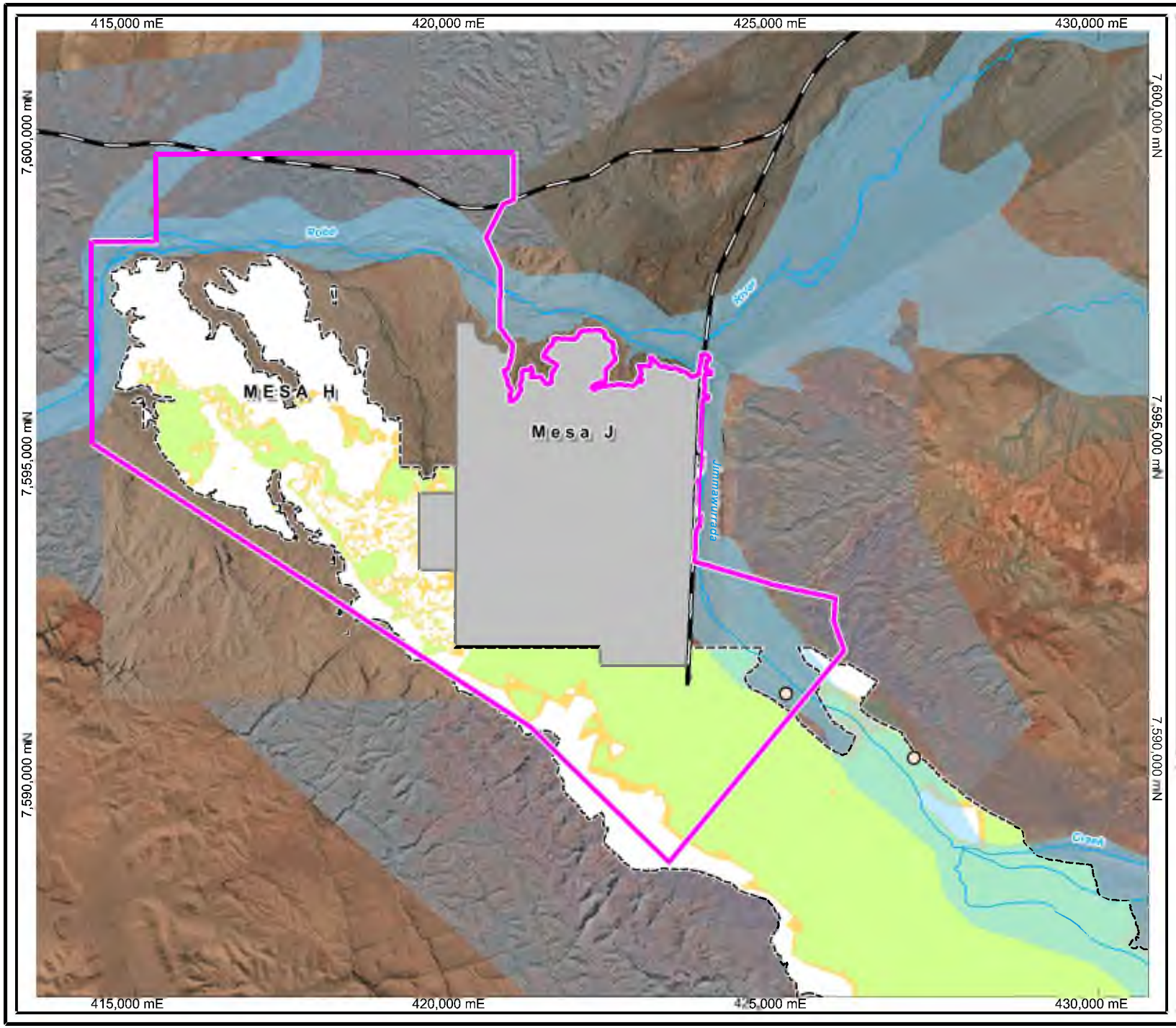


LEGEND

- Development Envelope
- Railway
- Major Watercourse
- Ministerial Statement 208
- Limit of high confidence habitat mapping

3D Modelled habitat Prospectivity **(CID)** *(high confidence)**

- Habitat Prospectivity: High
- Habitat Prospectivity: Medium
- Habitat Prospectivity: Low

