribution.

13.3.3 Ambient Air Quality (Particulates)

A desktop data gap analysis undertaken for the Proposal by SLR (2019) recommended a 12 month ambient air quality monitoring program to address a lack of publicly-available, representative air quality monitoring data in the Pilbara region. In a meeting with HPPL on 2 April 2019, DWER confirmed that a 12 month monitoring program was appropriate to establish a robust baseline for the Proposal and that the methodology proposed by SLR to obtain this data was acceptable. HPPL subsequently engaged SLR to undertake 12 months of continuous monitoring for fine particulates (as particulate matter with an aerodynamic diameter of less than 10 microns [PM_{10}]) at one location and bi-monthly dust deposition at three locations around the Development Envelope (**Appendix 18**).

SLR sited, installed and commissioned the monitoring equipment (with monitoring location shown in **Figure 13-1)** between 7 May 2019 and 9 May 2019 and performed monthly servicing, maintenance and reporting tasks throughout the monitoring period. The monitoring continued until 22 February 2021, beyond the original 12-month duration, due to COVID-19 and wet season conditions restricting site access.

The baseline ambient air quality monitoring program concluded the following (SLR 2021a):

- The maximum measured 24-hour average PM_{10} concentration was 62 µg/m^3 in December 2019, which is below the adopted project criterion of 70 µg/m^3;
- The measured dust deposition rates were highest during the start of the wet season, with an average baseline dust deposition rate recorded over the three monitoring locations of 2.1 g/m^2/month (November 2019 to January 2020);
- High PM_{10} concentrations were identified under all wind directions – i.e., there was no correlation between PM_{10} concentration and windspeed or wind direction;
- Both PM_{10} concentrations and dust deposition rates were higher during the wet seasons than during the dry seasons; and

- No significant change in PM_{10} concentrations or dust deposition rates was evident between monitoring years.

The Pilbara is a naturally dusty environment with wind-blown dust being a significant contributor to the airborne dust levels. In 2000, Sinclair Knight Merz (SKM) was commissioned by the then WA Department of Environmental Protection (DEP) to prepare an Aggregated Emissions Inventory of National Pollutant Inventory (NPI) substances for the Pilbara Airshed for the NPI Database for the 1999 to 2000 financial year (SKM 2003). The study calculated that approximately 170,000 tonnes of dust were emitted because of wind erosion from open bare areas. The open bare areas were associated with eroded land on alluvial plains where over grazing and a run of poor seasons had exposed the soil. Where overgrazing had occurred on soils with little stony mantle for protection from wind erosion, severe erosion had occurred with soil loss due to wind action.

Figure 13-1: Air Quality Monitoring Locations

640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000

7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000

Unit C Dust Deposition Gauge

Unit D Dust Deposition Gauge and eBam

Unit E Dust Deposition Gauge

Wittenoom Asbestos Management Area (WAMA)

Karijini North

GREAT NORTHERN HWY

MUNJINA RD

Legend

- Development Envelope
- Indicative Footprint
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)
- Air Quality Monitoring Sites
- Mulga Downs Exploration Camp (LGATE-013)
- Mulga Downs Homestead (LGATE-013)
- Automatic Weather Station (DPIRD-075)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 22-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:160,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

AIR QUALITY MONITORING LOCATIONS

FIGURE 13.1

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

13.3.4 Soils

As outlined in **Section** 3.10**3.10**, the most extensive soils within the region comprise shallow stony soils on hills and ranges and sand on the sandplains (Landloch 2009, Mine Earth 2021). The dominant soil groups occurring across the Development Envelope (Mine Earth 2021) are:

- Stony soils;
- Red shallow loams;
- Red loamy earths;
- Calcareous shallow loams; and
- Red-brown hardpan shallow loams.

Following heavy rainfall, red brown soils of the Pilbara can develop a hard surface crust, which can reduce the impact of wind erosion; however, disturbance of this crust through ground disturbance combined with low level rainfall can place these areas at risk of wind erosion, resulting in increased levels of airborne dust locally.

13.3.5 Geology

As discussed in **Section 3.93.9**, the bedrock within the Development Envelope comprises rocks of the Hamersley and Fortescue Groups. The Jeerinah Formation (Fortescue Group) and Marra Mamba Iron Formation outcrop in the Chichester Range on the northern side of the Fortescue Valley. The Wittenoom Formation subcrops beneath the valley floor and is overlain by the Brockman Iron Formation, which is a banded iron formation (BIF) within the Hamersley Range to the south. Tertiary deposits that infill the valley, collectively known as 'detrital', comprise alluvium, colluvium (both with varying degrees of iron cementation), pisolite, clay and calcrete. There is also lateritic hard cap development of Tertiary age on basement rocks that may be ferricrete (goethite) and calcrete/silcrete.

Asbestiform minerals are widely distributed in Western Australia, and amphibole and serpentine minerals are significant components of mafic and ultramafic rocks in the State's "greenstone belts". In the Pilbara, amphibole minerals may be encountered in the Brockman Iron Formation of the Hamersley Basin (DMP 2023). More specifically, crocidolite (the source of "blue" asbestos) is typically associated with the Dales Gorge Member of the Brockman Iron Formation (Grubb 1971). A thin (5 mm) band of crocidolite has also previously been identified in the Marra Mamba Iron Formation in the western Fortescue Valley (Barnett & Commander 1986).

Waste rock characterisation for the Proposal concluded that the mineralisation is primarily associated with the Nammuldi Member of the Marra Mamba Formation (that outcrops along the lower flanks of the Chichester Range), although there is also mineralisation in the overlying Tertiary detrital deposits.

As the ore body is located within the Marra Mamba Iron formation outcrop to the north of the Lower Fortescue River Valley, where the Brockman Iron Formation is absent, intersection of natural asbestiform minerals onsite (i.e., within the Brockman Iron Formation) during mining operation is low.

13.3.6 Hydrology

A comprehensive review of the hydrology of the Development Envelope is provided in **Section 3.113.11**. Surface water forms a potential pathway for asbestiform materials to be dispersed within the Development Envelope and to the wider surrounding area.

13.3.7 Historic Anthropogenic Activities

Asbestos Containing Materials are present in limited site structures within the Development Envelope as discussed in **Section 11.3.5**. Planning for the Proposal identified the potential for natural asbestiform minerals and anthropogenic ACM to be present within the Development Envelope, based on the proximity of the Development Envelope to the Wittenoom Asbestos Management Area (WAMA) (**Figure 13-1**).

Primary sources of ACM are from the known registered contaminated areas outside of the Development Envelope and surrounds. Secondary sources are from anthropogenic activities within the Development Envelope, including use of ACM within anthropogenic built forms (other than those already recorded as registered contaminated sites), and from miscellaneous historical dumping of ACM tailings.

13.3.8 Receptors

Receptors that have the potential to be impacted by reduced air quality (as shown in **Figure 14-2**:) include:

- Youngaleena and Wirrilimarra Aboriginal communities located 15 km south and 7 km southwest of the Development Envelope, respectively;
- Yandeyarra Reserve, located approximately 8 km to the north of the Development Envelope (6 km north of the Northern Access Road at Great Northern Highway);
- Karijini National Park – the northern boundary of the National Park is located approximately 16 km to the south of the Development Envelope;
- The Mungaroona Range Nature Reserve is approximately 13 km to the north of the Development Envelope;The eastern extent of the Development Envelope abuts Great Northern Highway, and the intersection of the Wittenoom-Mujina Road is approximately 20 km south.
- The Fortescue Valley which comprises a network of interconnected ephemeral swamps, claypans and floodplains (Goodiadarrie Swamp);
- The Koodjeepindarranna and Gnalka Gnoona claypans are a major hydrological feature located outside the Development Envelope. They are considered significant habitats for migratory and local birds and invertebrate species during inundation;
- Vegetation, and flora and fauna species within and surrounding the Development Envelope; and
- Heritage sites or potential places of cultural significance, including the lodged site ‘Mungurrdu’ located to the south of the Development Envelope.

13.4 Potential Impacts

An assessment of the potential impacts of the Proposal on air quality values in consideration of the EPA’s objective is provided below. Relevant assessment criteria are also provided.

13.4.1 Direct Impacts

13.4.1.1 Volatile Emissions and Airborne Particulates (Dust)

Construction and operation of the Proposal have the potential to generate volatile emissions (including NO_x and SO_x) through the combustion of diesel for electricity generation, operation of mobile plant and vehicles, and from explosives.

There are a number of activities associated with construction and operation of the Proposal which may give rise to dust emissions, including:

- Clearing of vegetation, removal and stockpiling;
- Wind erosion and dust lift off from stockpiles and unsealed surfaces;
- Heavy plant, haul trucks and light vehicle movements on unsealed surfaces causing disturbance of surface and suspension of fine particles in the air;
- Dust generated by surface disturbance during plant movement, blasting, movement of materials, and tipping of ore from trucks (i.e., fine material from within trucks or fine material disturbed from receiving surface); and
- Particulates emitted to air from the combustion of diesel for electricity generation, operation of mobile plant and vehicles, and from explosives (emissions are predicted to be negligible in the context of the remote location of the Proposal).

Airborne dust (PM_{10}) emissions can impact human health and result in amenity impacts or impacts on ecological or social values through deposition and inhalation pathways.

13.4.1.2 Asbestiform Minerals and Asbestos Containing Material

Asbestiform minerals and ACM may occur within the Development Envelope through the geological and hydrological pathways identified in **Section 33.11** above. These have the potential to be uncovered through activities associated with the Proposal and transported through air, impacting air quality within the Development Envelope and surrounding area. Sources of airborne asbestos with the potential to be carried by the wind to off-site receptors due to Proposal activities include:

- Site exploration and drilling - unintended surfacing of natural asbestiform minerals within the Brockman Iron Formation;
- Demolition and maintenance of existing structures - disturbance of ACM building materials within ancillary structures such as tank stands and bore infrastructure, and in the classified asbestos-contaminated area (registered ID 7303) associated with the former Mulga Downs homestead (JBS&G 2023); and
- Movement of material that was historically illegally dumped - disturbance of ACM historically imported into the Development Envelope, including as a construction base for new infrastructure or as dumped waste.

13.4.2 Indirect Impacts

Changes in air quality due to dust emissions have the potential to indirectly impact flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings.

Deposited dust may indirectly impact the health of vegetation, flora and fauna habitat within the Development Envelope. Detrimental effects on the health of the vegetation may potentially occur in susceptible species because of smothering the physiological processes of the plants. Similarly, deposited dust may impact the amenity of Aboriginal heritage areas.

13.4.3 Cumulative Impacts

HPPL will implement dust management measures to reduce dust emissions and subsequent deposition, throughout the Development Envelope over the life of mine. The Proposal may result in a minor, temporary increase in localised dust. Given proximity, cumulative dust emissions may arise from the Murray's Hill and Mulga Downs Hub and Rail projects located in the immediate vicinity of the Proposal.

The cumulative impacts associated with air quality during the construction and operation of the Proposal and other projects are discussed in more detail in **Section 17**.

13.5 Mitigation Measures

The hierarchy of impact management has been adopted and implemented for the Proposal by HPPL in relation to this environmental factor as outlined in **Table 13-3**.

Table 13-3: Mitigation Measures

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Direct Impacts			
Air quality impacts may occur due to volatile emission and fugitive dust (PM_{10}) emissions resulting from the following Proposal.	• Complete avoidance of volatile emissions and dust is not possible.	• Standard dust management measures will be utilised to minimise dust emissions, including: ○ Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; ○ Vehicle speeds limit on haul roads, work areas and campsites will be imposed and enforced where necessary to minimise dust emissions; ○ No vegetation clearing and earthworks during wind speed greater than 50 km/hr; and ○ Clearing activities will be staged to minimise areas of exposed surfaces. • Induction and education of the workforce and contractors with respect to dust minimisation.	• Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities. • Any dust complaints received will be reported to HPPL and entered into the incident management system.
Emissions of asbestos to air due to the presence of potential sources of airborne asbestos fibre.	• Asbestos contaminated areas will be clearly demarcated and access restricted. • Known asbestos contaminated area (abandoned infrastructure area) has been excised from DE, and access to site structure containing ACM will be restricted	• Adherence to the AMP (**Appendix 17**).	• If ACM is found onsite during construction and operation, it will be remediated as per AMP; • Asbestos management will be subject to monitoring through the AMP.

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Indirect Impacts			
Changes in air quality due to dust emissions have the potential to indirectly impact flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings.	• Complete avoidance of dust is not possible.	• Standard dust management measures will be utilised to minimise dust emissions, including: ○ Dust suppression techniques (e.g., water trucks) used on unsealed roads and access tracks, cleared areas and at locations of high dust risk; ○ Vehicle speeds on haul roads, work and campsites shall be reduced where necessary to minimise dust emissions; ○ No vegetation clearing and earthworks during winds greater than 50 km/hr; and ○ Clearing activities will be staged to minimise areas of exposed surfaces. • Induction and education of the workforce and contractors with respect to dust minimisation.	• Progressive rehabilitation as areas become available. • Dust monitoring at the Wirrilimarra and Youngaleena Communities. • Any dust complaints received will be reported to HPPL and entered into the incident management system.

13.6 Assessment and Significance of Residual Impact

An assessment of the significance of residual impacts to air quality as a result of the Proposal is addressed in this section.

13.6.1 Direct Impacts

13.6.1.1 Volatile Emissions and Airborne Particulates (Dust)

Volatile emissions (including NO_x and SO_x) generated from the Proposal are expected to have negligible impact on air quality.

Assessment Criteria – PM_{10}

The *National Environment Protection Council (NEPC) (Commonwealth) Act 1994* established the NEPC, which determines and evaluates NEPMs for the nation. The *National Environment Protection Council (Western Australia) Act 1996* is a mirror legislation of the commonwealth act and implements the NEPMs in Western Australia.

Air quality criteria are derived from the Air NEPM, which provides air quality standards applicable to urban airsheds, including criteria for particles such as PM_{10}. In Western Australia, the Air NEPM criteria are applied to sensitive receptors, defined as residences, hospitals, schools and other places where people may congregate, including sporting and recreational venues. The remoteness, low population and the high ambient dust levels within the Development Envelope and surrounds mean that these criteria are not directly applicable to the Proposal.

Although DWER does not have generic PM_{10} criteria applicable to remote mining operations, it has previously accepted that the Air NEPM PM_{10} standard cannot be met in the Pilbara region, recognising that its arid climate between June and November and areas of low vegetative cover can lead to periodic dust events caused by wind erosion of exposed surfaces.

The Port Hedland Dust Management Taskforce, established to plan for and coordinate dust management in the town, recommended an air guideline value (AGV) for PM_{10} of 70 µg/m^3 averaged over 24 hours. The AGV was based on the recommendations of a report commissioned by the Department of Health (Lung Institute of Western Australia Inc and Institute of Occupational Medicine 2007). The Western Australian Government has endorsed the AGV for residential areas of Port Hedland, and the value has been used to assess other mining Proposals in the Pilbara region.

Assessment Criteria - Dust Deposition

Without a Western Australian-specific guideline for deposited dust rates, guidelines from other state regulations have been sought. The New South Wales EPA has a dust assessment criteria of 4 g/m^2/month, with a maximum allowable increase of 2 g/m^2/month (NSW EPA 2022). These criteria are based on the outcomes of a study of

community perception of coal dust impacts and are frequently adopted as informal assessment criteria in the absence of other guidance. These criteria have been adopted for this assessment.

13.6.1.2 Expected Impacts

The ambient air quality monitoring program established a baseline for the Proposal. The monitoring determined an average dust deposition rate recorded over the three monitoring locations of 2.1 g/m^2/month. This background level would result in the adopted Proposal criteria of 4 g/m^2/month including background and 2 g/m^2/month excluding background being approximately equivalent. In addition, the ambient air quality monitoring program concluded that measured PM_{10} concentrations were below the adopted assessment criteria of 70 $\mu g/m^3$.

Given the large separation distances to residential receptors (the closest being the Wirrilimarra Community 7 km east of the Development Envelope), there are no sensitive human receptors with the potential to experience health or amenity impacts attributable to fugitive dust emissions carried in the air from the Proposal. In addition, winds are predominantly from the east and south-southwest, and both the Wirrilimarra Community and Youngaleena Community are located south of the Development Envelope; so both communities are located in upwind locations.

Dust may also interfere with the physiological processes of vegetation. However, the semi-arid environment of the Pilbara region is a naturally dusty environment, with wind-blown dust a significant contributor to ambient particulate levels in the region; hence, native vegetation is expected to be reasonably tolerant to dust deposition. Studies undertaken for Rio Tinto (Butler 2009) suggest that the potential for adverse dust deposition impacts on plants is seasonally related. The study failed to identify any significant loss of plant function for exposures of Pilbara species to deposited crustal dust loadings on plant leaves of up to 7,500 g/m^2. Another study by Matsuki et al. (2016) found no evidence of negative impacts on plant health from dust deposition in semi-arid environments.

13.6.1.3 Asbestiform Minerals and Asbestos Containing Material

The PESA concluded that there is a low risk of asbestos from existing structures, ground contamination (in-situ or from erosional deposition) or unexpected finds causing human health impacts at receptors through an inhalation pathway. Following implementation of mitigation measures the residual impact is considered low.

13.6.2 Indirect impacts

The significance of indirect air quality impacts to flora and vegetation, terrestrial fauna, terrestrial environmental quality and social surroundings are discussed in **Sections 9, 10, 11** and **14**, respectively**.**

13.7 Significant Residual Impact

Overall, the assessment of potential air emissions impacts indicates that the EPA's objective for Air Quality can be met and that there will be no significant residual adverse impacts from the Proposal. In addition,

consideration of other statutory decision-making processes (**Section 4.6**) determined that DWER can manage the potential air quality impacts of the Proposal under Part V of the EP Act and the CS Act to ensure that the environmental outcomes in **Section 13.8** are achieved.

Given that no significant residual impacts are predicted for this environmental factor, HPPL considers that the Proposal can be managed to meet the EPA's objective for Air Quality.

