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24 February 2021

Attn: Jonathon Barker
Rio Tinto Iron Ore
Level 12, Central Park
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Dear Jonathon,

Please find below a memo summarising the methods and outcomes of the recent fauna habitat extrapolation project for Brockman Syncline.

1. Introduction and Objectives

Biologic Environmental Survey (Biologic) were commissioned to extrapolate fauna habitat mapping for the Brockman Syncline Development Envelope (herein the Development Envelope) and apply this mapping to fauna species considered as Matters of National Environmental Significance (MNES), listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Fauna habitat mapping has previously been completed for the Development Envelope by Stantec (2020).

Based on the extensive habitats surrounding the Development Envelope, Biologic proposed completing broad-scale mapping within 10 km of the Development Envelope.

1.1 Objectives

The objectives of the extrapolated mapping were:

- Undertake a desktop assessment of fauna habitat mapping completed within the vicinity of the area of interest;
- Undertake regional fauna habitat mapping of key MNES habitats; and
- Provide a short technical memo to accompany fauna habitat mapping data, detailing methods and techniques used and any limitations.

2. Methods

2.1 Review of previous reports and mapping

A review of fauna habitats previously mapped was undertaken to determine likely fauna habitats occurring within the unmapped areas (10 km extrapolated area) beyond the Development Envelope. Biologic mapped the broad fauna habitats within the extrapolated area, and where possible were consistent with the fauna habitat types shown in previous surveys (Biologic, 2020; Stantec, 2020), however, some habitat types were merged and/or not mapped due to the inability to map at a fine scale without a field survey.

Three publicly available surveys have included fauna habitat mapping within parts of the 10 km extrapolated area (Biota, 2009; Ecoscape, 2018; Stantec, 2020). These surveys were used as a guide to assist in mapping the fauna habitats within the extrapolated area. Some areas have no previous vegetation or fauna habitat mapping completed and/or were not accessible.

2.1.1 Nomenclature of previous habitat naming

No consolidation of the previously mapped fauna habitats within the Development Envelopment was undertaken. New fauna habitats were mapped, and where possible, were aligned with existing mapping to ensure consistency (Table 2.1). The same level of detail in Stantec (2020) was not possible via desktop extrapolation and therefore changes to the scale, nomenclature and categories have occurred. In addition, inconsistencies within the previous dataset made it difficult for complete alignment, therefore some are named differently (Table 2.1).

A summary of the fauna habitat classifications defined in the Development Envelopment are provided in Appendix A (Stantec, 2020).

Table 2.1: Habitat classification and descriptions mapped within the extrapolated area by Biologic with corresponding names used in Stantec (2020)

Habitat Type	Corresponding habitat type/s as per Stantec (2020)	Description
Gorge/Gully and Free Face	• **Gorge/ gully and free face** • **Debris slope/rocky outcrop**	Gorge/Gully and Free Face habitat comprises rugged large rock faces and steep-sided valleys usually associated with ridges, with high potential to host caves, overhangs, crevices and alcoves. These areas, particularly gorges, also have potential to hold temporary water sources during inundation owing to the presence of bedrock. Vegetation within this habitat is variable depending on the position in the landscape and can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred. This habitat is important for various MNES species and fauna in general.
Hillslope	• **Footslope** • **Midslope/upper slope** • **Plateau**	Hillslope habitat tends to be more open and structurally simple than other fauna habitats. A common feature of this habitat is a rocky substrate, often with exposed bedrock, and skeletal red soils. These can contain cracks and crevices, but not to the same extent as within rocky upland areas of Gorge/Gully and Free Face habitat. This habitat is usually dominated by sparse open *Eucalyptus* woodlands, *Acacia* and *Grevillea* shrublands and *Triodia* hummock grasslands.
Gently Sloping Rise	• **Gently sloping rise** • **Pediment slope** • **Minor creekline (some instances)**	Gently sloping rise habitat is generally characterised by low to moderately inclined slopes dominated by a rocky/ stony substrate and occasionally hosts exposed bedrock. Some areas of this habitat type could support medium-sized rocks on the crest of hills, features that may provide limited shelter for fauna. This habitat is usually dominated by sparse *Eucalyptus* sp. and *Corymbia* sp. over shrubs including *Hakea* sp. and *Acacia* sp., over a high cover of *Triodia* hummock grasslands. In some instances, this habitat type adjoins/ overlaps with minor creeklines.
Major Creekline	• **Major creekline**	Major Creekline habitat is variable in structure and condition. Vegetation within this habitat is often dominated by *Eucalyptus* or *Melaleuca* species over a variable understory comprising mixed small to medium shrubs (*Acacia* sp.) and tussock grasses over sandy creek beds. Vegetation adjacent to the main channel or channels is denser, taller and more diverse than adjacent terrain. The structure and condition of vegetation often varies seasonally, particularly following rainfall events. Vegetation condition often subject to heavy cattle grazing. Temporary, semi-permanent – permanent water pools can occur within this habitat, usually after rainfall events.