2D surface geology habitat Prospectivity

Alluvials

- Habitat Prospectivity: High

* based on geology and water table levels

Thermosbaenacea

- Halosbaena tulki

N

SCALE

0 1 2 3 4km

1:85 000 @ A4

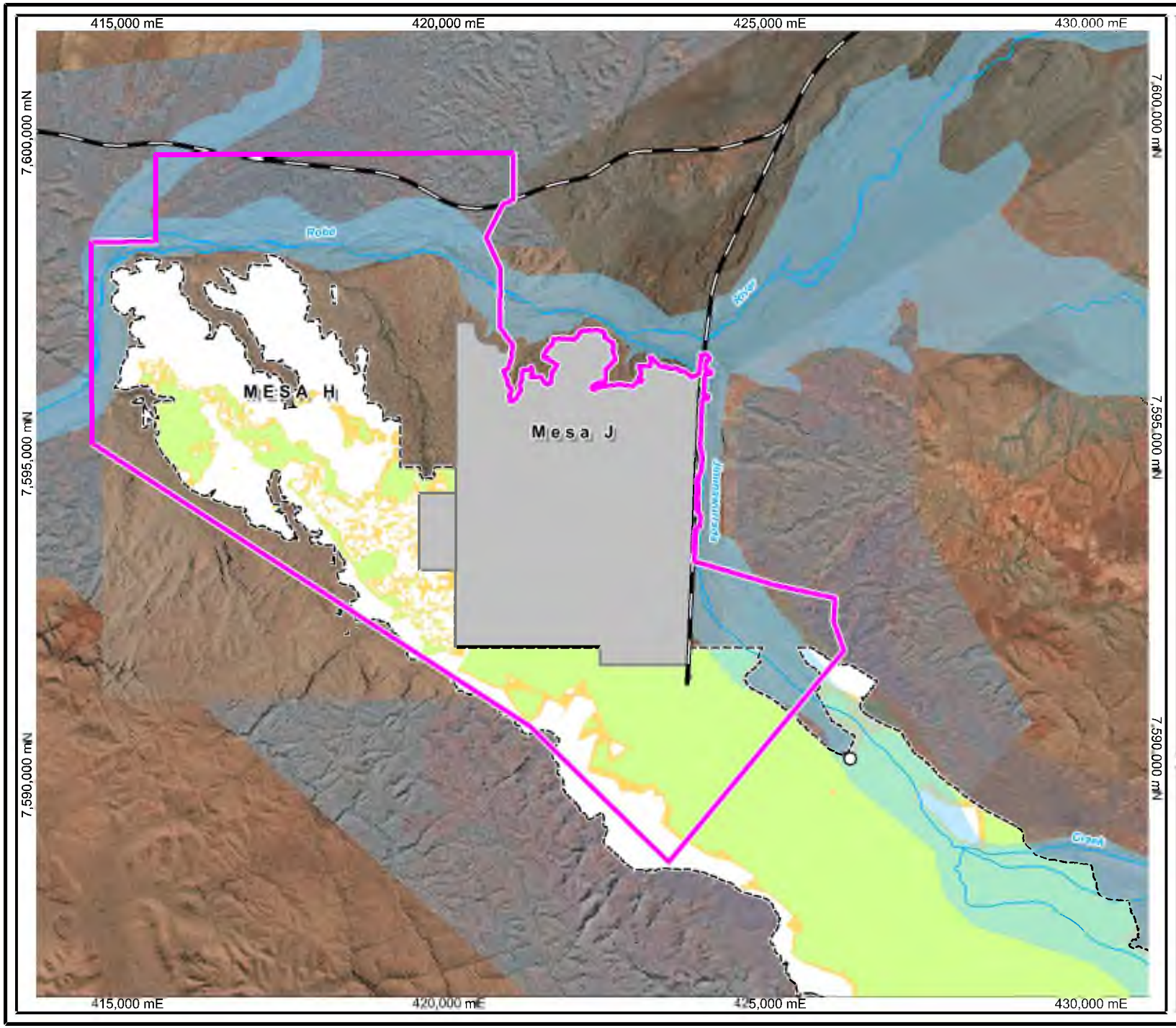
RioTinto

Iron Ore (WA)

Figure 7-14: Stygofauna records and Retained habitat in or near the Development Envelope Map 10 - Thermosbaenacea

Drawn: M.Swebbs
Date: Mar, 2019

Plan No: PDE0159872v7
Proj: MGA94 Zone50



LEGEND

- Development Envelope
- Railway
- Major Watercourse
- Ministerial Statement 208
- Limit of high confidence habitat mapping

3D Modelled habitat Prospectivity **(CID)**
*(high confidence)**

- Habitat Prospectivity: High
- Habitat Prospectivity: Medium
- Habitat Prospectivity: Low