13.8 Environmental Outcome

The outcomes of the assessment of potential impacts and proposed mitigation measures to reduce air quality impacts as a result of the Proposal meet the EPA's objective for this environmental factor. The predicted environmental outcomes are outlined in **Table 13-4**.

Table 13-4: Air Emissions Environmental Outcomes

Potential impact	Environmental Outcome
Dust (PM_{10} concentration or dust deposition)	No significant changes to ambient air quality (PM_{10} concentration or dust deposition) at sensitive receptor locations due to the implementation of the Proposal.
Volatile emissions	Negligible.
ACM and asbestiform minerals	Low risk of activities associated with the Proposal causing disturbance to ACM and asbestiform minerals within the Development Envelope and subsequent human health impacts on receptors.

14 Social Surroundings

14.1 EPA Objective

The EPA's objective for the environmental factor Social Surroundings is:

"to protect social surroundings from significant harm" (EPA 2023d).

Social Surroundings is defined in the EP Act as follows:

"In the case of humans, the reference to social surroundings in the definition of environment in subsection (1), is a reference to aesthetic, cultural, economic and other social surroundings to the extent to which they directly affect or are affected by physical or biological surroundings (section 3(2))."

14.2 Policy and Guidance

In addition to the legislation, policy and guidance outlined in **Section 4.1**, specific legislation, policy and guidance relevant to the social surroundings factor that has informed planning for the Proposal is summarised in **Table 14-1**.

HPPL has specifically considered this information for the social surroundings factor as described in **Table 14-1**, which includes:

- Description of the receiving environment and its significance in analyses undertaken to-date and proposed analyses;
- Identification of activities which may lead to impacts on social surroundings; and
- Application of the mitigation hierarchy in elements of Proposal design for potential impacts on social surroundings.

Table 14-1: Social Surroundings Policy and Guidance

References	Title	How Policy/Guidance has been considered
EPA 2023d	Statement of environmental principles, factors, objectives and aims of EIA	Referenced in completion of all aspects of environmental impact assessment.
EPA 2023c	Environmental Factor Guideline: Social Surroundings	Considered in the design (methods and approach) of the social surroundings surveys/ consultation.
EPA 2023e	Technical Guidance: Environmental impact assessment of Social Surroundings – Aboriginal cultural heritage	Considered in the impact assessment for social surroundings.
EPA 2004	Guidance Statement for the Assessment of Aboriginal heritage; No. 41	
DPLH 2023	Aboriginal Heritage Act 1972 Guidelines	
DWER 2021d	Draft Guideline: Assessment of environmental noise emissions	

References	Title	How Policy/Guidance has been considered
DWER 2021e	Draft Guideline: Dust emissions	

Other policy and guidance that are relevant for social surroundings is outlined in **Table 14-2**, including descriptions of how the policy and guidance was considered.

Table 14-2: Other Policy and Guidance

Author	Title	How Policy/Guidance has been considered
EPA 2024a	Instructions: How to prepare and environmental review document	Considered in the development of this ERD.
EPA 2021	Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual	
EPA 2024b	Instructions: How to prepare *Environmental Protection Act 1986* Part IV environmental management plans	Considered in the development of this ERD and for environmental management plans.
DCCEEW 2023	Interim Engaging with First Nations People and Communities on Assessments and Approvals under the Environment Protection and Biodiversity Conservation Act 1999	Considered during engagement with Traditional Owners and the development of this ERD.
DAA & DPC 2013	Aboriginal Heritage Due Diligence Guidelines.	
DMIRS 2023a	Mine Closure Plan Guidance – How to Prepare in Accordance with Part 1 of the *Statutory Guidelines for Mine Closure Plans.*	Considered in the development of this ERD and for the MCP (**Appendix 3**).
DMIRS 2023b	Statutory Guidelines for Mine Closure Plans	
IAP2 Federation. 2015.	Quality Assurance Standard for Community and Stakeholder Engagement	

Specific additional work required for assessment of the Proposal, relating to the environmental factor Social Surroundings, was provided in the ESD which was approved by the EPA on the 24 August 2022. These additional requirements (as outlined in **Table ES 4**) are considered in this section.

14.2.1 Native Title Act 1993

The *Native Title Act 1993* (Cth) recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters, according to their traditional laws and customs.

The Proposal is located within the Banjima native title determination area (**Figure 14-1**). The Banjima Traditional Owners hold native title rights and interests over approximately 10,185 km^2 as determined by the Federal Court in WAD6096/1998. The Banjima Traditional Owners are represented by the Banjima Native Title Aboriginal Corporation RNTBC (**BNTAC**).

A heritage agreement is in place between HPPL and the Banjima People. HPPL is in the process of negotiating a native title agreement with BNTAC, which will cover the implementation of the Proposal as it impacts the Banjima native title determination area. The negotiation process has timeframes inbuilt for BNTAC to consult with affected native title holders as required by the *Native Title (Prescribed Body Corporate) Regulations 1999* (Cth). Ongoing consultation will continue throughout the life of the Proposal through the implementation of the proposed Project Agreement (refer to **Section 5.2.2;**).

14.2.2 Aboriginal Heritage Act 1972

The AH Act sets out a framework for the management of Aboriginal heritage in Western Australia. The AH Act protects and manages Aboriginal heritage by requiring approval for activities that may impact or cause harm to an Aboriginal heritage site. HPPL is committed to the protection of Aboriginal cultural heritage and compliance with the AH Act.

Figure 14-1: Traditional Owner Native Title Determination Area

635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000 700000

7580000 7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000

YINDJIBARNDI PEOPLE

KARIYARRA PEOPLE

GREAT NORTHERN HWY

NANUTARRA RD

MUNJINA RD

BANJIMA PEOPLE

Legend

- Development Envelope
- Indicative Footprint

Native Title Determination (LGATE-066)

- Banjima People
- Kariyarra People
- Yindjibarndi People
- Highway
- Major road
- Minor Road

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 08-Oct-2024
Drawn By: droberts	Checked By: VC

Scale 1:200,000 at A3

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Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

TRADITIONAL OWNER NATIVE TITLE DETERMINATION AREAS

FIGURE 14.1

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Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

14.3 Receiving Environment

Defining the values of the receiving environment in terms of Social Surroundings necessitates consultation with the Banjima Traditional Owners, who have a long-standing relationship with Banjima Country that is woven into their social and cultural frameworks. Other relevant stakeholders (as listed in Section 14.3.3) have also been consulted. The receiving environment has environmental values that are largely consistent with the environmental values framework used by the EPA to evaluate the impacts and acceptability of Proposals. Social surroundings consultation is used to identify values and uses of the land beyond the generally expected environmental values assessed in other sections of this ERD.

14.3.1 Relevant Studies

A summary of the surveys and studies undertaken for the Proposal to support the understanding Social Surroundings aspects of the receiving environment, potential impacts and management is provided in **Table 14-3**. The assessment of potential impacts to Social Surroundings as a result of the Proposal draws on information from these reports**.**

Table 14-3: Social Surroundings Surveys and Studies

Reference	Report	Description	Guidance / Methodology
Ongoing – Baseline Dust and Noise Sampling at Youngaleena and Wirrilimarra Communities	N/A – Ongoing for 12-month monitoring period	Unattended background noise monitoring is currently being conducted at one location within the Youngaleena Community. which commenced in August 2024 and will continue until August 2025. This noise monitoring is being undertaken to provide an indication of the existing noise environment before any earthworks / construction activities for the Proposal commence. Data collection for baseline dust includes continuous monitoring of PM10 concentrations using a beta attenuation monitor and monthly monitoring of dust deposition rates in terms of grams of dust per month (mg/m^2/month).	Australian Standard 1055. *National Environmental Protection Council Act 1994* (NEPC Act; Cth) National Environment Protection (Ambient Air Quality) Measure (1998, as amended 2021) (National Environmental Protection Council 1994) NEPC Act National Environment Protection (National Pollutant Inventory) Measure (1998, as amended 2008) (National Environmental Protection Council 1994) Air Quality Modelling Guidance Notes (WA Department of Environment 2006) Guideline for managing the impacts of dust and associated contaminants from land development sites remediation and other related activities (WA Department of Environment and Conservation 2011) Environmental Factor Guideline: Air Quality (EPA 2020d) Guideline: Management of diesel emissions in Western Australian mining operations (Department of Mines and Petroleum 2013) Guideline: Management of noise in Western Australian mining operations (Department of Mines and Petroleum 2014)
Aboriginal Cultural Heritage Management (ACHM) 2024 **Appendix 25** **Section 14.3.4.2**	Report of an ethnobotanical survey of Mulga Downs Iron Ore Mine & Hub and Rail Spur	An assessment of flora within the Development Envelope that may be of cultural value to the Banjima People. The assessment included desktop and on-ground survey components.	Not applicable.

Reference	Report	Description	Guidance / Methodology
ACHM 2007- Ongoing **Section 14.3.4**	Archaeological Surveys (64) Ethnographical Surveys (6)	Archaeological surveys (site avoidance and site identification) have been ongoing at Mulga Downs since 2007 to support activities undertaken in this area. Heritage surveys are undertaken collaboratively with respective Traditional Owners. To date, 85% of the Development Envelope has been archaeologically surveyed to site avoidance level and 95% of known ACH within the Indicative Footprint has been surveyed to site identification level. 100% of the Development Envelope has been ethnographically surveyed. The remaining 15% of the Development Envelope will be surveyed for archaeological site avoidance in 2025, and prior to any construction works being undertaken. The results of the surveys undertaken to-date have informed the Proposal design, with amendments being made from the original referral to reduce impacts (**Table 14-7**, **Section 14.5**). The results of future surveys will continue to inform the detailed design of the Proposal, with the focus being to avoid and then minimise impacts to identified sites of heritage significance. These surveys will also inform the required approvals under the AH Act.	Conduct surveys sufficient to determine if an area meets the requirements of a Heritage Site as defined by Section 5 of the AH Act.
LGA 2024 **Appendix 27** **Section 14.6.2.2**	Noise and Vibration Assessment	An assessment of the potential noise and vibration impacts from the Proposal on surrounding noise sensitive receptors including the Youngaleena and Wirrilimarra Communities, heritage sites and bat caves.	Environmental Protection (Noise) Regulations 1997
Ecoscape 2024 **Appendix 21** **Section 14.6.1**	Visual Impact Assessment	Ecoscape undertook a Visual Impact Assessment (VIA) to support assessment of the Proposal based on analysis of seven representative viewpoints and associated photomontages created through 3D modelling. The receptor types were categorised as:	Visual Landscape Planning in Western Australia 2007 Guidance Note for Landscape and Visual Assessment, Australian Institute of Landscape Architects, 2018 provides guidance aimed at landscape architects which sets out minimum requirements and an accepted set of assessment methods;

Reference	Report	Description	Guidance / Methodology
		Culturally significant: including Aboriginal meeting places and culturally significant locations; **Residential:** including communities and camps; **Tourism:** including tourist facilities, attraction, hiking trails and accessible vantage points; and **Transient:** including roads and railways.	Guidelines for Landscape and Visual Impact Assessment (GLVIA), Third Edition (2013) prepared by the Landscape Institute and Institute of Environmental Management and Assessment. These guidelines provides detailed advice on the process of assessing the landscape and visual effects of developments and their significance, as well as cumulative effects
SLR 2021b **Appendix 19** **Section 14.4.3.2**	Ambient Noise Monitoring Program	Unattended background noise monitoring was conducted between May 2019 to February 2021 at two representative locations around the Development Envelope to provide an indication of the existing noise environment before any earthworks / construction activities commenced.	Australian Standard 1055.
SLR 2021 **Appendix 18** **Section 13.3.3**	Ambient Air Quality Monitoring Program	An ambient air quality monitoring program (from May 2019 to February 2021) was undertaken to address the lack of publicly available representative air quality monitoring data relevant to the location. SLR was engaged to undertake ambient air quality monitoring around the Mulga East proposed tenement, including continuous monitoring of PM10 concentrations at one location using a beta attenuation monitor and monthly monitoring of dust deposition rates in terms of grams of dust per month (mg/m2/month). .	*National Environmental Protection Council Act 1994* (NEPC Act; Cth) National Environment Protection (Ambient Air Quality) Measure (1998, as amended 2021) (National Environmental Protection Council 1994) NEPC Act National Environment Protection (National Pollutant Inventory) Measure (1998, as amended 2008) (National Environmental Protection Council 1994) Air Quality Modelling Guidance Notes (WA Department of Environment 2006) Guideline for managing the impacts of dust and associated contaminants from land development sites remediation and other related activities (WA Department of Environment 2011) Environmental Factor Guideline: Air Quality (EPA 2020) Guideline: Management of diesel emissions in Western Australian mining operations (Department of Mines and Petroleum 2013)

Reference	Report	Description	Guidance / Methodology
			Guideline: Management of noise in Western Australian mining operations (Department of Mines and Petroleum 2014)
PSM 2024 **Appendix 28 Section 14.6.2.2**	Geotechnical Assessment of Caves	PSM (2024) was engaged to undertake geotechnical assessments of caves located within the Development Envelope and in close proximity to the northern extent of Fridge Hill pit, to understand potential impacts of the Proposal as a result of blasting and operational vibration	NA
AQ2 2024a **(Appendix 4) Section 7**	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies – Baseline Assessment (171X_492a)	Baseline groundwater, surface water and ecohydrological studies, to support the environmental assessment of the Project. This report details all baseline and conceptualisation work undertaken from 2018 until November 2023	NA
AQ2 2024b (**Appendix 5**) **Section 7**	Mulga Downs Groundwater, Surface Water & Ecohydrological Studies - Impact Assessment (171X_493a)	This assessment provides an environmental impact assessment of the Proposal, identifying key environmental assets and water management strategies.	NA
ACHM 2024b **(Appendix 30) Section 14**	Banjima Social Surroundings Assessment 6-10 May 2024	Report summarises environmental matters raised by Banjima People during a social surrounds consultation for the Mulga Mine Proposal.	NA

14.3.1.1 Ambient Noise

Typical Noise levels of 35 to 40 dB LAeq,15min between 11am to 6pm, then reducing to 23 dB (Minima) and 29 dB (Median) at Night. Key contributors to ambient sound levels are wind behaviour and distant road traffic from Great Northern Highway, and local fauna (insects).

Ambient noise levels broadly increase in warmer months of the year:

- December to March inclusive, LAeq 30-35 dB at night, and 35-40 dB during the day.
- April to November inclusive, LAeq 20 dB at night, and 33-39 during the day.

Under specific weather conditions such as high wind or rain, ambient sounds levels often exceeded night time Assigned Noise Levels.

14.3.1.2 Ambient Dust

The findings of the baseline ambient air quality monitoring program undertaken by SLR (2021a) are discussed in **Section 13.3.3**.

14.3.2 Location and Land Use

The Proposal is located in a remote area of the Pilbara region of WA. The Development Envelope comprises an area of 16,348.53 ha, with an Indicative Footprint of 4,339.16 ha. The nearest town is Tom Price which is located approximately 110 km southwest of the Development Envelope. Port Hedland is located approximately 210 km north, whilst Newman is located approximately 180 km east.

The area within and surrounding the Proposal is dominated by low rocky hills. The location of the Development Envelope avoids topographical features such as large hills or rivers. The visual landscape of the region would generally be described as being natural in appearance with disturbance being limited to pastoral and mining land uses with sparse roads and rail lines. The land uses identified within and adjacent to the Development Envelope are:

- Cultural – the Proposal is situated on the Banjima Native Title determination area;
- Residential - local communities of Youngaleena and Wirrilimarra;
- Tourism – generally passing traffic travelling along the Great Northern Highway;
- Mining - currently no other active mines within 20 km; and
- Transient - roads and railways.

These land uses are discussed below in the context of sensitive receptors.

14.3.2.1 Sensitive Receptors

Two remote Aboriginal Communities are located within the vicinity of the Proposal. The Youngaleena Community is located approximately 15 km south of the Development Envelope, and the Wirrilimarra Community is located approximately 7 km east of the Development Envelope.

Aboriginal heritage values and cultural associations including heritage and ethnographic sites, and are discussed in further detail at 14.3.4.

Wittenoom is located approximately 5 km west of the Development Envelope but no longer has any residents, as the town was degazetted in 2007 and closed in 2013 (DPLH 2021). Wittenoom was originally established as a mining town to support the mining and production of asbestos and was closed due to the health risk. The Wittenoom Asbestos Management Area (WAMA) was established to identify the mine-affected area as a contaminated site and manage impacts from the asbestos contamination.

The Yandeyarra Aboriginal Reserve is located approximately 8 km north of the Development Envelope. The reserve comprises an area of 473,529 ha and is managed by the Mugarinya Community Association Incorporated.

The Development Envelope is located entirely within the boundaries of the Mulga Downs Pastoral station. The land is mainly used for pastoral activities and is also used by Traditional Owners for hunting and other culturally significant purposes. Within the Mulga Downs Pastoral Station is the Mulga Downs Homestead, located directly north of the Development Envelope (**Figure 14-2**:). The Mulga Downs Homestead is uninhabited and has been identified as a contaminated site, which has been fenced off to restrict access.

Tourism in the immediate area surrounding the Development Envelope is very limited. Accommodation is provided (motel and caravan) at the Auski Roadhouse which is located approximately 24 km to the south east of the Development Envelope at the junction of Great Northern Highway and Nanutarra-Munjina Road. Roads through the Development Envelope are associated with access to the Mulga Downs Pastoral facilities and exploration drilling and are not generally used for tourism. The nearest major tourist attraction is the Karijini National Park and the associated gorges within the park. The northern boundary of Karijini National Park is located approximately 7.6 km south of the Development Envelope.

The Mungaroona Range Nature Reserve is approximately 13 km north of the Development Envelope.