Habitat Type	Corresponding habitat type/s as per Stantec (2020)	Description
Plains	• **Alluvial plain** • **Colluvial plain** • **Hardpan plain** • **Minor creekline (some instances)** • **Pediment slope**	"Plains" covers a variety of plains habitat including but not limited to hardpan plain, spinifex stony plain, spinifex sandplain, floodplain, calcrete plain, claypan and/or alluvial plain. Generally low-lying (but sometimes gently undulating) plains comprising of stone, sand, loam, clay and/or hardpan soils. Stony plain, sandplain and calcrete plain are dominated by soft and hard spinifex hummock grasslands (Triodia spp.) with scattered patches of various small to medium shrub species (*Acacia* sp.) Sandplains have a high burrowing suitability. Hardpan plains are dominated by stands of mulga, with a high proportion of the substrate comprising bare soil with a grassy understorey (tussocks). Floodplain/ alluvial or/and colluvial plains generally have a higher shrub cover owing to the increased influence of drainage. Vegetation typically comprises mulga, *Acacia* sp. *Hakea* sp. and *Eucalyptus* sp. with an understorey of tussock and hummock grasses. Plains habitat are generally associated with drainage lines and depressions and may become inundated during widespread flooding and/ or heavy rainfall events. The frequency of inundation is likely to vary for this habitat, with areas more prone to inundation supporting tussock grasses and softer soils (less stony), and the remaining areas dominated by hummock grasses. No rocky features comprising of caves, crevices or outcroppings are present.

2.2 Extrapolation of MNES habitat to 10 km radius surrounding the Development Envelope

Extrapolated habitats of significance to MNES were delineated to a 10 km radius surrounding the Development Area. For the purposes of this assessment, critical habitat followed that of DoE (2013), being areas necessary "for activities such as foraging, breeding, roosting, or dispersal". Habitat critical to the survival of a species is defined by DoE (2013) as *"areas that are necessary: for activities such as foraging, breeding, roosting, or dispersal, the long-term maintenance of the species, to maintain genetic diversity and long term evolutionary development, or for the reintroduction of populations or recovery of the species"*. Habitat's considered marginally suitable were deemed to be of moderate significance.

Table 2.2 below shows the adapted habitat significance scores from Biologic (2020) for each of the habitat types present in the extrapolated area. Due to differing habitat preferences of conservation significant species (including habitat features and/or microhabitats), habitat significance was assessed on a species by species basis.

Table 2.2 Habitats of significance at Brockman for MNES species, adapted from Biologic (2020)