2D surface geology habitat Prospectivity
Alluvials

- Habitat Prospectivity: High

* based on geology and water table levels

Synbranchiformes

- Ophisternon candidum

N

SCALE

0 1 2 3 4km

1:85 000 @ A4

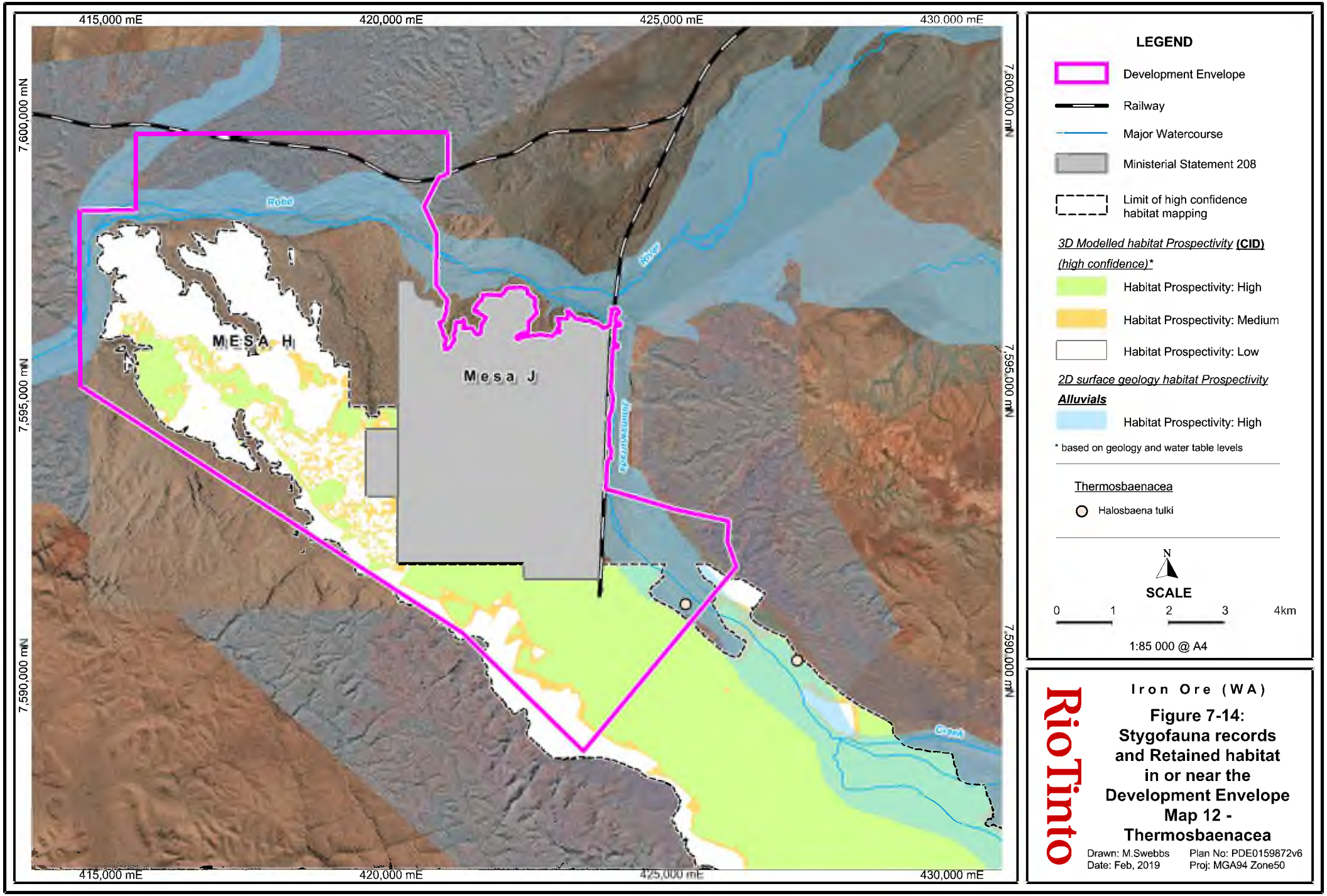
RioTinto

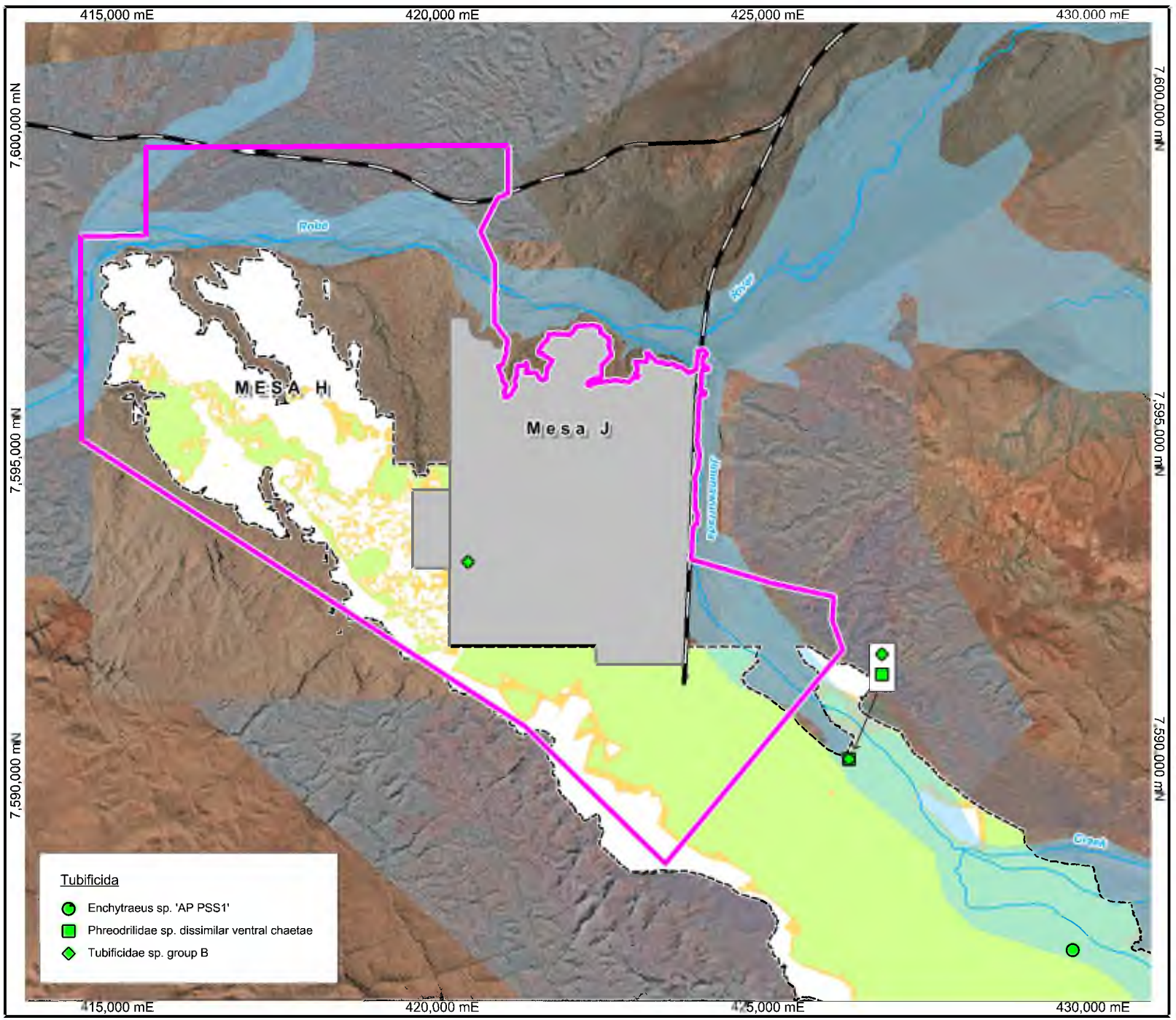
Iron Ore (WA)

Figure 7-14: Stygofauna records and Retained habitat in or near the Development Envelope Map 11 - Synbranchiformes

Drawn: M.Swebbs
Date: Feb, 2019

Plan No: PDE0159872v6
Proj: MGA94 Zone50


415,000 mE
420,000 mE
425,000 mE
430,000 mE
7,600,000 mN
7,595,000 mN
7,590,000 mN
MESA H
Mesa J
Road
LEGEND
Development Envelope
Railway
Major Watercourse
Ministerial Statement 208
Limit of high confidence habitat mapping
3D Modelled habitat Prospectivity (CID) (high confidence)*
Habitat Prospectivity: High
Habitat Prospectivity: Medium
Habitat Prospectivity: Low
2D surface geology habitat Prospectivity
Alluvials
Habitat Prospectivity: High
* based on geology and water table levels
Thermosbaenacea
Halosbaena tulki
N
SCALE
0 1 2 3 4km
1:85 000 @ A4
RioTinto
Iron Ore (WA)
Figure 7-14: Stygofauna records and Retained habitat in or near the Development Envelope Map 12 - Thermosbaenacea
Drawn: M.Swebbs
Date: Feb, 2019
Plan No: PDE0159872v6
Proj: MGA94 Zone50