The location of the Proposal in relation to sensitive receptors is shown on **Figure 14-2**:

Figure 14-2: Land use and sensitive receptors

625000 630000 635000 640000 645000 650000 655000 660000 665000 670000 675000 680000 685000 690000 695000 700000 705000 710000

7585000 7580000 7575000 7570000 7565000 7560000 7555000 7550000 7545000 7540000 7535000 7530000 7525000

Mungaroona Range Nature Reserve

YANDEYARRA ABORIGINAL RESERVE

HOOLEY STATION

MULGA DOWNS STATION

MT FLORANCE STATION

GREAT NORTHERN HWY

KOODJEEPINDARRANNA CLAYPAN

GNALKA GNOONA CLAYPAN

NANUTARRA RD

Wirrilimarra

Youngaleena

MUNJINA RD

Karijini National Park

Auski Roadhouse

MUNJINA-ROY HILL RD

Legend

- Development Envelope
- Indicative Footprint
- Wittenoom Asbestos Management Area (WAMA) (DWER-059)
- Lodged Site - Mungurrdu or Mangurrdu (DPLH-100)
- Lodged Site - Other (DPLH-100)
- Yandeyarra Aboriginal Reserve (LGATE-227)
- Pastoral station boundaries (DPIRD-018)
- Claypans (AQ2)

Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve

Directory of Important Wetlands in Australia (DBCA-045)

- Fortescue Marshes [WA066]
- Aboriginal Communities and Town Reserves (DPLH-002)

Roads (LGATE-195)

- Highway
- Major road
- Minor Road

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Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 18-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:250,000 at A3

0 5 10
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

LAND USE AND SENSITE RECEPTORS

FIGURE 14-2

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Image Reference: World Imagery: Earthstar Geographics

14.3.3 Social Surroundings Consultation

HPPL has undertaken extensive consultation with a range of different stakeholders (Section 5), with consultation related to Social Surroundings addressed below. Social Surroundings consultation requirements were upgraded by the EPA in 2016 to include recognition of the potentially significant impacts on culture and country for Traditional Owners. This subsequently became a Key Environmental Factor for many environmental impact assessments under Part IV of the EP Act and is now industry-best practice for Traditional Owner consultation, impact identification and impact mitigation. Regarding Wirrilimarra Community, Youngaleena Community and Yandeyarra Community HPPL wishes to understand concerns of the communities relevant to the Proposal; and ensure the Proposal does not unacceptably impact these communities.

14.3.3.1 Methodology

The Banjima Traditional Owners were identified as a stakeholder as well as other communities in proximity of the Proposal. General stakeholder identification processes were used to plan the overall consultation. This identified the nearby communities and infrastructure located in close proximity to the Development Envelope.

14.3.3.2 Banjima consultation

HPPL has undertaken extensive consultation with the Banjima Traditional Owners through BNTAC since 2021, including several agreement negotiation meetings, Hancock Heritage and Environment Reference Committee (HHERC) meetings, on-country consultations, ethnobotanical surveys, heritage surveys and meetings with BNTAC's technical advisors. HPPL is in the process of negotiating a native title agreement with BNTAC, which will cover the implementation of the Proposal as it impacts the Banjima native title determination area. HPPL has been working with BNTAC to understand the potential impacts of the Proposal on Banjima country.

Consultation undertaken to date with Banjima Traditional Owners is detailed within **Section 5.**

HPPL has been consulting with Banjima in regard to:

- understand the social surroundings of the area important to the Banjima people; and
- developing a SCHMP for the Proposal.

Social Surroundings consultation undertaken to date with Banjima native title holders has incorporated:

- Introduction to Social Surroundings and the consultation process;
- Environmental approvals process;
- Introduction to the Proposal, associated infrastructure, mine planning, Indicative Footprints and closure landforms;
- Overview of Environmental and Heritage studies, monitoring and surveys completed;
- Flora and fauna management;
- Technical presentation/discussion: Hydrogeology, groundwater management and downstream risks;
- Water transfer infrastructure;
- Closure planning;

- Waste rock characterisation;
- Technical presentation/discussion: Waste characterisation;
- Surface water and potential impacts on pools/claypans;
- Airport operation and potential associated noise;
- Cumulative impacts to country; and
- Outline of the use of an SCHMP to define ongoing management and consultation of issues of significance to Traditional Owners that require ongoing management and communications throughout implementation of the Proposal.

Through this consultation, the Banjima People have been provided the opportunity to voice any potential concerns they may have and have been able to work with HPPL to identify suitable mitigation and management measures, which are summarised in **Section 14.4.1**.

The on-country consultation sessions were arranged to provide on-ground access with a separate helicopter overview opportunity provided in one of the sessions. Banjima only sessions during the on-country consultation sessions were convened as required. Accommodation was provided at the nearby Auski Roadhouse (Auski).

The itinerary for each day was planned to be flexible to consider and accommodate requests to visit certain places, with consideration for meal and comfort stops.

BNTAC staff and consultants helped to facilitate the discussion sessions and to record the outcomes of the consultation. The consultation records are provided in the ACHM Social Surroundings Assessment 6-10 May 2024 (**Appendix 30**).

HPPL is committed to ongoing consultation and engagement with the Banjima native title holders in relation to the Proposal, including ethnographic and archaeological surveys to identify Aboriginal heritage sites and other places associated with traditional customs linked to the environment. HPPL is committed to ensuring that through all stages of the Proposal (exploration, pre-feasibility studies, design, construction, operation, rehabilitation and closure) important social surroundings factors as defined by the Banjima People are protected and managed appropriately.

Where HPPL identifies any knowledge gaps, targeted engagement with the Banjima People will be sought to further investigate how the Proposal will impact the environment in relation to areas of cultural importance, and to ensure appropriate management of any risks associated with construction and operation.

14.3.3.3 Yindjibarndi consultation

HPPL initiated consultation with the Yindjibarndi People at commencement of the Social Surroundings consultation - on the basis that the MDIOP would need to dispose of excess water via Managed Aquifer Recharge (MAR). Subsequent downsizing of the mining operations and further investigations resulted in the Mulga West Borefield being removed from the Proposal and the Development Envelope in December 2023 (refer to **Section 2.3**). Although the Proposal no longer directly impacts Yindjibarndi Country, HPPL will continue to consult with the Yindjibarndi People regarding any potential indirect impacts of the Proposal on Yindjibarndi Country.

14.3.3.4 Youngaleena Community consultation

HPPL has commenced consultation with the Youngaleena Community, with the first meeting held on 13 May 2024 at Youngaleena. During this meeting an overview of the Proposal was provided along with the proposed timeframes for environmental approvals. In addition, proposed management was discussed including dust, noise, water and visual amenity aspects.

The outcome of the consultation has allowed HPPL to set up and install dust and noise monitors to gather baseline data and enabled the collection of water depth and quality samples from the Community. The VIA has also been updated to include potential impacts to visual amenity at the Community as a result of the Proposal (**Section 14.4.3**).

It is intended that consultation with the Youngaleena Community will be ongoing throughout the Proposal lifecycle. HPPL also intend to monitor at the Community for any potential impacts as a result of dust, noise or altered hydrogeological regimes throughout construction and operation of the Proposal.

14.3.3.5 Wirrilimarra Community consultation

HPPL has commenced engaging with the Wirrilimarra Community, through BNTAC as an intermediary, regarding the Proposal. Feedback has been received in relation to the Proposal's impact on the Wirrilimarra community both formally and informally through BNTAC members. Consultation with Wirrilimarra Community will be ongoing throughout the Proposal lifecycle. HPPL also intend to request permission to monitor at the Community for any potential impacts as a result of indirect impacts such as dust or noise throughout construction and operation of the Proposal.

14.3.3.6 Yandeyarra Aboriginal Reserve consultation

HPPL has ongoing consultation with the residents of the Yandeyarra Reserve, through the Mugarinya Community Association (MCA), and has met regularly with the MCA Board. HPPL continues to consult with MCA in regard to access to the Yandeyarra Reserve, including in relation to any access permits as required.

14.3.3.7 Consultation Outcomes

Key issues and outcomes identified during consultation with the Banjima Traditional Owners are outlined below and are addressed throughout this chapter. Hancock is committed to ongoing consultation with the Banjima People.

Water

Water was identified as a key focal area for Banjima Traditional Owners. Both groundwater and surface water were raised, as well as responsible use of water and concern about the location and extent of MAR required for the Proposal.

Potential indirect impacts to the DPLH lodged Mungurrdu heritage (40484) site through altered hydrological and hydrogeological processes were also raised.

There are two culturally significant pools (claypans) located 3-4 km south of the Development Envelope, Koodjeepindarranna (also referred to as Koodjeepindarrnna) and Gnalka Gnoona (also referred to as Ngarlganoona). These sites have been identified through heritage surveys as significant sites for the Banjima People. The Koodjeepindarrnna and Ngarlganoona claypans are not located within the Development Envelope; however, they may be considered proximal.

The Ngarlganoona Claypan can form into an extensive (> 1,000 ha) waterbody which may persist for extended periods. There are records of these claypans being inundated for several years following continuous favourable climate sequences.

Fortescue Valley

HPPL understands through consultation that the Fortescue Valley, including the surface water and groundwater resources that feed into and support this landscape feature, are culturally significant for the Banjima People.

HPPL has undertaken comprehensive site investigations for groundwater, surface water and ecology to understand baseline conditions, eco-hydrological relationships, and impact pathways associated with the Project (**Section 7**). A key objective in developing water management strategies for the Proposal is minimisation of change to baseline conditions. Surface water and groundwater modelling have been developed to simulate surface water and groundwater management strategies and quantify changes (see **Section 7** and **Section 14.5** for more detail on the management strategies).

Development of a SCHMP

An SCHMP will be developed to address the management of residual impacts on Social Surroundings as they may impact differently over the life of mine, and as is the case with Mine Closure, require ongoing consultation and management. The SCHMP for this Proposal will focus on the social cultural impacts from the Proposal and will be a separate document to the Cultural Heritage Management Plan (CHMP) which is the primary document to support management of Aboriginal Heritage. The CHMP will be prepared to support management and approval under the AH Act.

BNTAC and the Banjima People will have the opportunity to provide input through the development and implementation of the SCHMP. The SCHMP will outline appropriate avoidance and mitigation measures in relation to the placement of Proposal elements, culturally significant flora and fauna and a commitment to ongoing consultation throughout the life of mine.

HPPL is committed to addressing the Social Surroundings factor and ensuring that design, construction and operation of the Proposal considers important factors as defined by the Banjima native title holders, and adopts appropriate protection and management measures. Future consultation will aim to clarify key themes and values that are important to Banjima native title holders.

The outcomes of consultation with the Banjima People and other stakeholders will be formally documented in the SCHMP.

Other Consultation Outcomes

The below list is not exhaustive however other consultation outcomes included the following:

Cultural Awareness Induction Training - Banjima Traditional Owners requested input into the cultural awareness training and induction package for the Proposal.

Location of Proposal elements - Banjima Traditional Owners raised during consultation that the originally proposed airport and camp locations were in the vicinity of key cultural areas located to the west of the Development Envelope.

Amenity - Dust emissions and the impact from dust on Country (amenity) was raised as a concern by Banjima.

Contamination - The Development Envelope for the Proposal (as part of the original Referral) was located in close proximity to the WAMA. It was queried if there was any potential for the DE to be contaminated from activities at Wittenoom.

Environmental Management - Banjima have raised that environmental significance of the area in which the Proposal is situated is of high value and is considered culturally and environmentally important to the Banjima People

Cultural Heritage and Social Surroundings - The Proposal is located within an area that contains significant heritage and cultural associations. The original Proposal also included mining activities and supporting infrastructure within the DPLH lodged Mungurrdu heritage site. The original Proposal Development Envelope and footprint impacted directly on some key features that Banjima had concerns with.

Life of Proposal and Closure Planning - Closure planning and the state of the environment after decommissioning of the Proposal were raised as key aspects for the Banjima People. "What will be left for our People?"

Mine closure and Rehabilitation – Banjima have provided feedback and input into mine closure principles. Banjima People expressed concern about pit lakes left on Banjima Country at the completion of mining and how waste rock dumps will be managed.

Culturally significant flora and fauna - Impacts to culturally significant flora and fauna as a result of the Proposal are of concern to the Banjima People.

Access - Banjima have requested access to certain areas in and around the Development Envelope during Proposal operation for hunting or other activities.

Youngaleena Community - The Community is concerned regarding the potential impacts from dust, noise, water and visual impacts as a result of the Proposal on the Community.

Wirrilimarra Community – HPPL recorded concerns that the previous mine access road (referred to as the 'Fenceline Road') and the airstrip location was too close to the Wirrilimarra Community.

14.3.4 Aboriginal Heritage Values and Cultural Associations

The Proposal is located entirely within Banjima Country. HPPL commenced consultation and engagement with the Banjima Traditional Owners in 2007 - initially focused on Aboriginal Heritage surveys to support exploration activities.

14.3.4.1 Heritage Sites

The known archaeological record of the inland Pilbara region within the respective Traditional Owner Countries extend back to over 43,000 years before the present. The Banjima Traditional Owners maintain day-to-day cultural connections with the land within the Development Envelope, by means of the practice of Traditional Law and the exercise of hunting rights (ACHM 2012).

A rich cultural landscape has been identified within and surrounding the Development Envelope.

Aboriginal Cultural Heritage Inquiry System Search

The Aboriginal Cultural Heritage Inquiry System (ACHIS) maintained by the DPLH was utilised to research and determine which historical heritage survey reports and site files held by the DPLH may be relevant to the Proposal. A search of the ACHIS was undertaken within and surrounding the Development Envelope for identified Registered Sites (ethnographic and archaeological), Other Heritage Places, and the nature and frequency of previous heritage surveys.

Within the Development Envelope, there 6 'registered' sites and 134 'lodged' heritage places (**Figure 14-2**:). Of these, 5 'registered' sites and 33 'lodged' heritage places intersect the Indicative Footprint (**Figure 14-2**:).

Heritage Surveys

HPPL has surveyed the majority of the Development Envelope and surrounding area for both ethnographic and archaeological heritage sites. These surveys have been undertaken in consultation with Banjima Traditional Owners and confirmed the presence of Aboriginal cultural heritage values within the Development Envelope. **Table 14-4** outlines the survey effort completed to date within the Development Envelope and Indicative Footprint. **Table 14-5** provides a summary of the ethnographic and archaeological heritage surveys undertaken for the Proposal. Survey coverage is presented in **Figure 14-4.**

Table 14-4: Extent of on-ground heritage surveys completed to date for Banjima Traditional Owners

Development Envelop (ha)	Area Surveyed (Development Envelope – ha)		Indicative Footprint (ha)	Area Surveyed (Indicative Footprint – ha)	
	Archaeological Survey	Ethnographic Survey		Archaeological Survey	Ethnographic Survey
16,848.53	14,650	16,848	4,339.16	3,683	4,786

Table 14-5: Summary of Aboriginal heritage surveys undertaken for the Proposal

Survey Type	Years	Method	Total surveys to date
Ethnographic	2012 - 2023	Site Avoidance	6

Survey Type	Years	Method	Total surveys to date
Archaeological	2007 - Ongoing	Site Avoidance/Site identification	64

The entire Development Envelope has been subject to baseline ethnographic surveys. Within the Indicative Footprint, 85% of land has been surveyed for archaeological material - to site avoidance level, the remaining area to be surveyed includes the airstrip and the northern access road. Of the known Aboriginal cultural heritage sites within the Indicative Footprint, 95% have been recorded to site identification level. Further Archaeological site avoidance and site identification surveys are anticipated in 2025.

The heritage surveys undertaken to date have identified 303 sites of heritage value within the Development Envelope, and 41 sites of heritage value within the Indicative Footprint (refer to **Table 14-6** and **Figure 14-5**). HPPL will comply with all obligations as required under the AH Act.

Table 14-6: Sites of heritage value identified to date within the Development Envelope and Indicative Footprint

Heritage Value Type (simplified for clarity)	Development Envelope	Indicative Footprint
Artefact Scatter	235	22
Culturally Modified Tree	37	15
Rockshelter	26	4
Ethnographic	1	-
Historical	1	-
Grinding patch	3	-
Total	**303**	**41**

Koodjeepindarrnna and Ngarlganoona Pools

There are two pools located 3-4 km south of the Development Envelope, Koodjeepindarrnna and Ngarlganoona. These sites have been identified through heritage surveys with for the Banjima People. The Koodjeepindarrnna and Ngarlganoona pools are claypans that do not persistently have an expression of water and instead are seasonal. As discussed in **Section 7.3.4**, baseline studies (AQ2 2024a, b, c) on the hydrology and hydrogeology of these pools concluded that they are supported by direct rainfall and surface water flows and are not groundwater dependent. Based on consultation, their cultural significance is considered high. The Koodjeepindarrnna and Ngarlganoona pools/claypans are also habitats for migratory and local birds and invertebrate species during inundation and have cultural significance to Traditional Owners (ACHM 2024).