Habitat Type	Significance to target species						General habitat significance
	Northern quoll	Greater bilby	Pilbara leaf-nosed bat	Ghost bat	Night parrot	Pilbara olive python	
Gorge/ Gully and Free Face	**High -** Provides core habitat (shelter, denning and foraging). Consistent with core habitat as described by DoE (2013).	Provides nil habitat.	**High –** Provides core roosting habitat (caves). Consistent with core habitat as described by DoE (2013).	**High –** Provides core roosting habitat (caves). Consistent with core habitat as described by DoE (2013).	Provides nil habitat.	**High -** Provides core breeding and shelter habitat. Consistent with core habitat as described by DoE (2013).	**High** Primary/core habitat for MNES species. Provides significant refugia/shelter sites. Contains significant microhabitats: caves, crevices, overhangs.
Hillslope	**Low** - Provides limited foraging and dispersal habitat potential.	Provides nil habitat.	**Low** - Provides limited foraging and dispersal habitat potential.	**Moderate** - Provides some core roosting habitat. Provides limited foraging and dispersal habitat. Consistent with core habitat as described by DoE (2013).	Provides nil habitat.	**Low** - Provides limited foraging habitat potential.	**Low** Low value to MNES species as it provides limited foraging habitat. Low value to a range of fauna species that are likely to reside in this habitat type.
Gently Sloping Rise	**Low** - Provides limited foraging and dispersal habitat potential.	Provides nil habitat.	**Low** - Provides limited foraging and dispersal habitat.	**Low** - Provides limited foraging and dispersal habitat.	Provides nil habitat.	**Low** - Provides limited foraging and dispersal habitat potential.	**Low** Low value to MNES species as it provides limited foraging habitat. Low value to a range of fauna species that are likely to reside in this habitat type.
Major Creekline	**Moderate** - Provides potential foraging and dispersal habitat. Consistent with core habitat as described by DoE (2013).	Provides nil habitat	**Moderate** - Provides high value foraging and dispersal habitat. Consistent with core habitat as described by DoE (2013).	**Moderate** - Provides high value foraging and dispersal habitat. Consistent with core habitat as described by DoE (2013).	Provides nil habitat.	**High -** Provides shelter, foraging, and dispersal habitat. Consistent with core habitat as described by DoE (2013).	**High** Moderate to High value for MNES species for foraging and dispersal. High value to a wide range of fauna species.
Plains	**Low -** Provides low quality foraging and dispersal habitat.	**Low -** Provides low quality foraging and burrowing habitat.	**Moderate** - Provides high value foraging and dispersal habitat. Consistent with core habitat as described by DoE (2013).	**Moderate** - Provides high value foraging and dispersal habitat. Consistent with core habitat as described by DoE (2013).	**Low -** Provides low quality nesting/ foraging habitat.	**Low -** Provides low quality foraging and dispersal habitat.	**Moderate** Moderate value for some MNES species (bats) for foraging opportunities.

3. Limitations

The limitations associated with the extrapolated fauna habitat mapping are outlined below:

- The extrapolation of significant fauna habitats inevitably involved a high level of interpretation as these processes were done through desktop methods, and without ground-truthing via habitat assessments or sampling.
- The scale at which the extrapolated habitats were mapped would not allow for accurate mapping of 'Minor Creekline' habitat.
- Natural variation of each extrapolated habitat exists in the regional setting of the Development Envelope.
- There is a lower confidence in the confirmation of certain habitat types identified by desktop mapping.
- There was a degree of inconsistency within the previous fauna habitat mapping dataset (Stantec, 2020) making it difficult to completely align habitat types.