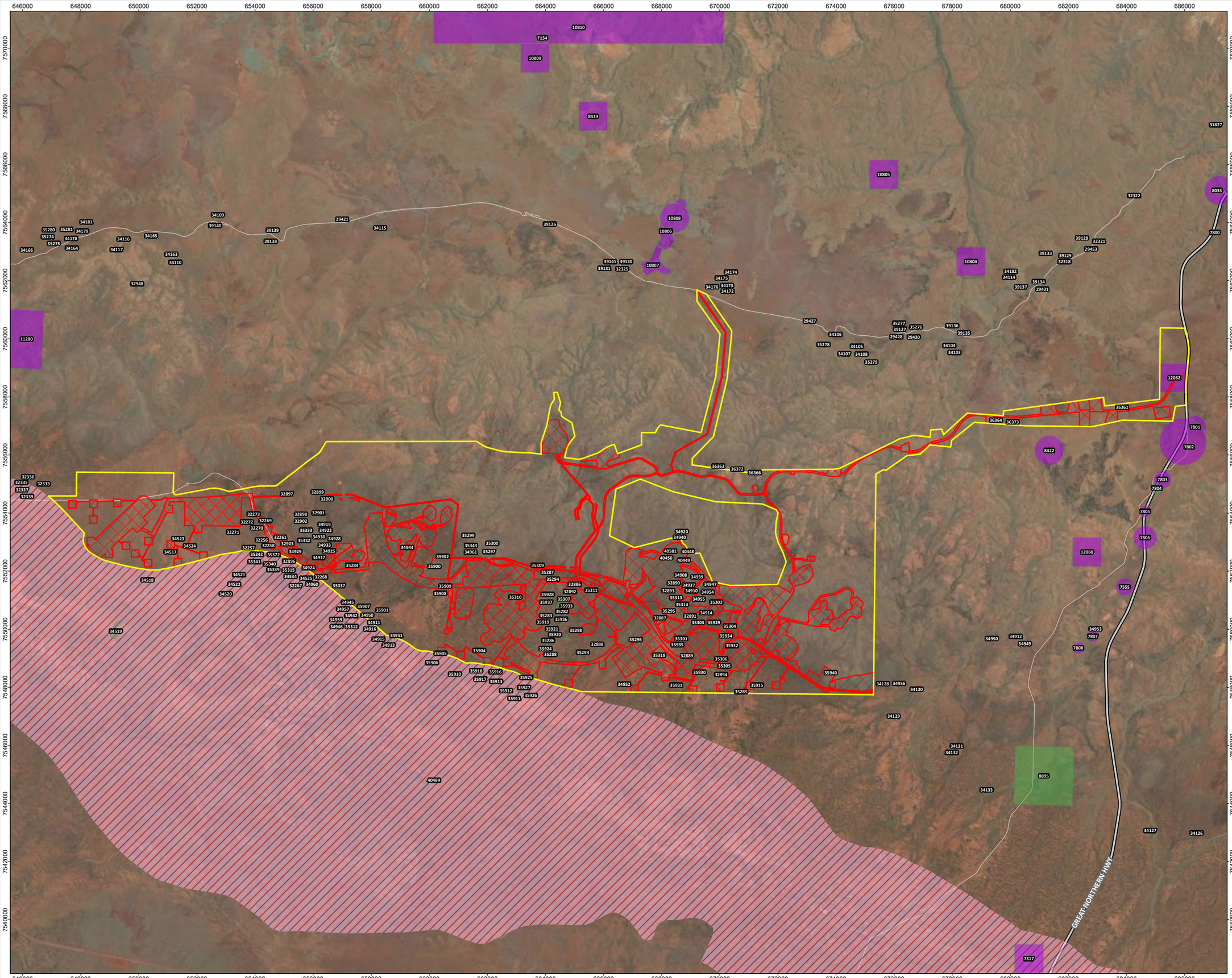
Mungurrdu heritage site (40484)

The Mungurrdu heritage site (40484) was lodged with DPLH and covers a significant portion of the Fortescue River Valley. Mungurrdu is located outside but immediately south of the Development Envelope (**Figure 14-2**:). According to the lodgement record, (Place Type) Mungurrdu is import for the following reasons:

- Burial;
- Birthplace;

- Camp;
- Ritual/Ceremonial;
- Creation/Dreaming Narrative;
- Hunting Place;
- Meeting Place;
- Other;
- Plant Resource; and
- Water Source.

Figure 14-3: Heritage Sites (DPLH)



Legend

- Development Envelope
- Indicative Footprint

Aboriginal Heritage Place Status

- Registered Site (DPLH-099)
- Lodged Site - Mungurrdu or Mangurrdu (DPLH-100)
- Lodged Site - Other (DPLH-100)

Roads (LGATE-195)

- Highway
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 11-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:120,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

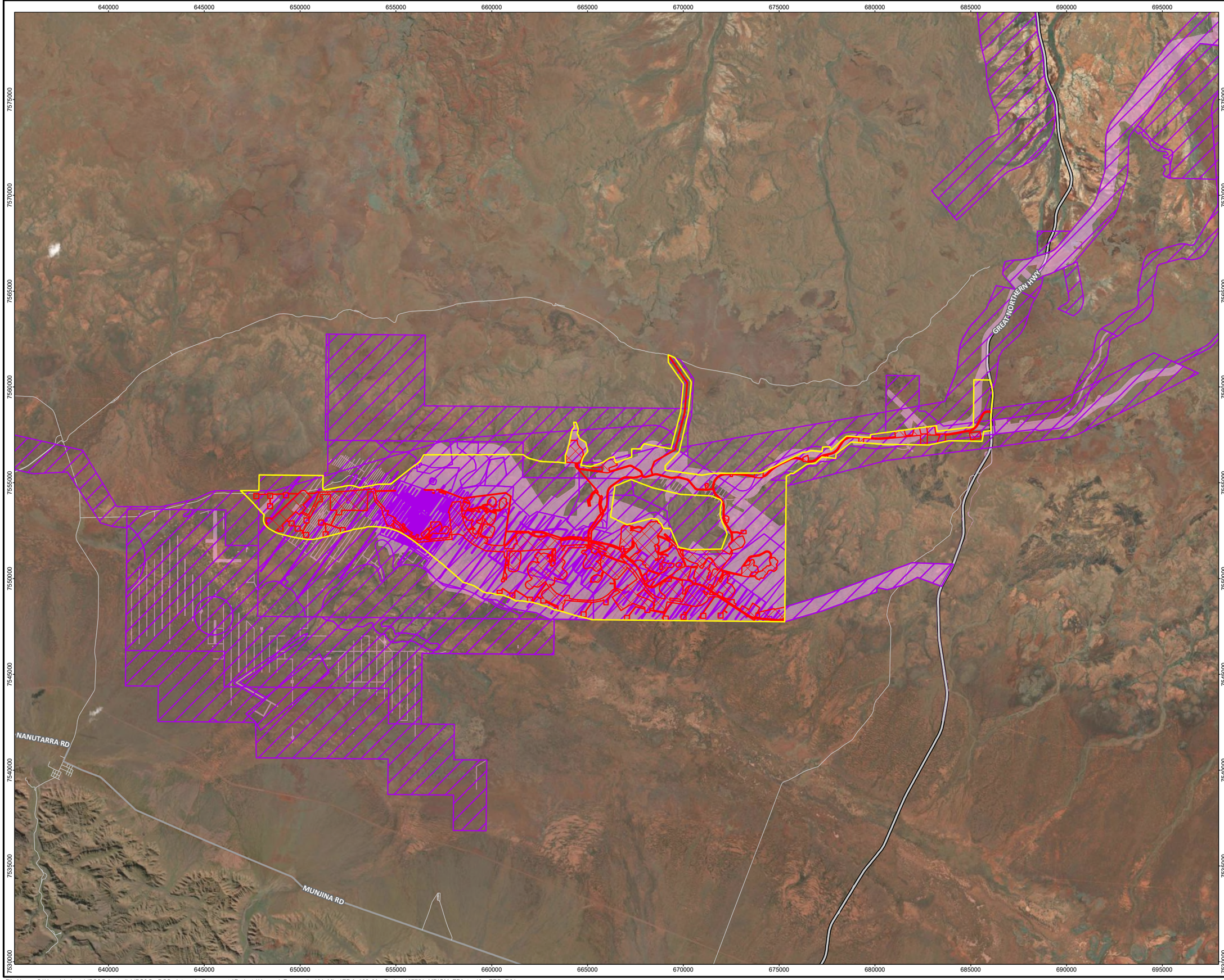
Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

HERITAGE SITES (DPLH

FIGURE 14.3

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics

Figure 14-4: Heritage Survey and Social Surroundings Coverage



Legend

- Development Envelope
- Indicative Footprint
- Completed Archaeological Survey Completed Ethnographic Survey (HanRoy,2024)
- Completed Ethnographic Survey (HanRoy,2024)
- Highway
- Major road
- Minor Road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 07-Nov-2024
Drawn By: droberts	Checked By: VC

Scale 1:180,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

Heritage Survey and Social Surroundings Coverage

FIGURE 14.4

File Name: C:\Users\droberts\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_ERD_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

Figure 14-5: Heritage Sites Identified During Heritage Surveys

HANCOCK PROSPECTING

This page has been redacted for confidentiality.

14.3.4.2 Ethnobotanical Survey

An ethnobotanical survey was completed in conjunction with the Banjima Traditional Owners and their heritage services provider, ACHM. The field work component of this survey was undertaken between 30 July 2024 – 1 August 2024. The purpose of the survey was to record the Banjima language names and traditional and cultural uses of the plants that Banjima representatives identified in the landscape. A copy of the survey report can be found in **Appendix 25**.

A total of 20 plants within the Development Envelope were identified from the survey as having traditional and cultural uses to the Banjima People. These are detailed in **Table 14-8** below.

During the survey, the ACHM Anthropologists recorded the following comments and observations from the Banjima People:

- There are more plants and trees with traditional cultural uses that were not recorded on the present survey and so additional surveys of this type would be useful to continue the plant inventory process.
- Rehabilitation of the landscapes altered and disturbed by exploration, mining, and associated infrastructure should be an ongoing project during the entire life-of-mine process rather than being something that might be commenced at the end of a mining project.
- Mining proponents should consider establishment of plant nurseries, employing Traditional Owners, to propagate endemic species that can be used in the land rehabilitation process during the life-of-mine.
- Bush medicine and bush food plants seem rarer than tree resources (such as “mulga” (Acacia sp.) that are used for their wood. The medicine plants seem to be slow to grow to maturity.
- The Banjima People representatives stated that they felt it was hard to access the plant resources on their Native Title lands because the mining operations of multiple companies meant that there are many fences, rail lines, gates and other associated restrictions to them accessing their traditional lands.
- The machinery noise created by exploration and mining operations creates a disturbance that scares animals away from those areas. For example, the author has had several previous conversations with Banjima People on surveys in the Fortescue Marsh area and surrounds where the Banjima People representatives have commented on their being fewer kangaroos and emus in the area – which they attribute to the animals having been scared away by the noise of the mining activities of multiple companies operating in the region. The Banjima People representatives on this ethnobotanical survey stated that they had observed the same thing and that this is a concern because animals are involved in the spreading of plant seeds (via eating the fruits and then defecating the seeds to new locations), but if the animals are scared away from inhabiting a region due to loud noise disturbance there is less natural regeneration of plants in that region.
- Is it possible that dust from mining operations, that comes down to coat the leaves of trees and shrubs in the surrounding area, is inhibiting plant growth? A Bush Orange (Gudjawari - likely *Capparis*

umbonata) was observed by the side of a track to the Mulga Downs exploration camp and was covered in dust and the Banjima representatives had thought it looked somewhat unhealthy.

An overview of where the Survey Team travelled during the three days of the survey and the areas on the ground where ethnobotanical plants were recorded is presented in Figure 14-6. On the first field day of the survey the helicopter was used to fly an inspection flight of both the MDIOM and Hub and Rail Spur Project Areas to give the Banjima People representatives an overview of the scale of the Project area and the opportunity for them to nominate any particular areas they might like to land to look for ethnobotanical plants.

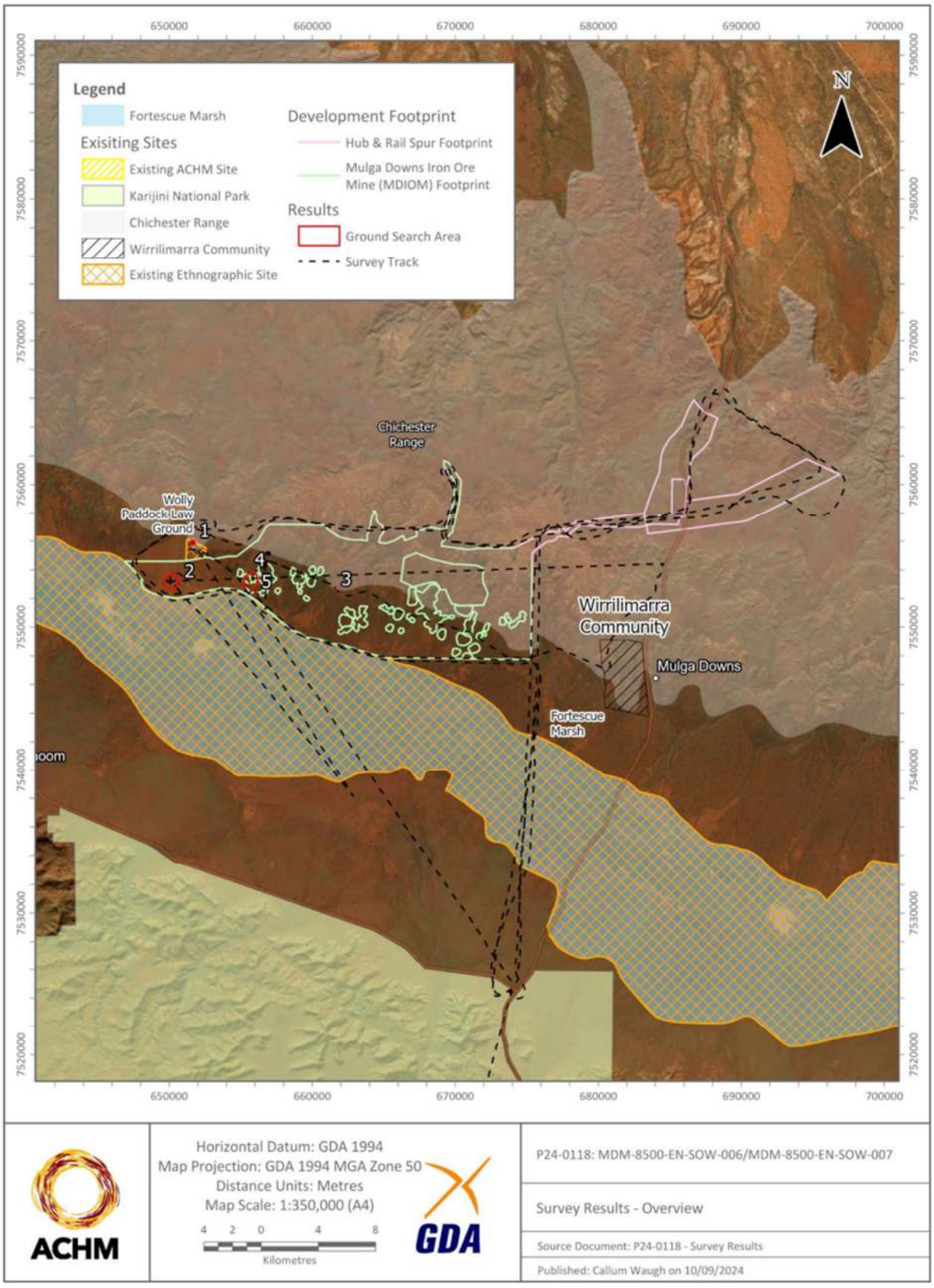


Figure 14-6: Overview of where the ethnobotanical Survey Team travelled (ACHM 2024)

Table 14-7: Culturally significant flora identified within the Development Envelope (ACHM, 2024)

Traditional Name	Scientific Name	Description and traditional uses	Photo
Gawarra	Potentially *Eremophila longifolia*	Tree to approximately 3m high. Leaves deep green with visible venation on top and underside of leaf. Leaves have slight curl to them. Banjima representatives stated that the trees usually occur in small groups of one or two trees together and usually occur far apart from one another and that because of their importance for ritual use, people often remember locations that contain these trees, so they can return to obtain the leaves. ***Uses***: The green leaves of this plant are burnt to create smoke (burrgun) used for cleansing rituals. It was said that one kneels down and puts their head in the smoke. Ritual use examples include: • At ritual ceremonies where boys are initiated to manhood, they will be cleansed with the smoke from these green leaves. • Sisters, mothers and aunties of the initiands will also be cleansed. • The smoke is also used to cleanse the belongings of the recently deceased, which are then redistributed throughout the kinship network of the deceased. • The cleansing effect of the smoke may also be used at a house or place where it is thought that “bad” energy or “bad” spirits may have been encountered. • Smoke from Gawarra can also be used to keep flies and insects away from raw meat while it is being butchered.	
Windarrmrrha	Potentially *Acacia aneura* (Mulga)	***Uses****:* • Used to make various wooden tools such as punishment spears (*muggurndurr*), men’s fighting sticks (*djuna*), and a type of spear called a *bungidee*. • The tree also provides edible fruit that is greyish-green in colour when ripe to eat and found after the tree has flowered. Banjima representatives described the fruit as “crispy or crunchy” and containing “a little bit of juice” and observed that if the fruit doesn’t develop properly due to a dry season, the fruit will be small and dry.	

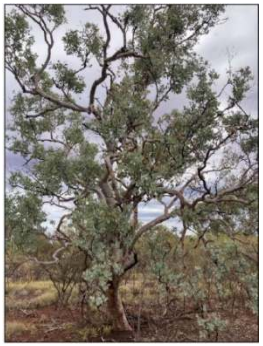
Traditional Name	Scientific Name	Description and traditional uses	Photo
Garrangba	Potentially *Hakea lorea*	Tree or shrub, 1-10 m high, with epicormic buds. Fl. cream-yellow-green-white-orange, Apr to Sep. Red sand, alluvium, clayey soils, sandstone, ironstone, granite, basalt. Plains, ranges, drainage lines, claypans. [A. Spooner, Descriptive Catalogue, 23 June 2003]. The Banjima representatives described that when they observe the flowers of this small tree ripening, they know that it will soon be time for emu chickens to hatch (they are usually growing in their eggs around August and September and the eggs should not be eaten). Emu chicks and adult birds will eat the dried remains of *Hakea lorea* flowers. ***Uses:*** • The flower contains nectar which is sucked from the flowers for sweetness/taste. • The cork-like bark is burnt to produce black coals/charcoal which has several uses including: being rubbed on babies from head to toe to cool them down; and being used in men's ceremonies. • The coal/charcoal can be mixed with animal fat such as emu or kangaroo fat to help the black, cooling barrier adhere to the skin for longer.	
Marruwa	Likely *Acacia xiphophylla*	Often gnarled, bushy shrub or tree, 1.5-7 m high. Fl. yellow. Stony clay flats or plains, near rocky creeks. [A. Spooner, Descriptive Catalogue, 18 August 1997]. ***Uses:*** • The wood is used for making boomerangs – the snaking shape of the wood means that many limbs of this tree are already in the correct shape for a boomerang. • The wood is also good firewood that burns for a long time and provides good coals [in which large meat food items can be cooked]. • Sap or "gum" from the tree is also dissolved in the mouth as a food and medicine and is said to be good for treating constipation. The gum is usually available from the tree from August-October but the Banjima informants have observed that if they want to obtain the	

Traditional Name	Scientific Name	Description and traditional uses	Photo
		gum out of season they can cut the bark from the tree with a knife or axe and "come back in a week" to obtain the gum from where they removed the bark. • Dried leaves still on the tree are collected and burnt to ash, which is collected and is called *jurnpa*, and this ash is added to chewing tobacco. • The younger, smaller trees are said to make a good windbreak, as they have a thicker, more dense, canopy that reduces the wind.	
Ngurrungnum	Possibly *Acacia victoriae*	Prickly shrub or tree, 2-5(-8) m high. Fl. cream-white/yellow-green, Jun or Aug to Oct. Variety of soils. Often along rivers & stony creek beds, saline flats. [A. Spooner, Descriptive Catalogue, 23 July 1997]. ***Uses*** • Seeds (*dorrndu*) can be eaten straight from tree when green and in pod. The seed pod can also be cooked lightly on coals, or on some burning spinifex. • The sap or "gum" (*gnarlgarla*) is referred to also as "bush lolly" and can be picked straight from the tree and dissolved in the mouth, usually from around September onwards. It is also collected and taken home where it can be soaked in water to soften it before eating. People also "keep it in the freezer for the off season" [when it is not available]. • Bardi grubs are also found underground in and around the roots of this plant. The grubs usually leave an observable hole near the base of the stem and their frass, a type of sawdust-like substance, can be seen outside the entry hole at the base of the stem where the grub has chewed its way in, excreting material as it goes. To find the edible grub, dig the dirt out from around the roots of a tree that shows the signs of the grub. Grubs can be eaten raw after first biting off the head and spitting that out, then eating the rest. The informants stated they preferred to roast the grub on hot coals until it is a "golden colour" and that if you heat the grub too fast, it will burst.	

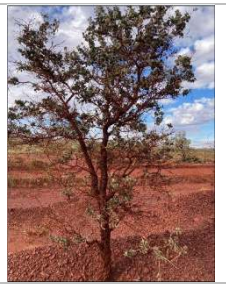
Traditional Name	Scientific Name	Description and traditional uses	Photo
Nyirrilyi	Likely *Enchylaena tomentosa* or *Enchylaena tomentosa* var. *tomentosa*	This was a small shrub to approximately 50cm high and other specimens were observed with diameters between 20-100cm. The succulent looking leaves are approximately 5mm long and only 1-2mm wide, are smooth and a sage green colour. The Banjima representatives noticed several of these plants and suggested that Mulga Downs must have the right conditions for them to be plentiful. ***Uses**:* • The plant bears a small red edible fruit. Sometimes the fruits are yellow or white near where you pull the fruit from the plant.	
Gurrarda	Likely *Acacia tetragonophylla*	***Uses**:* • The wood is used to make tools such as boomerangs ("if you can find the right tree") and fighting sticks. The wood is prized for the pinkish-red colour it has that imparts a particular look to tools made from it. • The seeds are edible. They can be eaten as is or can be crushed to make a kind of flour/seedcake. • The bark can be used as a leather dye. The bark is added to cold water and the leather soaked in there for several days.	
Bugurlda	Possibly *Acacia sclerosperma* subsp. *sclerosperma*	***Uses*:** • The seeds are eaten by both people and emus but the seeds of the *Ngurrungnum* (possibly *Acacia victoriae*) are preferred by the Banjima informant.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Galarangba	Possibly *Acacia coriacea* subsp. *pendens*	Weeping shrub or tree, (1-)3-6(-8) m high. Fl. yellow/cream, Mar to Aug. Sandy soils. Along rivers & creeks, stable sand dunes. [A. Spooner, Descriptive Catalogue, 17 July 1997]. ***Uses*:** • The wood can be used to make tools such as fighting sticks, but is best taken from younger specimens of this tree when the wood quality is deemed similar to Mulga. The older wood is not great for making tools. Wood from this tree is not the first choice of wood for making tools.	
Wirlu	Likely *Eucalyptus victrix*	Spreading tree, 1-12(-22) m high, bark smooth, sometimes with box-type stocking to 1 m. Fl. white-cream, Nov or Jan to Mar. Red loamy or sandy soils, clay loam. Floodplains, flats. [G. Paczkowska, Descriptive Catalogue, 5 December 1995]. The tree usually grows away from main permanent water sources and that where permanent waters are found in gorges of Karijini and elsewhere, there is a different type of “gum tree” (*Eucalyptus* sp.). ***Uses:*** • Tree is used for shade from the sun. • Branches of leaves are used for a surface on the ground on which to place cooked meat • Honey (*jundaru*) can be found in mature hollow branches of this tree, made by native bees.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Gulya (Murru) and / or Nyirrinyi	Possibly *Ipomoea* sp., OR possibly *Vigna lanceolata* subsp. *lanceolata*	DBCA Florabase description of Ipomoea species, I. muelleri: Prostrate, trailing or climbing perennial, herb, 0.05-0.3(-1) m high, to 2.6 m wide. Fl. pink/red-purple, Mar to Oct or Dec. Sand, clay. Along watercourses. [A. Spooner, Descriptive Catalogue, 8 September 1999]. ***Uses:*** To find the edible tuberous portion underground, people look for "where the ground is cracked" and using a crowbar, or digging stick, can tap the ground and tell by the sound the ground makes whether there is an edible tuber below or not. The tuber is said to be an "orangey, dirty colour". The tuber is cooked by making a fire and then burying the tuber in hot sand already heated by the fire and also (perhaps) with some hot ashes and coals in the immediate vicinity.	No photo available from survey.
Gudjawari	Likely *Capparis umbonata*	"Gujawari/gularndi" in the Banyjima language being the name fora plant with the common name "wild orange or bush orange" and identified as *Capparis mitchelli*. Discussion regarding this plant was interrupted by rain before any ethnographic details were recorded. ***Uses:*** • Edible fruit.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Djirrbilin	Possibly *Capparis lasiantha*	Spiny, twining shrub or climber, 0.5-4 m high. Fl. white, Jun to Sep. Sandy & clayey soils. [G.Paczkowska, Descriptive Catalogue, 16 April 1996]". In the field this plant was noted as "small shrub 40-50cm tall and in diameter, small thorns at each node". Banjima participants described the fruit on this plant as being approximately 5cm long, with lots of seed inside. The fruit will be yellowish when ripe and the skin of the fruit will start cracking. Aboriginal descriptions in the Taylor and van Leeuwen (2011) document include that "the fruit is yellow when ripe", and "fruit 3-5cm long and 2cm wide. The inside of the fruit is grey in colour", and ". . . the seeds must be removed before eating". ***Uses***: • Edible fruit. The fruit pulp can be squeezed from the fruit and into the mouth but the seed is spat out after sucking the pulp from it. • The leaves are used as medicine. They are boiled in water and the brew is drunk. People also make creams with this plant in current times and mix it with beeswax and oil.	
Mirrgun (Mallygun)	Likely *Eucalyptus leucophloia* subsp. *leucophloia*	(Mallee) or tree, 2.5-6 m high, white or white and pink powder bark with black spots. Fl. white-cream, Apr or Aug. Rocky slopes, gullies, plains .[A.Spooner, Descriptive Catalogue, 27 November 2007]. ***Uses***: • The wood is cut from the trunk of the tree to make a carrying bowl (yandi). The yandi is used "to carry heavy food like meat". A yandi can also be used to carry a baby and to cradle the baby off the ground when the group are stationary at camp. • Honey (jundaru) is obtained from hollows in old, mature limbs of the tree. The honey is made by native bees (warnbi – pronounced, roughly, as "worn-bye"). The honey may be carried on a piece of bark cut from the tree.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Jilarn	Likely *Eremophila cuneifolia*	Spreading, viscid shrub, 0.5-1.8 m high. Fl. blue-purple-pink, Jun to Oct. Red sandy or clayey soils. Stony rises, hillsides & plains, saline plains. [A. Spooner, Descriptive Catalogue, 5 March 1997]. ***Uses***: • Used as a medicine. The leaves are boiled in water and the liquid is drunk. The liquid can be applied to "school sores", cuts, wounds.	
Balarra	Unkown	The author made the following observations: dense shrub to approx. 190cm tall, approx 150cm wide. Single specimen with another approx. 10m away and another approx. 8m away. Dry feeling leaf. Banjima commented that the shrub had a white flower that might be 5-6cm wide; however, no flowers were present. They also observed that this plant and surrounding vegetation seemed rather more dry than usual. ***Uses:*** • Has an edible fruit that is eaten by people and emus, usually available end of August/beginning of September. The fruit is round and is a black colour when it is ripe. All the fruit is eaten except the seed. The fruit contains one small seed, according to the Banjima informants.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Wirralu	Likely *Grevillea striata*	Tree or shrub, 3-12(-15) m high. Fl. white-cream/yellow-green, Jul or Oct to Dec or Jan or Mar. Red sand, loam, clay. Near watercourses, plains. [G.Paczkowska, Descriptive Catalogue, 17 August 1995]. ***Uses:*** • The wood is used to make shields as well as artefacts used in men's ceremonies.	
Bunurra	Likely *Corymbia* sp., possibly *C. hamersleyana*	***Uses***: • The sap from the tree is collected and dissolved in hot water and is drunk as a medicine to "cleanse the blood". • Honey is sometimes gathered from old, hollow limbs. • "Bush Coconut" - A round cricket-ball sized gall (galu galu) occurs on these trees and is eaten. It is described as usually being the same colour as the bark on the trunk of the tree and having an "eye" on the underside from which one can dig in one's fingers and pull it apart. The young from whatever insect caused the gall is inside the "coconut" in the form of an edible grub that is "a little bit sweet". The inside of thegall contains firm, fibrous flesh that can be eaten and is said to taste a bit like coconut.	
Barderri	Likely *Acacia inaequilatera*	***Uses:*** • The bark from this small tree is used in the same way as that of the "Corkwood" known as *Garrangba* (likely *Hakea lorea*) – i.e. the bark is turned to charcoal for rubbing on children's bodies to keep them cool or it may be used in men's ceremonies.	

Traditional Name	Scientific Name	Description and traditional uses	Photo
Budardu (Burdardu)	*Santalum* sp.	Sandalwood - No photo was taken as this tree was discussed in general conversation, rather than after locating a specimen. ***Uses:*** • Can eat the seed, or heat in fire and rub the seed onto the skin, for its oil, which was said to perhaps partly act as an insect repellent to keep away flies and mosquitoes.	No photo available from survey.

14.3.5 Other Historic Heritage

In WA, the *Heritage Act 2018* (WA) recognises and promotes the importance, understanding and appreciation of WA's cultural heritage. The implementation of the *Heritage Act 2018* provides for the identification and documentation of places of cultural heritage significance and for the conservation, use, development and adaptation of such places. Places of cultural heritage significance are documented within the State Register of Heritage Places, which is organised by the Heritage Council of WA within the 'inHerit' database.

The Mulga Downs shearing shed (place number 01745) was identified in a search of the 'inHerit' database. The shed is not located within the Development Envelope, however, is located in proximity within the boundaries of the Mulga Downs Station and homestead (**Figure 14-2**:).

The Mulga Downs Station and homestead has heritage value for the following groups:

- Banjima Traditional Owners: many of the people who worked and lived on the station were members of the Banjima Traditional Owners. There are known heritage restricted zones for the Banjima across the pastoral station; and
- Hancock Family: the station has been owned by and associated with the Hancock family since 1915. Members of the family are buried in the homestead graveyard.

Places of Commonwealth heritage significance are protected under Part 15 of the EPBC Act and include World Heritage properties, National Heritage places and Commonwealth Heritage places. There are no identified Commonwealth or State listed historic heritage sites within or immediately adjacent to the Development Envelope (Heritage Council, 2020).

14.3.6 Social Surroundings Values

Hancock has undertaken extensive consultation with stakeholders, including the Banjima People, in relation to the Project. Based on the information provided above, the following social surroundings values were determined to require assessment for this factor:

- Disturbance to sites of social, cultural and heritage significance;
- Restricting Access to Country and ability to Care for Country;
- Activities that may impact amenity such as alteration of landscape or installation of infrastructure;
- Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of:
  - Altered hydrological and hydrogeological regimes, including altered water quality;
  - Activities that generate dust, noise and/or vibration; and
- Disturbance to broader cultural associations as a result of environmental changes to Country.

14.4 Potential Impacts

Under the EP Act, social surroundings is considered in EIA where there is a clear direct link between a Proposal impact on the physical or biological surroundings and the subsequent effect on a person's aesthetic, cultural, economic or other social surroundings. This may include impacts to local tourism and land uses, surrounding sensitive receptors such as communities and Aboriginal cultural heritage values through physical ground disturbance, changes to surface water resources, significant dust emissions extending into surrounding areas, ecological impacts to culturally and locally significant flora and fauna (such as flora or fauna used for bush tucker or teaching), or significant visual impacts to landscapes (EPA 2023c).

14.4.1 Proposal Design Considerations

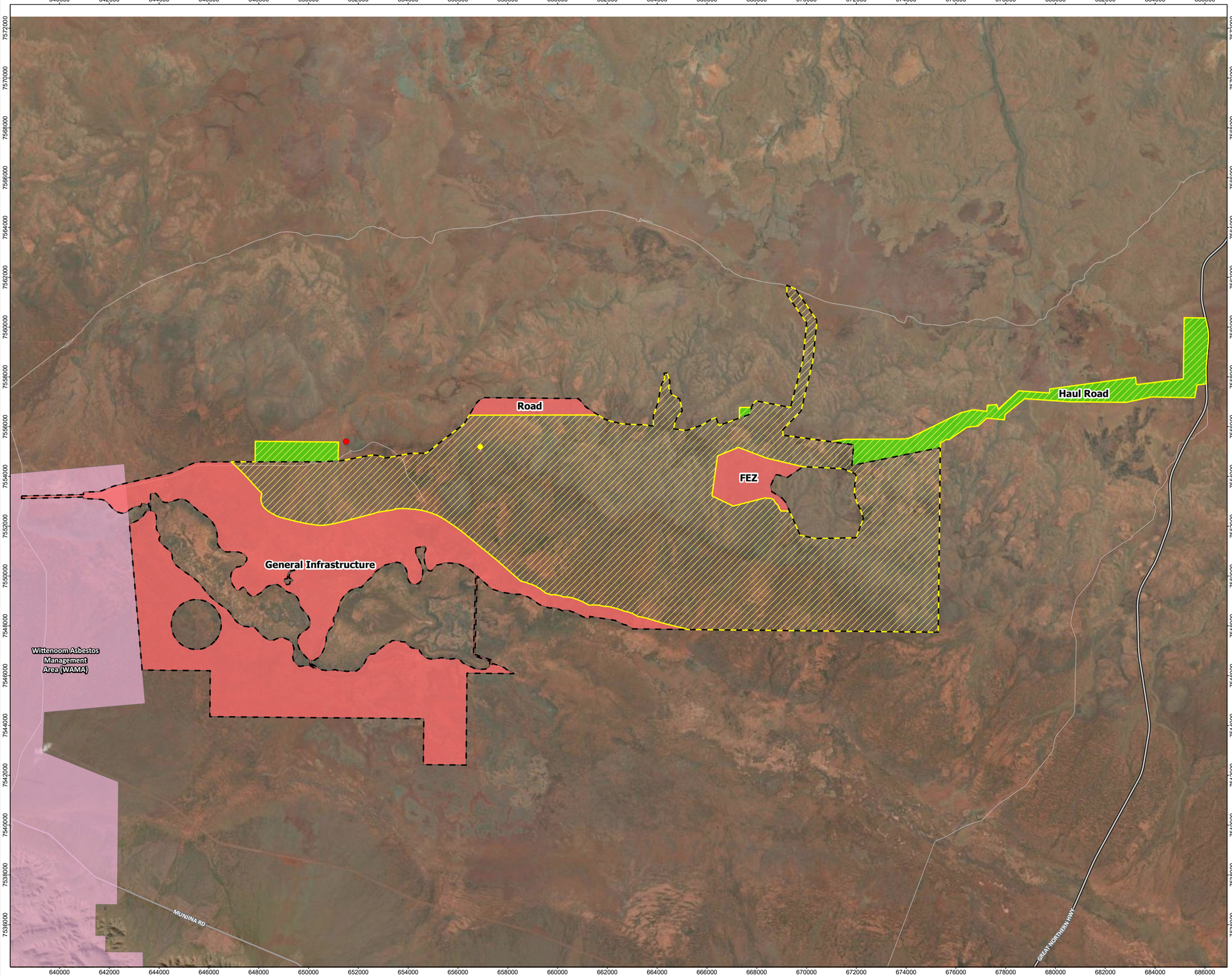
An assessment of the potential direct and indirect impacts of the Proposal to Social Surroundings in consideration of the EPA objectives is provided in the following sections. The assessment is based on the Proposal footprint as modified based on consultation with the Banjima People. A detailed discussion of the changes made to the Proposal during assessment is outlined in **Section 2.3**. A summary of the changes to the Proposal design that have already been implemented and are relevant to consultation with the Banjima People is shown in Table 14-8 below. The table shows avoidance measures included in the Proposal design achieved by excluding areas from the Development Envelope and by altering the mine plan to avoid large dewatering volumes requiring significant aquifer re-injection activities and avoiding the WAMA. The changes in Development Envelope are shown in Table 14-8.

Table 14-8: Summary of consultation outcomes with Banjima Traditional Owners on Proposal design and avoidance and minimisation measures already implemented.