4. Results and Discussion

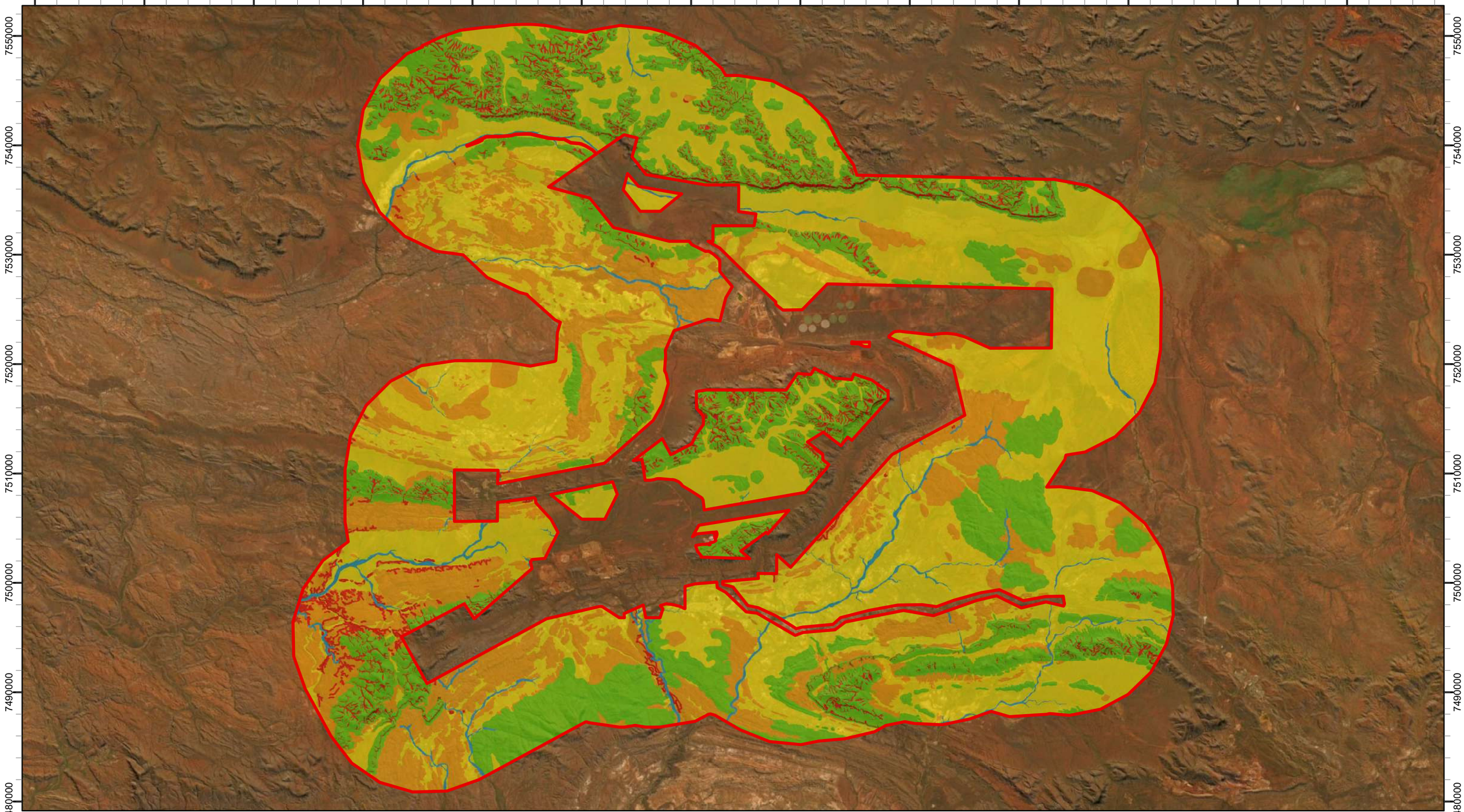
The delineation of fauna habitat mapping for the extrapolated area beyond the Development Envelope boundary was informed via desktop assessment and aerial imagery including land system mapping, broad geological and soil mapping, pre-European vegetation mapping and topography (contours). The desktop assessment involved a review of available spatial data from surveys completed within the Development Envelope and within the 10 km extrapolated area. The habitat types identified within the extrapolated area, and the land systems in which these habitats occur, are considered typical of the region.

A total of 332,568.79 hectares (ha) of extrapolated mapping has been undertaken to accommodate a 10 km buffer around the Development Envelope boundary (Table 4.1; Figure 4.1). Five fauna habitats were mapped, comprising, in increasing order of extent; Major Creekline, Gorge/Gully and Free Face, Gently Sloping Rise, Hillslope and Plains. Plains, Hillslope and Gently Sloping Rise were the dominate fauna habitats covering 47.68%, 25.04% and 22.54% of the extrapolated area, respectively (Table 4.1).

This extrapolated mapping includes habitats considered of significance to MNES species (Table 2.2; Table 4.1), including Gorge/Gully and Free Face, and Major Creekline habitats. Gorge/Gully and Free Face habitats are considered of high significance for the northern quoll, ghost bat, Pilbara leaf-nosed bat and Pilbara olive python and covers approximately 3.46% (11,491.29 ha) of the extrapolated area (Table 2.2; Table 4.1). Major Creekline habitat is classified as high significance for the Pilbara olive python and moderate significance for the northern quoll, ghost bat and Pilbara leaf-nosed bat, covering approximately 1.28% (4,269.68 ha) of the extrapolated area (Table 2.2; Table 4.1).