Theme	Issue Raised	Avoidance and Minimisation Measure Implemented
Location of Proposal elements	Banjima Traditional Owners raised during consultation that the originally proposed airport and camp locations were in the vicinity of key cultural areas located to the west of the Development Envelope.	The airport and camp locations have been relocated (to the west and south respectively) to avoid key cultural areas being located further away from the identified cultural areas of significance.
Water	Water was identified as a key focal area for Banjima Traditional Owners. Both groundwater and surface water were raised, as well as responsible use of water and concern about the location and extend of managed aquifer recharge required for the Proposal. Identified potential indirect impacts to the DPLH lodged Mungurrdu heritage (40484) site through altered hydrological and hydrogeological processes was also raised.	Through the s43 application approved on 4 October 2024, HPPL has significantly reduced the amount of dewatering required to construct and operate the Proposal, this in turn has significantly reduced the potential for indirect impacts on Mungurrdu through altered hydrogeology. The Water Management Plan prepared for the Proposal was provided to the Traditional Owners and their advisors for review and input and the feedback provided has been considered in preparing revised versions.
Contamination	The Development Envelope for the Proposal is located in close proximity to Wittenoom Asbestos Management Area. Is there any potential for the DE to be contaminated from activities at Wittenoom?	Through the s43 application approved on 4 October 2024, the Development Envelope for the Proposal no longer intersects the WAMA. There will no longer be ground disturbing works within the WAMA and therefore the potential impacts associated with the redistribution of ACM is reduced.

Theme	Issue Raised	Avoidance and Minimisation Measure Implemented
Cultural Heritage and Social Surroundings	The Proposal is located within an area that contains significant heritage and cultural associations. The original Proposal also included mining activities and supporting infrastructure within the DPLH lodged Mungurrdu heritage site. The original Proposal Development Envelope and footprint impacted directly on some key areas of significance the Banjima.	The Proposal was amended from what was originally referred (20 Mtpa) to the reduced 12 Mtpa mine removes any mining and associated mining infrastructure from within the lodged Mungurrdu heritage site. There is no longer the requirement for any dewatering infrastructure to be constructed and operated within Mungurrdu. Throughout the design process, the Development Envelope and Indicative Footprint has been amended to avoid impacts to key cultural areas.
Wirrilimarra Community	Previous mine access road (referred to as 'Fenceline Road') was too close to the Wirrilimarra Community.	HPPL has now designed the 'northern haul road' to facilitate mine access and haulage of ore. The new route is located approximately 12 km to the north of Wirrilimarrra at its closest point, and the 'Fenceline Road' has been removed from the Development Envelope.

Figure 14-7: Development Envelope Changes



Legend

- Development Envelope (12 Mtpa)
- Development Envelope (20 Mtpa)
- Wittenoom Asbestos Management Area (WAMA)
- Mulga Downs Exploration Camp
- Mulga Downs Homestead
- Highway
- Major road
- Minor road

JBS&G

Job No: 67751	
Client: Hancock Prospecting Pty Ltd	
Version: A	Date: 29-Aug-2024
Drawn By: dmills	Checked By: LT

Scale 1:140,000 at A3

0 2 4
Kilometers

Coord. Sys. GDA2020 MGA Zone 50

Mulga Downs Iron Ore Mine
Central Pilbara, Western Australia

DEVELOPMENT ENVELOPE CHANGES

FIGURE 14.7

File Name: C:\Users\dmills\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Hancock Prospecting\01_Mine\EP Act\02_MapProjects\67751_MDIOM_EPAct_s43a_12mpta_Pivot_R01.aprx
Image Reference: World Imagery: Earthstar Geographics www.nearmap.com© - Imagery Date: 28. May 2022.

14.4.2 Direct Impacts

The potential direct impacts of the Proposal to Social Surroundings within or surrounding the Development Envelope, have been identified as follows:

- Disturbance to sites and areas of social, cultural and heritage value;
- Restricting access to country and ability to care for country;
- Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure that impacts ability to enjoy

The Development Envelope excludes the potential for direct impacts to national parks or other recreational or tourism features within the vicinity of the Proposal.

14.4.2.1 Disturbance to Sites and areas of Social, Cultural and Heritage Value

The disturbance of Aboriginal Heritage Sites is regulated under the AH Act.

The Development Envelope includes 303 sites of heritage significance identified during surveys undertaken in consultation with the Banjima Traditional Owners. Sites meeting the criteria for an Aboriginal site under the AH Act are protected by law. Disturbance of some sites will be unavoidable and will be subject to further consultation with the Banjima Traditional Owners and approvals under the AH Act.

Within the current Indicative Footprint, there are 41 sites of heritage significance, representing approximately 14% of the sites identified (**Table 14-6**) .

The direct disturbance of Heritage Sites is acknowledged to have impacts on Social Surroundings as it results in the removal of artefacts and disturbance of sites that have been inhabited and used by previous generations of Banjima People. The changes in Country (caused by clearing, mine pits, waste rock dumps, storage of materials and infrastructure) around any Heritage Sites that remains accessible during mining will change the experience and amenity of visiting a Site.

14.4.2.2 Restricting Access to Country and ability to Care for Country

Implementation of the Proposal includes ground disturbance and placement of infrastructure, which has the potential to alter or restrict access for the Banjima People to Country, including sites of cultural or heritage significance. This has the potential to impact the locations available for traditional social activities and practices, including connection to and the ability to teach and care for country, gather bushtucker, camp, fish and hunt.

Access restrictions will impact the ability of Banjima Traditional Owners to visit particular locations on their native title determination area within the footprint area and may impact on access through the Development Envelope. Access restrictions will be based on ensuring peoples safety, given that mining activities present hazards within certain areas of the mine. The key access restrictions will be around the mine pits, internal roads, haul roads, and key mine infrastructure such as the processing facility and any other areas where access must be restricted for safety reasons. The access restrictions are necessary during active mining for safety reasons.

Access restrictions will apply to those areas for all or part of the mine life whilst construction, mining and rehabilitation works are being undertaken. Access can be resumed as mining activities cease and areas are rehabilitated to be safe. Access to pits shall be restricted via abandonment bunds for safety reasons. Pits are being backfilled to above the groundwater level. When factoring material settlement and depth to groundwater, some pits may be backfilled to surface, while some pits may be mounded above pre-existing ground level. A conservative approach would be to assume access restrictions to all mine pits. The indicative pit layout is illustrated in **Figure 2-3**. Fences, gates and other physical barriers will be used to prevent access to restricted areas, which will be identified and confirmed through consultation. Signs and other written communication methods will be utilised to identify when and where access will be restricted.

14.4.2.3 Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure

The construction and operation of the Proposal will directly alter the visual amenity of the local landscape within the footprint as a result of mining activities, including changes to landforms such as:

- Excavation of mine pits with associated abandonment bunds for closure;
- Construction of waste rock landforms; and
- Supporting infrastructure such as roads, bores, pipes, laydown areas, airport, accommodation village and wastewater treatment plant.

Mining activities and the resulting alteration of visual amenity may alter the experience of Banjima Traditional Owners when on Country within the Development Envelope.

The VIA undertaken by Ecoscape (2024) to support assessment of the Proposal recognised locations with cultural significance (such as Aboriginal meeting places and heritage restricted zones) as relevant receptors for the purpose of the VIA. The VIA is provided as **Appendix 21**.

The highest degree of impact from the Proposal will occur within the operational phase and specifically towards the end of mine life where above ground mound elements are established. Assessment of the operational phase represents the worst case impact and is inherently conservative, whereas in reality, all Proposal elements are not likely to all be visually significant at the same time. It is anticipated that construction and maintenance activities will be significantly less than the modelled operational impacts.

Other than Mulga Homestead, which was also assessed as 'Moderate', the other viewpoints (including Karijini National Park, Youngaleena and Wirrilimara) were assessed to experience a generally Low level of visual impact, mainly the result of large distance between the viewpoint and Proposal infrastructure.

HPPL was not granted access to the Wirrilimara Aboriginal community for the VIA. However, 3D modelling was created to assess the site, and the results showed a low level of impact from Proposal elements.

14.4.3 Indirect Impacts

Potential indirect impacts arising from the current Indicative Footprint or activities within the Proposal may cause indirect impacts to Social Surroundings, including heritage sites, social, cultural and environmental values within and/or surrounding the Development Envelope. The potential indirect impacts have been identified as follows:

- Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including changes to groundwater depth, water, surface water flows and altered surface and groundwater quality;
- Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and/or vibration; and
- Disturbance to broader cultural associations as a result of environmental changes to country.

14.4.3.1 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality

Mining activities that contribute to altered hydrological and hydrogeological regimes (including altered water quality), from dewatering, MAR and changes to surface water flow may indirectly impact sites of cultural significance by altering the surface water and groundwater regimes that characterise these sites.

The key potential impacts of the Proposal to hydrological regimes are:

- Groundwater drawdown from orebody dewatering;
- Groundwater mounding from MAR to dispose of excess water with a predicted groundwater uplift to within 2.5 m below ground, causing vegetation health impacts and increased salt accumulation; and
- Altered surface water flows and catchment modifications which may impact including creek lines, floodplains and the Fortescue Valley environmental and cultural assets resulting in a modification of inflows and potential changes to the persistence of water.

These impacts are discussed further in **Section 7**.

Sites that may be indirectly impacted within the vicinity of the Development Envelope include the Mungurrdu lodged DPLH site (40484 - located immediately south; **Figure 14-2**:) and the Koodjeepindarrnna and Ngarlganoona pools (located 3 km and 4 km south, respectively; **Figure 3-11**).

14.4.3.2 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust, noise and/or vibration

Dust, noise and vibration emissions will be produced from construction and operation of the Proposal through mining activities including (but not limited to) blasting, vegetation clearing, and rehabilitation. These emissions may indirectly affect the amenity of sites of cultural significance through dust deposition, impacts to the structural integrity of heritage sites and overall disruption of Traditional Owners customary practises.

Dust emissions have the potential to indirectly impact flora that is used for cultural and traditional purposes (**Section 13**). Noise can disturb and displace fauna species used in hunting, requiring Traditional Owners to travel further when hunting. Heritage sites within the Development Envelope may be impacted and negotiation with the Traditional Owners who are the custodians of these areas is in process. While many sites are not likely to be inhabited or visited for long periods by people, some may be sensitive to vibration levels caused by mining activity.

These emissions may also indirectly impact surroundings sensitive receptors including the Youngaleena and Wirrilimarra Communities (located 15 km south and 7 km east, respectively), and conservation reserves such as Karijini National Park (located 7.6 km south).

Noise and Vibration Assessments

LGA (2024) was engaged to undertake an assessment of the potential noise and vibration impacts from the Proposal on surrounding noise sensitive receptors, including:

- Wirrilimarra and Youngaleena Communities;
- Heritage sites;
- Auski Roadhouse;
- Munjina East Gorge;
- Karijini Eco Retreat; and
- Mulga Downs Homestead (North).

Four scenarios were modelled as part of the assessment. These scenarios were considered to be 'worst-case' to ensure a conservative approach to modelling:

1. Scenario 1A: East-Central Areas with Conveyors;
2. Scenario 1B: East-West Areas with Conveyors;
3. Scenario 2A: East-Central Areas with Road Trains; and
4. Scenario 2B: East-West Areas with Road Trains.

The noise assessment also modelled noise levels at bat cave receptor locations. Potential impacts to terrestrial fauna from noise and vibration are discussed in **Section 10**.

PSM (2024) was engaged to undertake geotechnical assessments of caves located within the Development Envelope and in close proximity to the northern extent of Fridge Hill pit, to understand potential impacts of the Proposal as a result of blasting and operational vibration. A copy of the geotechnical assessment, including the locations of caves surveyed is provided as **Appendix 28**.

The findings of LGA (2024) and PSM (2024) are discussed in the following sections.

Noise Limits

The Regulations adopt three noise metrics to quantify the noise limits:

- LAmax signifies a noise level which is not to be exceeded at any time;
- LA1 signifies a noise level which is not to be exceeded for more than 1% of the time; and
- LA10 signifies a noise level which is not to be exceeded for more than 10% of the time.

A summary of the applicable noise limits is provided below in **Table 14-9**. The criteria limit utilised for the assessment of noise levels was "Noise sensitive premises: any other area than highly sensitive area".

Table 14-9: Assigned Noise Limits Summary (LGA, 2024)

Part of premises receiving noise	Time of day	Assigned limit dB(A)		
		LA10	LA1	LAmax
Noise sensitive premises: highly sensitive area	07:00 to 19:00 hours Monday to Saturday	45 dB(A) + Influencing Factor	55 dB(A) + Influencing Factor	65 dB(A) + Influencing Factor
	09:00 to 19:00 hours Sundays and public holidays	40 dB(A) + Influencing Factor	50 dB(A) + Influencing Factor	65 dB(A) + Influencing Factor
	19:00 to 22:00 hours all days	40 dB(A) + Influencing Factor	50 dB(A) + Influencing Factor	55 dB(A) + Influencing Factor
	22:00 hours on any day to 07:00 hours Monday to Saturday and 09:00 hours Sunday and public holidays	35 dB(A) + Influencing Factor	45 dB(A) + Influencing Factor	55 dB(A) + Influencing Factor
Noise sensitive premises: any other area than highly sensitive area	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Commercial premises	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Industrial and utility premises	All hours	65 dB(A)	80 dB(A)	90 dB(A)

Noise Levels

The maximum noise levels for the four scenarios modelled at each of the sensitive receptors considered in the assessment are outlined in **Table 14-10**.

Operational mining noise from the Proposal received at the nearest sensitive receptors, is predicted to comply with the criterion provided in the Environmental Protection (Noise) Regulations 1997 at all times and in worst case scenarios. The sensitive receptors considered in accordance with the Regulations were Communities, accommodation villages and tourism sites.

The criteria at one heritage receiver location was not achieved (MIB-MD13-042). The closest Heritage site (MIB-MD13-042) is 40 metres from the pit edge and therefore receives the highest noise level when mining activities occur nearby. All other heritage site received locations were found to be compliant with the adopted criteria

(LGA 2024). For safety reasons it is expected that Traditional Owners access will be restricted in proximity (approximately 1 km) to work areas.

Table 14-10: All Scenario's Assessment, L10 dB(A) (LGA, 2024)

Receiver					
	Approximate Nearest Distance to Site	Predicted	Adjusted	Criteria Level	Assessment
Bat Sites	60-150 metres	38-68	68	70	Complies
Homesteads	33 km	-	-	35	Complies
Auski Village	23 km	-	-	35	Complies
Karajini Eco Retreat	37 km	-	-	35	Complies
Munjina East Gorge	36 km	-	-	35	Complies
Communities	8.5 km	18	23	35	Complies
Heritage Sites	40 metres	67	67	60	+ 7

Notes:

- *Adjusted by + 5 dB for tonality when assessing to human receptors.
- Cells denoted with a "-" result are greater than 20km away and not predicted by the computer model.

Noise level predicted from the airport for the nearest sensitive sites are summarised in **Table 14-11**. The assessment predicted compliance at all receptor locations for aircraft arrivals and departures (LGA 2024).

Table 14-11: Aircraft Noise Assessment, dB LAmax (LGA, 2024)

Receiver	Nearest distance to runaway (km)	Departures, dB LAmax	Arrivals, dB LAmax	Assessment Criteria dB LAmax	Assessment
Bat Sites	18 km	<12	<10	70	Complies
Homesteads	33 km	-	-	80	Complies
Auski Village	38 km	-	-	80	Complies
Karajini Eco Retreat	33 km	-	-	80	Complies
Communities	21 km	<10	<5	80	Complies
Heritage Sites	5 km	30	25	80	Complies

* Predictive noise modelling does not calculate to locations farther than 20km from a given noise source so those locations are shown as "-" results.

Airblast and Vibration

Airblast noise and vibration levels have been predicted to the nearest caves receiver locations and heritage receiver locations. The Wirrilimarra Community is 8.5km from the nearest pit and has also been considered. Impacts from blast noise and vibration to homesteads, accommodation villages, tourism sites (including Karijini Eco Retreat) and communities in the vicinity of the Proposal are demonstrated to be compliant with relevant criteria noting the distances to these receptors exceeds 8.5 km (LGA 2024).

Guidance on airblast noise and vibration levels to address the nearest heritage sites were assessed however, there are no applicable criteria. Blasting strategies will be developed based on the outcomes of the airblast noise and vibration model in conjunction with the geotechnical surveys and monitoring to minimise impacts on sensitive heritage sites.

Ground vibration levels at the closest heritage sites, within 100 m are most critical. Cave integrity assessments have been undertaken for selected heritage caves.

Caves

PSM (2024) undertook geotechnical assessments of caves located within the Development Envelope and in close proximity to the northern extent of Fridge Hill pit, to understanding potential impacts due to Proposal blasting and operational vibration. This included an assessment of structural integrity and therefore safe vibration limits. To assist in assessing appropriate blasting limits for the caves, each site was assigned a qualitative susceptibility rating based on key geotechnical features observed in the cave and/or escarpment around the cave entrance, including:

- Identified specific potential rockfall hazard sources;
- Open/dilated defects;
- Structural controls on cave formation or stability (e.g. major joints, bedding);
- Interpreted potential for significant roof collapse events, including observations of:
  - Wide spans;
  - Flat roof profiles;
  - Persistent sub-horizontal bedding partings; and
  - Highly jointed and dilated rock mass.

Based on the assessment undertaken across 19 caves, four were considered low risk, 11 were considered medium risk and four were considered high risk.

14.4.3.3 Disturbance to broader cultural associations as a result of environmental changes to country

It is understood that each Traditional Owner group holds different values, practices and Lore associated with their ancestry and Country. As knowledge holders and the Traditional custodians of the land, Traditional Owners protect Country in accordance with Traditional lore.

The Traditional Owners hold an extensive body of biocultural knowledge on fauna and flora and pass this knowledge to the younger generations. Within the Development Envelope, 20 plant species have been identified as having cultural or traditional uses to Banjima People (**Appendix 25**). The Koodjeepindarrnna and Ngarlganoona pools/claypans are also habitats for migratory and local birds and invertebrate species during inundation and have cultural significance to Traditional Owners (ACHM 2024). The Mungurrdu site was identified during heritage surveys, which encapsulates the upper Fortescue River. The Fortescue Valley is part of a songline which extends the length of the Fortescue River to where it goes below ground at Millstream (Goode 2009). Traditional songs are shared during Lore time.