Table 4.1: Summary of extrapolated habitat mapped for the current project

Habitat	Area mapped (ha)	Extent in the extrapolated area (%)
MNES extrapolated habitat		
Gorge/Gully and Free Face	11,491.29	3.46
Hillslope	83,262.62	25.04
Gently Sloping Rise	74,960.14	22.54
Major Creekline	4,269.68	1.28
Plains	158,585.05	47.68
Total	**332,568.78**	**-**



Legend

- Extrapolation Area

Broad Fauna Habitats

- Gently Sloping Rise
- Gorge/Gully and Free Face
- Hillslope
- Major Creekline
- Plains

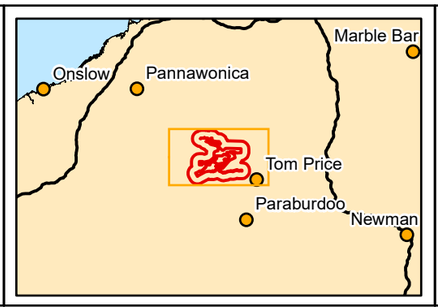
N

biologic Environmental Survey

Scale: 1:325,000

0 2 4 6 8 10 12 14 16 18 Km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994 Created 04/02/2021



RIO TINTO

Greater Brockman

Figure 4.1: Extrapolated fauna habitats within 10 km of the Development Envelope

5. References

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Appendix A – Habitat classifications and descriptions defined by Stantec(2020) and used in the previous report Biologic(2020) occurring within the Development Envelopment

Habitat Type	Description
Plateau	The Plateau habitat was the most elevated habitat in the Study Area, and was either flat or crested, with gently sloping spinifex hummock grasslands over a substrate with coarse fragments dominated by ironstone. This habitat tended to be more exposed and only supported a sparse cover of vegetation in the mid and upper stratum, with limited debris for shelter by fauna.
Gorge/ gully and free face	Gorge/Gully and Free Face habitat was characterised by large rock faces and gorges usually associated with ridges, with high potential to host caves, overhangs, crevices and alcoves. These areas, particularly gorges, also have potential to hold temporary water sources during inundation owing to the presence of bedrock. This habitat was predominantly located adjacent to the Midslope/Upper Slope habitats, however also occurred adjacent to the Footslopes and gently sloping rises habitats. Vegetation tended to include *Eucalyptus* and *Grevillea* sp. over *Triodia* and tussock grasses. This habitat also supported occasional *Ficus* sp. however, these did not comprise large stands or wet leaf litter. Gullies supported a relatively high vegetation cover, including larger *Eucalyptus* trees, often with small or large hollows. The substrate comprised coarse fragments dominated by ironstone.
Midslope/upper slope	The Midslope/Upper Slope habitat comprised steep slopes leading into lower footslopes. This habitat was characterised by steep slopes with a high proportion of coarse fragments dominated by ironstone. Vegetation tended to comprise a sparse upper story of *Eucalyptus leucophloia*, over a sparse mid cover of *Grevillea*, *Hakea* and *Acacia* shrubs, with a relatively high cover of *Triodia* hummock grassland.
Footslope	The Footslope habitat was typically downslope from the steeper Midslope/Upper Slope habitat. This habitat was characterised by gently to moderately inclined slopes with coarse fragments dominated by ironstone. Vegetation tended to comprise a sparse upper story of *Eucalyptus leucophloia*, over a low to sparse cover of shrubs and trees including *Hakea* sp. and *Acacia* sp., over a high cover of *Triodia* hummock grassland. Aside from reduced slope angle, Footslope habitat differed from Midslope/Upper Slope areas by having less rocky areas and a high *Triodia* cover.
Gently sloping rise	The Gently Sloping Rise habitat occurred at the base of the Footslope habitat. Typically, the substrate was dominated by coarse fragments, with sparse *Eucalyptus* sp. and *Corymbia* sp. over shrubs including *Hakea* sp. and *Acacia* sp., over a high cover of *Triodia* hummock grassland. This habitat contained very little woody debris and leaf litter, and occasionally hosted exposed bedrock. Some areas of this habitat type also supported medium-sized rocks on the crest of hills, features that may provide limited shelter for fauna.
Debris slope/rocky outcrop	The Debris Slope and Rocky Outcrop habitat comprised rocky areas ranging from large boulders forming crevices and shelter, to small rock faces. This habitat contained conglomerates, ironstone and shale, which may form shelter for fauna, and caves or alcoves, however, not to the extent of the Gorge/Gully and Free Face habitat. This habitat generally occurred in close proximity to gently sloping rises. The upper and mid storey of this habitat comprised a low to sparse cover of trees and shrubs, including *Eucalyptus* sp. and *Acacia* spp., and occasionally *Ficus* sp. These species provided leaf litter and woody debris, ranging from rare to very common. Where exposed bedrock was absent, lower vegetation tended to include *Triodia* hummock grassland, however, in shaded areas lower vegetation tended to comprise a sparse cover of *Cymbopogon* tussock grassland. Similar to Gorge/Gully and Free Face habitat, the Debris Slope and Rocky Outcrop habitat has potential to provide refugia from less intense fires, with more sheltered conditions than the surrounding landscape.
Pediment slope	Pediment Slope habitat was characterised by gently sloping or flat areas, usually associated with low rises or footslopes. Upper and mid story typically comprised *Acacia*, *Grevillea* and *Hakea* shrubs over a stony substrate, with a high cover of *Triodia*. Most areas of this habitat would be influenced by laminar sheet flow but would be unlikely to support ponding.
Colluvial plain	Colluvial Plain habitat was usually associated with alluvial plains or drainage lines, which provide depositional surfaces. Substrates within this habitat were typically less stony than that of the adjacent pediment slopes and tended to have a higher shrub cover owing to the increased influence of drainage. Increased shrub cover likely provides additional habitat for avifauna, while leaf litter and woody debris provide shelter for reptiles and mammals. The lower story was largely dominated by *Triodia*. This habitat has a higher burrowing and foraging suitability for fauna due to the reduced stony substrate.

Habitat Type	Description
Alluvial plain	The Alluvial Plain habitat occurred in flat areas in association with creeklines and depressions. The habitat generally supported increased shrub cover, tussock grasses and clay-based soils. Vegetation typically comprised Mulga, *Acacia* sp. *Hakea* sp. and *Eucalyptus* sp. The frequency of inundation is likely to vary for this habitat, with areas more prone to inundation supporting tussock grasses, and the remaining areas dominated by hummock grasses. Alluvial Plain tended to contain a moderate to high burrowing suitability, which may support foraging reptiles and mammals. Woody debris and leaf litter were common compared to other habitat types. This habitat was also more prone to disturbance from cattle grazing and trampling, likely due to the presence of palatable tussock grasses (van Vreeswyk *et al.*, 2004).
Major creekline	The Major Creekline habitat supported an upper story of relatively tall and mature *Eucalyptus* or *Corymbia*. Lower vegetation comprised soft *Triodia sp.* and tussock grasses (e.g. Buffel Grass), which are both considered palatable to livestock, often leading to degradation (van Vreeswyk *et al.*, 2004). The mature *Eucalyptus* or *Corymbia* provided foraging habitat for nectivorous avifauna when in flower, and shelter and roosting habitat for avifauna. Increased leaf litter and woody debris may also provide shelter for small mammals and reptiles. When inundated, Major Creekline habitat is more likely to retain water, serving as an important temporary resource for aquatic and terrestrial fauna, including habitat for amphibians. Conversely, dry channels may support fauna dispersal.
Minor creekline	Minor Creekline habitat usually lacked a tall dense upper storey, but with a dense mid storey. Substrate was typically sandy channels or clay banks, with relatively dense fringing vegetation including sparse *Eucalyptus* sp., and *Acacia* sp. over tussock grasses including Buffel Grass (*Cenchrus ciliaris*) and *Triodia* sp. hummock grasses.
Hardpan plain	Hardpan Plain comprised flat clay-based plains dominated by stands of mulga, with a high proportion of the substrate comprising bare soil. Vegetation also comprised *Hakea* sp. and a lower storey of shrubs and grasses (*Triodia* sp. and tussocks) which tend to be palatable for livestock, and the habitat was in poor condition due to cattle trampling, scats and grazing. This habitat would experience sheet flow following rain.
Disturbed	N/A