Changes to environmental values or the Fortescue River have the potential to disrupt this lineage and impact traditions. The potential environmental impacts to the claypans of the Fortescue River (including the Koodjeepindarrnna and Ngarlganoona pools and the Mungurrdu site) due to changes in hydrological regimes are discussed in more detail in **Section 7**.

Artificial light pollution can have impacts on the Banjima people, who are connected to their land and cultural practices in the Pilbara region of Western Australia.

Disruption of Traditional Practices: The Traditional Owners rely on the night sky for navigation, storytelling, and cultural ceremonies. Light pollution can obscure the visibility of stars and celestial bodies, disrupting these traditional practices.

Loss of Cultural Knowledge: Many Indigenous knowledge systems are tied to the night sky. Light pollution can hinder the transmission of this knowledge to younger generations, leading to a potential loss of cultural heritage

Surrounding sensitive receptors, including the Youngaleena and Wirrilimarra Communities and users of the Mulga Downs Pastoral Station or Karijini National Park may also have an altered experience in the area as a result of mining activities.

14.4.4 Cumulative Impacts

Banjima Traditional Owners raised concerns of cumulative impacts to country during consultation for this Proposal, as noted in **Section 14.3.2.1**. Traditional Owners hold a deep spiritual connection to the environment, as it encompasses Caring for Country, which according to traditional lore, is their responsibility to maintain.

The EPA raised the issue of cumulative environmental impacts of developments and projects within the Pilbara region (EPA 2014). The issues raised by the EPA include legacy mine pit lakes, water management, introduced species and native vegetation clearing. The Proposal and other projects in the Pilbara will have a cumulative impact on social surroundings values in the region. Nearby projects include (but are not limited to):

- HPPL- Mulga Downs Hub and Rail Spur – within the eastern boundary of the Development Envelope;
- HPPL - Murray's Hill Mine – within the Development Envelope;
- Fortescue Metals Group Limited (FMG) - Solomon Project Lower Fortescue Borefield Development (20 km west of the Development Envelope) and Solomon Rail (directly north of the Development Envelope); and
- Rio Tinto Iron Ore (RTIO) – Koodaideri (Gudai-Darri) Project and heavy haulage rail line - ~20 km south of the Development Envelope.

Cumulative Impacts are addressed in detail in **Section 17**.

14.5 Mitigation

The hierarchy of impact management (Avoid, Minimise, Rehabilitate/Monitoring) has been adopted and implemented for the Proposal by HPPL, in relation to the Social Surroundings environmental factor.

In response to the potential direct and indirect impacts identified in **Section 14.4** and the issues raised during consultation with Banjima Traditional Owners (**Section 14.3.3**), HPPL have proposed the mitigation measures in **Table 14-12**.

Table 14-12: Summary of consultation outcomes with Banjima Traditional Owners and proposed mitigation

Theme	Issue Raised	Proposed Mitigation
Cultural Awareness Induction Training	Banjima Traditional Owners requested input into the cultural awareness training and induction package.	Banjima will be provided opportunity to review and input into the cultural awareness induction and training.
Water	Water was identified as a key focal area for Banjima Traditional Owners. Both groundwater and surface water were raised, as well as responsible use of water and concern about the location and extend of managed aquifer recharge required for the Proposal. Identified potential indirect impacts to the DPLH lodged Mungurrdu heritage (40484) site through altered hydrological and hydrogeological processes was also raised.	Surface water management measures will be implemented for the Proposal, and design of the Proposal will consider mitigation of altered surface water flows to reduce indirect impacts on Mungurrdu through altered hydrology. The surface water management concept is to reinstate surface water flows downstream of Proposal infrastructure. The Water Management Plan prepared for the Proposal was provided to the Traditional Owners and their advisors for review and input and the feedback provided has been considered in preparing revised versions.
Amenity	Dust emissions and the impact from dust on Country (amenity) was raised as a concern by Banjima.	HPPL is committed to sealing the mine access road (northern haul road) to minimise dust emissions. In addition, dust management measures will be utilised by HPPL including water carts, road maintenance and other emerging technologies. HPPL will investigate the use of alternate dust suppression methods.
Environmental Management	Banjima have raised that environmental significance of the area in which the Proposal is situated is of high value and is considered culturally and environmentally important to the Banjima People	HPPL has committed to working with the Banjima Traditional Owners to ensure appropriate environmental management is incorporated throughout construction and operation of the Proposal. All management plans developed for the Proposal have been provided to the Traditional Owners and their advisors for review and input.
Cultural Heritage and Social Surroundings	The Proposal is located within an area that contains significant heritage and cultural associations. The original Proposal also included mining activities and supporting infrastructure within the DPLH lodged Mungurrdu heritage site. The original Proposal Development Envelope and footprint impacted directly on some key features that Banjima had concerns with.	HPPL is aware and will comply will all commitments as required under the AH Act and HPPL will continue to work with Banjima to develop a CHMP where required by Law. Indirect impacts to heritage such as through erosion and sedimentation, dust or altered hydrological regimes will be managed through the relevant management plans developed for the Proposal, of which Banjima and their Technical Advisors have been provided opportunity to review.
Life of Proposal and Closure Planning	Closure planning and the state of the environment after decommissioning of the Proposal were raised as key aspects for the Banjima People. “What will be left for our People?”	The Proposal will be implemented in accordance with the MCP prepared to support the Mining Proposal under the Mining Act. HPPL are committed to working with the Banjima Traditional Owners to develop this MCP, which will include commitments regarding closure objectives and measures, and the management of residual risk.

Theme	Issue Raised	Proposed Mitigation
Rehabilitation	Through consultation, the Banjima People identified that there are to be no pit lakes left on Banjima Country at the completion of mining.	HPPL have committed to ensuring all pits will be backfilled to ensure backfill is above the water table after settlement. This will avoid the creation of pit lakes at closure. HPPL is committed to caring for country and returning disturbed land to a state which ties into the surrounding landscape where possible. During the preparation and implementation of HPPL's Mine Closure Plan, HPPL will commit to ongoing engagement and involvement with the Banjima People in regard to rehabilitation and mine closure. HPPL will engage with the Banjima People on land rehabilitation matters including: • safe access to country; • final rehabilitated landform design; • social surroundings aspects; • designs that integrate into the surrounding landform; • that the land is left safe to humans and animals; • that the land is revegetated with native vegetation species consistent with surrounding land including species of bush tucker and bush medicine where possible. HPPL will provide Banjima the opportunity to review and comment on rehabilitation aspects as documented in the Mine Closure Plan including the final seed list used for rehabilitation. Training and work opportunities will be offered to the Banjima People for delivering this service.
Culturally significant flora and fauna	Impacts to culturally significant flora and fauna as a result of the Proposal are of concern to the Banjima People.	HPPL are committed to undertaking ethnobotanical surveys with Banjima. The results of these surveys and subsequent management measures will be included in the SCHMP.
Access	Banjima have requested access to certain areas in and around the Development Envelope during Proposal operation for hunting or other activities.	Access to certain areas within the Development Envelope will form part of the negotiation agreement between HPPL and Banjima.
Youngaleena Community	The Community is concerned regarding the potential impacts from dust, noise, water and visual impacts as a result of the Proposal on the Community.	HPPL is currently undertaking baseline data (dust and noise) monitoring at the Community, to further understand any potential impacts resulting from the Proposal. HPPL will monitor for dust, noise and water levels and quality at the Community during construction and operations.

The Proposal will be undertaken in accordance with a SCHMP which will be prepared in consultation with the Banjima People to outline any residual avoidance and management strategies to be implemented by the Proposal to manage potential impacts to Social Surroundings. The SCHMP will include the mitigation measures

already discussed with Banjima as outlined in **Table 14-12**.. The SCHMP will be treated as confidential to the Banjima Traditional Owner group.

A Heritage Agreement is in place between the company and the Banjima native title holders which sets out an agreed process by which heritage surveys are undertaken. Impacts to heritage sites (as identified through heritage surveys and in consultation with Banjima – **Section 14.3.4.1**) will be managed through the development of a CHMP. The CHMP will be developed and implemented in accordance with the AH Act, which will outline mitigation and management measures to be implemented by the Proposal for heritage sites. HPPL are aware and will comply with all obligations as required by legislation under the AH Act. Where possible, every effort will be made to avoid or reduce impacts to Aboriginal cultural heritage through the planning, design and construction phases.

Table 14-13 details the mitigation measures (avoidance, minimise and rehabilitate/monitoring) relevant for potential direct and indirect impacts to Social Surroundings from the Proposal. These measures have considered issues raised during consultation with Banjima Traditional Owners, and are in addition to the mitigation measures previously proposed as outcomes of previous consultation (**Table 14-12**). They are also in addition to mitigation measures that will be implemented for the Proposal generally, which address potential impacts associated with the other key environmental factors.

Table 14-13: Mitigation Measures for Social Surroundings

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Direct Impacts			
Disturbance to sites of social, cultural and heritage value	• Indicative Footprint amended to avoid key heritage sites with ongoing refinement of the Mine Plan to maximise site avoidance. • Development Envelope excludes the lodged Mungurrdu site. • Heritage sites will be demarcated and identified as no-go areas for site personnel prior to ground disturbing works. • Aboriginal cultural heritage, or suspected Aboriginal cultural heritage, must not be removed from any heritage place under any circumstance, unless authorised under the AH Act.	• Personnel must not enter an Aboriginal Cultural Heritage site or a Heritage Restriction Zone (HRZ) without prior consent. • Ongoing engagement with Traditional Owners to understand key impacts and avoid where possible. • Appropriate education of the workforce will occur through the implementation of a Cultural Awareness Training program. • Adherence to internal GDP procedures. • Maintenance of Traditional Owner access to culturally significant places where safe and practical. • Implement a CHMP. • Implement HPPL's Heritage Management Framework; a suite of management procedures.	• Impacts to specific sites of cultural and heritage significance, if unavoidable, will be discussed with Traditional Owners and Approvals sought under the AH Act. • Salvage of heritage material will be undertaken, where appropriate, in consultation with Traditional Owners, prior to direct impact. • Repatriation and restitution of salvaged Heritage material will be undertaken in consultation with Traditional Owners. • Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes in consultation with Traditional Owners and the objectives of the MCP, as required under the Mining Act. • Monitor sites of cultural and heritage significance and report new or unauthorised

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
			disturbances to culturally sensitive sites.
Restricting access to Country and ability to care for Country	• Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi Country. • Indicative Footprint amended to avoid key heritage sites with ongoing refinement of the Mine Plan to maximise site avoidance and avoid access restrictions. • Development Envelope excludes the lodged Mungurrdu site.	• Ongoing consultation with Traditional Owners during the Proposal. • Maintenance of access to culturally significant places where safe and practical. • Implement a SCHMP. • Facilitate Banjima Traditional Owner involvement in monitoring activities where possible.	• Rehabilitation and closure undertaken to meet land use outcomes negotiated with Traditional Owner groups and MCP. • Post-closure access to sites of cultural significance will be maintained. • Post-closure access restrictions will be limited only to areas immediately adjacent to remaining open pits (due to safety reasons).
Activities that may impact amenity such as alteration of landscape or installation of infrastructure	Impacts cannot be avoided and therefore minimisation and rehabilitation are the key mitigation measures.	• Minimise clearing areas as far as practicable. • Ongoing consultation with Traditional Owners during the Proposal. • Waste dumps will be designed to blend in with the surrounding landscape. • Implement a SCHMP. • Noise, dust and vibration mitigation measures to be implemented.	• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners and the objectives of the MCP, as required under the Mining Act. • Monitoring for dust, noise and visual impacts will be ongoing.
Indirect Impacts			

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality	Avoidance measures are not applicable, the focus will be on minimisation measures to reduce the likelihood of impacts.	• Implement the CHMP. • Implement water management measures, including implementation of the Water Management Plan. • Engagement with Traditional Owners to identify sites of cultural significance and avoid impacts to these sites where possible. • Minimise, as far as practicable, interactions with significant water features and impacts to surface water flow, including changes to the hydrological regimes of culturally significant water sources. • Minimise clearing and access restrictions within areas used for cultural purposes or areas that have cultural significance (e.g. at watercourse crossings). • Ensure sediment controls are in place during construction at waterway crossings. • Implement a SCHMP that is co-developed with the Banjima Traditional Owner group. • Implement waste rock management plan.	• Monitoring surface water quality in accordance with a Water Management Plan. • WRDs at closure will be rehabilitated to ensure they are stable, non-poluting and revegetated. • Closure landforms are designed to minimise long-term impacts to hydrological regimes associated with sites of cultural significance. • Groundwater recovery will be investigated and incorporated into the final MCP, to be submitted to support the Mining Proposal.
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate	• Avoidance buffers of 25m (individual sites may have additional buffers applied in consultation with Banjima traditional owners) will be established around retained heritage sites within the Development Envelope, in	• The Proponent will implement standard dust management measures to minimise potential airborne dust emissions and associated impacts to amenity. This includes (but is not limited to) use of dust suppression on access roads and open areas, water sprays for ore processing, transport and stockpiles, limiting the number and height of stockpiles, controlling/reducing trip distance and	• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners and the objectives of the MCP, as required under the Mining Act.

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
dust, noise and vibration	consultation with Traditional Owners. These avoidance buffers will be demarcated and managed in accordance with appropriate site procedures. This will be monitored via the Ground Disturbance Permit process. • HPPL will consult with the Banjima Traditional Owners regarding asbestos management. The Proposal is located outside of the WAMA. HPPL is not proposing to undertake any mining in proximity to Wittenoom and has no intention to reopen Wittenoom.	ensuring vehicles are confined to designated routes with speed limits strictly enforced. • Implement a CHMP. • Operating noise, vibration and potential mitigation measures (e.g. sound absorption devices) must be considered when selecting equipment. • Equipment must be fitted with appropriate noise reduction devices (where necessary) to comply with Proposal HSE and regulatory requirements. • Blasting activities must be undertaken in accordance with Mines Safety Inspection Regulations 1995 and Noise Regulations. • Regularly inspect, maintain and replace mobile equipment so that noise levels are minimised during the equipment life. • Implement HPPL's Drill and Blast near ACH Procedure.	• Monitor sites of cultural and heritage significance and the avoidance buffer zones. Report new or unauthorised disturbances to culturally sensitive sites and avoidance buffers.
Disturbance to broader cultural associations as a result of environmental changes to Country	• Direct impacts to claypans (including Koodjeepindarrnna and Ngarlganoona pools) and Fortescue valley are avoided through Proposal design. • Removal of the Mulga West borefield from the Development Envelope avoids impacts on Yindjibarndi country.	• Implement a SCHMP. • Engagement with Traditional Owners to identify and avoid potential impacts where possible.	• Rehabilitation and closure of the Proposal will be undertaken to meet land use outcomes negotiated in consultation with Traditional Owners, includingincorporation of bushtucker/ medicine species, and habitat for traditional hunting species and the objectives of the MCP, as required under the Mining Act.

Potential Impacts	Avoid	Minimise	Rehabilitate / Monitoring
			• Seed collection prior to/during construction and operations for use in rehabilitation with involvement of Traditional Owners. •

14.6 Assessment and Significance of Residual Impact

An assessment of the significance of residual impacts of the Proposal on Social Surroundings is presented in the following sections.

14.6.1 Direct Impacts

14.6.1.1 Disturbance to sites and areas of Social, Cultural and Heritage value

The Development Envelope for the Proposal contains 303 sites that have been identified as having cultural and heritage value to the Banjima Traditional Owners. Within the Indicative Footprint there are 41 sites of value (refer to **Figure 14-4**). Direct impacts to Aboriginal heritage sites resulting from the Proposal will be managed under the provisions of the AH Act and through the development and implementation of a CHMP where required under the Act.

The Development Envelope has been amended since the Proposal's initial referral to the EPA to exclude key sites of significance to the Banjima Traditional Owners. These include:

- Koodjeepindarrnna and Ngarlganoona pools; and
- Mungurrdu lodged DPLH heritage site.

The Indicative Footprint design has also been amended to further reduce impacts to sites with culture and heritage value to the Banjima Traditional Owners. It is expected that at least 85% of the sites within the Development Envelope will be avoided.

The avoidance, minimisation and rehabilitation measures outlined within **Section 14.5** have been developed to ensure that this direct impact is mitigated. HPPL will continue to engage with Banjima on the development of a CHMP in relation to the sites that will be impacted by the Proposal to inform the development and implementation of the proposed and additional mitigation and management measures, and will comply with legislative requirements under the AH Act. Given the above assessment, it is expected that there will be no significant residual impacts related to the disturbance to sites of Cultural and Heritage value.

14.6.1.2 Restricting Access to Country and Ability to Care for Country

During construction and operation of the Proposal, access to sites of cultural significance within the Development Envelope may be restricted due to safety reasons. Access to heritage sites by the Banjima Traditional Owners is currently being assessed during the negotiations undertaken for the Proposal.

The Mungurrdu DPLH lodged heritage site and the Koodjeepindarrnna and Ngarlganoona pools are located outside of the Development Envelope and therefore access to these areas will not be directly restricted.

HPPL commits to ongoing engagement with Banjima native title holders in relation to ongoing access into, or across, the Development Envelope, noting that heritage sites (including Mungurrdu) in close proximity to active mining areas may become inaccessible for periods of time for safety reasons. Access will be renewed following completion of works in the area and when it is considered safe.

HPPL intends to provide ongoing access during construction and operations through:

- Development of an access protocol through the negotiation of the project agreement;
- Involvement in flora, fauna and water monitoring;
- Involvement in heritage monitoring; and
- Potential creation of additional access tracks to specific Aboriginal cultural heritage of significance, if required.

HPPL will aim to provide ongoing access post-closure to sites and places of cultural significance. HPPL will also restrict workforce and contractors' access to Aboriginal cultural heritage within the Development Envelope except for the purposes of monitoring.

The above proposed management and mitigation commitments in relation to ongoing consultation, workforce and contractors' access to areas of cultural concern and the provision of ongoing access to the Development Envelope, are expected to be sufficient to minimise restrictions to country. After consideration of the above assessment and through the implementation of the mitigation measures outlined in **Section 14.5**, it is expected that there will be no significant residual impact related to restricting access to Country and the ability to care for Country.

14.6.1.3 Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure

The Proposal involves the development of a mine and associated mining infrastructure in a previously undisturbed area, contributing to potential direct impacts to amenity due to the alteration of the landscape. Proposal components that are potentially significant to visual amenity are the pits, WRDs, stockpiles, borrow pits and supporting infrastructure such as accommodation and workshops.

While visual impacts are expected at culturally significant sites during the construction and operations phase, mitigation measures outlined within **Section 14.5** will minimise impacts post-closure, including rehabilitation of disturbance, focussing on minimisation and rehabilitation/monitoring. Ongoing consultation will occur with the Traditional Owners on visual impacts from the proposed infrastructure and final landscape at closure. Through implementing these mitigation measures and ongoing consultation, no significant residual impacts are expected for this potential direct impact.

14.6.2 Indirect Impacts

14.6.2.1 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality

Altered hydrological and hydrogeological regimes

The key potential impacts of the Proposal to hydrological regimes are:

- Groundwater drawdown from orebody dewatering.
- Groundwater mounding from MAR to dispose of excess water with a predicted groundwater uplift to within 2.5 m below ground, causing vegetation health impacts and increased salt accumulation.

- Altered surface water flows and catchment modifications which may impact including creek lines, floodplains and the Fortescue Valley environmental and cultural assets resulting in a modification of inflows and potential changes to the persistence of water.

The conceptual ecohydrological model provides a basis for evaluating groundwater drawdown that could affect the Fortescue Valley vegetation and claypans. There is no observed or conceptualised groundwater contribution to any surface water features within the Development Envelope. Therefore, changes to groundwater levels are not anticipated to affect surface water features of cultural significance.

Further, no GDE's were identified in the Mulga East or Malay Well tenements and a reduction in groundwater levels is not predicted to impact the terrestrial environment. However, the predicted groundwater uplift to within 2.5 m could potentially interface with vegetation root systems and therefore the health and condition of native vegetation. This is discussed further in **Section 7**.

Mitigation and management of impacts as a result of alterations to groundwater levels and surface water flows are discussed in **Section 7** and include implementation of a WMP, pit optimisation and mine planning to reduce dewatering and MAR if required. The Proposal includes several operational MAR areas, to allow agile water management, where increases in MAR in some areas can happen if reductions in MAR in other areas are required. Additional mitigation measures for Social Surroundings values related to water are discussed in Section 14.5, including mine planning to manage surface water flows to Mungurrdu and the provision of the WMP to Banjima Traditional Owners and BNTAC for review and feedback.

The residual risks of reduced surface water flows to the environment (Fortescue Valley and associated features, including the Koodjeepindarrnna and Ngarlganoona pools) on the downstream side of the Proposal, are generally considered to be low. The Koodjeepindarrnna and Ngarlganoona pools are outside of the Development Envelope and located within catchments to the west and east of the mine disturbance areas which do not experience significant changes.

Impacts to surface water flows will be managed through the design and implementation of the surface water management measures (via the WMP) which will minimise the potential impact of altered surface water flows resulting from the Proposal on sites of Aboriginal significance to an acceptable level. HPPL will ensure compliance with Bed and Banks Permits, as required under the RiWI Act. In addition, HPPL will manage any sites of Aboriginal heritage significance in consultation with the Banjima Traditional Owners.

Ongoing monitoring for development of the Baseline Water Quality data set to monitor the potential impact of the Proposal on the downstream environment will be undertaken.

Based on the above assessment, it is considered that alterations to surface water flow and groundwater levels can be managed to ensure that there is no significant residual impact to heritage sites or areas of cultural significance.

Water quality

During construction and operation, the Proposal has the potential to contaminate surface water due to storage and handling of hazardous materials, hydrocarbons, and waste. Site drainage infrastructure will be designed to minimise or eliminate surface water runoff into areas where hydrocarbon contamination may occur.

Modification of the physical water quality (i.e. suspended sediments) may occur in the downstream environment, which may be due to erosion of disturbed areas or diversion of surface water flows resulting in increased sediment loads to the Fortescue Valley and associated features, including the Koodjeepindarrnna and Ngarlganoona pools.

Potential impacts to surface water quality will be managed by appropriate storage and management of hydrocarbons and chemicals, diversion of stormwater around operating areas and diversion structures are design to capture and minimise sediment runoff to undisturbed areas and drainage lines. A Water Management Plan (**Appendix 6**) has been prepared which provides additional information on the surface water management measures proposed.

Groundwater contamination may occur from sources such as the WRD landforms or spills. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low.

Given the absence of observed or conceptualised groundwater contribution to any surface water features within the Development Envelope, changes in groundwater quality are not anticipated to affect surface water features of cultural significance. However, MAR may give rise to salt accumulation in the upper soil profile, resulting from the combined effects of increased evaporative concentration and/or reduced salt leaching into the deeper profile. If sustained over long periods, this could have adverse impacts on vegetation health by reducing soil water extractability. Water quality at claypans (including Koodjeepindarrnna and Ngarlganoona pools) could also be affected by salt loads in the upper profile. As discussed in Section 7.7.1 of the Inland Water Section, predicted groundwater salinity beneath the claypan areas shows only minor fluctuations (<500 mg/L TDS) throughout the LoM.

With the recession of water table associated with decreased MAR, surviving tree root systems (i.e. above zone of prolonged saturation) would be expected to gradually recolonise the desaturated zone down to root impeding layers and salt flushing processes would be reinstated. A program of ongoing monitoring of groundwater levels and vegetation condition will be undertaken. Further, given no GDE's are present, any impacts to groundwater quality will not significantly impact the terrestrial environment.

Groundwater management and monitoring is outlined in the WMP (**Appendix 6**). Ongoing monitoring for development of the Baseline Water Quality data set to monitor the potential impact of the Proposal on the downstream environment will be undertaken.

Based on the above assessment, it is considered that water quality can be managed to ensure that there are no significant residual impacts to Aboriginal cultural heritage.

14.6.2.2 Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust and noise and vibration

Dust

Dust could affect the amenity of the Development Envelope and surrounding area; however, the Proposal is remote from communities and other sensitive receptors and, as such, impacts to residences from dust are

expected to be limited. The amenity of places of cultural significance, heritage sites and the land in general may be affected by dust, but it is anticipated that dust impacts will be confined to the Development Envelope.

HPPL commits to implementing standard dust management measures to minimise airborne dust emissions and deposition outside of active mining areas. These measures are expected to minimise potential visible dust impacts within the Development Envelope.

The SCHMP will be updated as additional on-country consultation provides information in relation to the identification and management of impacts, including those related to dust emissions at culturally significant sites.

Dust may also interfere with physiological processes of vegetation (refer to **Section 9**), including bush tucker. However, the semi-arid environment of the Pilbara region is a naturally dusty environment with wind-blown dust a significant contributor to ambient dust levels in the region, hence, native vegetation is expected to be reasonably tolerant to dust deposition. Studies undertaken for Rio Tinto (Butler, 2009) suggest that the potential for adverse dust deposition impacts on plants is seasonally related. The study failed to identify any significant loss of plant function for exposures of Pilbara species to deposited crustal dust loadings on plant leaves of up to a high level of 7,500 g/m². Another study by Matsuki (2016) also found no evidence of negative impacts on plant health from dust deposition in semi-arid environments. This is considered likely to include any plants used for bush tucker, medicine or other cultural purposes. The Proposal has been designed to limit the potential for dust emissions.

HPPL will implement a number of dust management measures during construction and operation of the Proposal (**Section 14.5**); including, but not limited to:

- Use of dust suppression to manage dust generation from access roads and open areas;
- Use of water sprays to manage dust generation from ore processing, transport and stockpiles;
- Limit the number and height of stockpiles;
- Trip distances controlled and reduced where possible; and
- Vehicles confined to designated routes with speed limits strictly enforced.

Based on the above assessment, residual impacts to sites of cultural significance and surrounding sensitive receptors are not considered to be significant, due to the implementation of mitigation measures outlined in **Section 14.5**.

Noise and Vibration

The noise and vibration assessment conducted by LGA (2024) found that the criteria at one heritage receiver location was not achieved (MIB-MD13-042). The closest Heritage site (MIB-MD13-042) is 40 metres from the pit edge and therefore receives the highest noise level where mining teams work nearby. All other heritage site locations were found to be compliant with the adopted criteria (LGA 2024). For safety reasons it is expected that access to Traditional Owner, will be restricted in proximity (approximately 1 km) to work areas.

Guidance on airblast noise and vibration levels to address the nearest heritage sites were assessed, however, there are no applicable criteria. Blasting strategies will be developed based on the outcomes of the airblast noise

and vibration in conjunction with the geotechnical surveys and monitoring to minimise impacts on sensitive heritage sites.

Based on the PSM (2024) assessment undertaken across 19 caves, four were considered low risk, 11 were considered medium risk and four were considered high risk. To reduce the likelihood of significant damage above the natural background level of degradation, the recommended PPV limits were as follows:

- 75 mm/s for low to medium susceptibility caves; and
- 25 mm/s for high susceptibility caves (PSM, 2024).

The CSFMP (**Appendix 12**) outlines HPPL's approach to managing potential impacts on conservation significant terrestrial fauna from implementation of the Proposal which includes minimising disturbance to caves.

14.6.2.3 Disturbance to broader cultural associations as a result of environmental changes to country

HPPL recognises that important cultural values are held by Traditional Owners in relation to areas and landforms such as country, the night sky, waterways, waterholes and rock shelters. These areas are often associated with stories and songs which Traditional Owners hold sacred and pass on through generations.

Native fauna also has cultural value for hunting and other purposes. Fauna are expected to avoid and/or move away from the noise and activity of construction areas. With large areas of connected habitat surrounding the Development Envelope, this may result in a localised decrease in fauna abundance and diversity. Any impacts are expected to remain localised to the Development Envelope. Extensive areas of habitat will remain in the Development Envelope and surrounding areas which will continue to support culturally significant flora and native fauna.

In consideration of the above and by implementing the mitigation measures outlined in Section 14.5, including ongoing consultation with Traditional Owners, there is likely to be no significant residual impact to broader cultural associations as a result of environmental changes to country.

14.7 Significant Residual Impact

Overall, with the implementation of mitigation actions as formalised and detailed within management plans such as the SCHMP, impacts to Social Surroundings are considered manageable and that the EPA's objectives for this factor can be met. This will be managed via ongoing consultation with Banjima Traditional Owners and other stakeholders identified above.

14.8 Environmental Outcome

HPPL will implement the Proposal to ensure no significant, irreversible damage occurs to social surroundings values. In addition, HPPL are committed to minimise indirect impacts to the health of nearby communities or damage to Traditional Owner's spiritual connection to the environment. HPPL will implement the Proposal in alignment with an agreed policy and process for survey engagement, management, reporting, record keeping and the development of management plans.

An SCHMP will be co-developed and finalised with appropriate mitigation measures identified during consultation with Banjima Traditional Owners . Noting ongoing consultation is being undertaken, HPPL have identified in **Table 14-14** initial environmental outcomes for the Proposal for the Social Surroundings factor.

Table 14-14: Environmental Outcomes

Potential impact	Environmental Outcome
Direct impacts	
Disturbance to sites and areas of Social, Cultural and Heritage Values	The entire Development Envelope will be surveyed for heritage significance, impacts to sites will be managed via the AH Act. No disturbance to Aboriginal cultural heritage sites as identified in consultation with the Banjima Traditional Owners, unless consent is granted to disturb that site under the AH Act.
Restricting access to Country and Ability to Care for Country	Subject to reasonable health and safety requirements, no interruption of ongoing access to land utilised by the Banjima people.
Activities that may temporarily impact amenity such as alteration of landscape, mining activities or installation of infrastructure	The level of visual impact to be generally 'Low' with one area of 'Moderate' impact experienced at the Mulga Downs homestead, noting that this area has been identified as a contaminated site, is uninhabited and fenced off (VP04)
Indirect impacts	
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of altered hydrological and hydrogeological regimes, including altered water quality	Groundwater drawdown and catchment area modifications will not materially impact on the key ecohydrological receptors. Potential impacts on claypans (including Koodjeepindarrnna and Ngarlganoona pools)can be managed to ensure they are not significant. Water quality and hydrological/hydrogeological regimes will be maintained and monitored through implementation of the Water Management Plan. Water quality and hydrological/hydrogeological regimes can be managed to ensure no significant impact to heritage sites or areas of cultural significance
Disturbance to sites of cultural significance and surrounding sensitive receptors as a result of activities that generate dust and noise and vibration	No dust plumes originating from the Proposal received at sensitive receptors outside of the Development Envelope. Noise and vibration will be managed in accordance with relevant regulations (Table 14-1).
Disturbance to broader cultural associations as a result of environmental changes to country	No impacts to cultural associations outside the Development Envelope.

Based on the above, the Proposal is considered to be able to meet the EPA's objective for this factor. The mitigation measures adopted in the Proposal design phase together with the implementation of the proposed mitigation measures is expected to ensure that there are no significant residual impacts to Social Surroundings.

15 Other Factors

The ESD notes the following 'Other' factors which may be relevant to the Proposal. The potential impacts of the Proposal on these factors are addressed in **Table 15-1**:

- Landforms; and
- Human Health.

Table 15-1: Assessment of Other Environmental Factors

Factor	EPA Objective and Guidance	Receiving Environment	Assessment of Proposal Impact	Proposed Mitigation
Landforms	EPA Objective: "To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected." (EPA 2021a). EPA Guidance: Environmental Factor Guideline: Landforms (EPA 2018b).	The Pilbara landscape is one that has evolved over millions of years through several orogenic events, repeated and ongoing erosion and material deposition. The landscape is variable and closely related to the underlying geology, the structural geological features and weathering over time (van Vreeswyk et al. 2004; Pepper et al. 2013). The most noticeable (or dominant) features of the landscape that have evolved over time in the Pilbara region are the plateaus of the iron rich Hamersley and basaltic Chichester Ranges that traverse the craton from east to west over a distance of approximately 350km and reach elevations of up to 900mAHD and 600mAHD respectively (Pepper et al. 2013). The geomorphology within the Development Envelope and surrounding areas is closely related to the underlying geology. To the north it is dominated by the low, topographically subdued hills of the Chichester Ranges whilst to the south the landscape is dominated by the Fortescue River valley.	Baseline environmental surveys for the area of the Proposal and surrounds relevant to the 'Landforms' factor have been completed as outlined within Landloch (2009) and Mine Earth (2020). Mining activity will result in a direct residual direct effect (loss) on a portion of the Chichester Range landform through the excavation of mine pits and construction of waste landforms, over a linear distance of approximately 40 km. In consideration of the broader local extent of such landforms (noting Chichester Ranges extend ~350 km) and the extent of similar landforms across the wider Pilbara region, the effect of the Proposal to the Chichester Ranges landform is not considered to be environmentally significant. The Fortescue Valley is split by the Goodiadarrie Hills into the Fortescue Marsh to the east, and the Goodiadarrie Swamp to the west. The Proposal is fully contained within the Goodiadarrie Swamp catchment. The Goodiadarrie Swamp comprises a series of variably interconnected ephemeral swamps, claypans, and floodplains that form a wetland mosaic over a distance of 70 km. Collectively, the Goodiadarrie Swamp has an area of approximately 4,140 km^2. The Goodiadarrie Swamp catchment is bounded by the Chichester Range to the north and the Hamersley Range to the south (AQ2 2024a). Discharge of surface water into the Fortescue Valley is from the northern Chichester Ranges and the southern Hamersley Ranges. The Proposal will be developed to ensure the flow of surface water from the northern Chichester Range to the Lower Fortescue River valley is maintained and	HPPL propose to manage the potential effect of the Proposal to 'Landforms' through key management measures including: • Avoidance of Claypan habitat features within the Fortescue River Valley landform; • Surface water management structures designed to maintain natural patterns of surface water flow; and • Progressive and post-mining rehabilitation of landforms to restore flora and vegetation values and fauna habitat values. Based on the predicted impacts of the Proposal to the recorded landform values, subject to the implementation of the identified management measures (above), it is considered EPA objective for the environmental factor of 'Landforms' can be met.

Factor	EPA Objective and Guidance	Receiving Environment	Assessment of Proposal Impact	Proposed Mitigation
			sustained. Accordingly, the impact of the Proposal to the Fortescue River Valley landform is not anticipated to be significant.	
Human Health	EPA Objective: "To protect human health from significant harm." (EPA 2021a). EPA Guidance: Environmental Factor Guideline: Human Health (EPA 2016i).	The Proposal is located in a remote area of the Pilbara region in Western Australia. The nearest town is Tom Price which is located approximately 110 km to the southwest of the Development Envelope. Port Hedland is located approximately 210 km to the north, whilst Newman is located approximately 180 km to the east. The Youngaleena community is located approximately 12 km to the south of the Development Envelope. The Wirrilimarra community is located approximately 8.5 km to the east of the Development Envelope. There is no community at Wittenoom, as the town was degazetted in 2007 and closed in 2013 (DPLH 2021). Tourism in the immediate area surrounding the Development Envelope is very limited. Accommodation is provided (motel and caravan) at the Auski Roadhouse which is located approximately 24 km to the south east of the Development Envelope at the junction of Great Northern Hwy and Nanutarra-Munjina Rd. The nearest major tourist attraction is the Karijini National Park and the associated gorges within the park. The northern boundary of the National Park is located approximately 7.6 km to the south of the Development Envelope.	For the purposes of EIA, consideration of possible impacts to human health is largely confined to EIA of harmful emissions to air and harmful discharges to soil, inland waters and marine waters, that is through impacts to the physical environment. Because the consideration of the above health hazards are explicitly informed through other EPA guidelines, the assessment of impacts to human health provides the specific framework for considering the possible impacts to human health arising from the emission of radiation. The Proposal has no potential to cause or emit radiation that could impact on human health.	Not applicable. However, radioactive materials, if required, can be managed by under DEMIRS and DG Act.