LEGEND

- Development Envelope
- Railway
- Major Watercourse
- Ministerial Statement 208
- Limit of high confidence habitat mapping

3D Modelled habitat Prospectivity **(CID)** *(high confidence)**

- Habitat Prospectivity: High
- Habitat Prospectivity: Medium
- Habitat Prospectivity: Low

2D surface geology habitat Prospectivity

Alluvials

- Habitat Prospectivity: High

* based on geology and water table levels

N

SCALE

0 1 2 3 4km

1:85 000 @ A4

RioTinto

Iron Ore (WA)

Figure 7-14: Stygofauna records and Retained habitat in or near the Development Envelope Map 13 - Tubificida

Drawn: M.Swebbs
Date: Feb, 2019

Plan No: PDE0159872v6
Proj: MGA94 Zone50

7.5.2 Potential impacts

A number of potential impacts are identified in the ESD. The potential direct, indirect and cumulative impacts identified for the Proposed Change on the basis of stygofauna surveys and assessments are described in Section 7.5.3.

7.5.2.1 Direct impacts

Direct impacts on stygofauna species comprise both habitat removal where the mine pits extend BWT and the dewatering necessary to enable this to occur.

Potential direct impacts of the Proposed Change have therefore been identified as:

- Reduction in stygofauna habitat due to BWT pit excavation at Mesa H (physical removal of habitat).
- Reduction in stygofauna habitat due to groundwater abstraction resulting in groundwater drawdown at Jimmawurrada Creek and Mesa H.
- Loss of individuals and changes to assemblages due BWT mining at Mesa H and due to groundwater abstraction at Mesa H and Jimmawurrada Creek.

Figure 7-15 shows the maximum modelled extent of groundwater drawdown at Mesa H and Jimmawurrada Creek due to the cumulative drawdown from the Revised Proposal and includes the cumulative groundwater drawdown due to Mesa J, the Southern Cutback Borefield and the CWSP in relation to modelled stygofauna habitat prospectivity. This extent also includes the direct reduction in stygofauna habitat due to BWT pit excavation at Mesa H.

Sixteen key stygofauna species, comprising 13 potential SRE species and three conservation significant species were recorded from the cumulative groundwater drawdown area. Figure 7-15 shows the distribution of these species relative to the mine pits and the maximum modelled drawdown extent for the Revised Proposal. Three species recorded from within the Proposed Change Area are also known from the Mesa J Iron Ore Development and have also been recorded from other locations outside the Development Envelope Table 7-20 summarises the sites that the 16 key species occur at and the level of predicted groundwater drawdown impact.

Table 7-20: Summary of Records of Impacted Stygofauna Key Receptors Relative to the Drawdown Extent (Reference Sites From Biota (2019a); Species Shaded Grey Known Only from the Drawdown Extent)

Species	Impact Sites	Predicted Drawdown (m)	Reference Sites; Wider Distribution
*Ophisternon candidum**	MB17MEH0015	1	RR1, 25, RRD2, Control, Cape Range.
	JW021	3	
	JW023	4	
	JW024	2	
	BC186	5	
*Nedsia hurlberti**	JW011A	20	Mesa J, Bungaroo Creek headwaters, Barrow Island.
	JW021	3	
	JW023	4	
	JW024	2	
	JIMDD080	12	
	JIMDR094	4	

Species	Impact Sites	Predicted Drawdown (m)	Reference Sites; Wider Distribution
*Nedsia sculptilis**	JW011A	20	Mesa J, Bungaroo Creek headwaters, Barrow Island.
	JW021	3	
	JIMDR094	4	
Hydrobiidae sp. 2	JW023	4	-
Areacandona sp. 'BOS1039'	BC186	5	31 (Mesa J, Middle Robe)
Megastygonitocrella unispinosa	MB17MEH0015	1	Robe River valley.
Candoninae sp. 'BOS541'	JW024	2	-
Pilbaracandona sp. 'BOS526'	JW024	2	-
Parastenocaris sp. 'B28'	JW023	4	-
Haptolana sp. 'B01'	JW024	2	-
Nedsia sp. 'AMM026'	RC13MEH0097	21	31
Paramelitidae sp. 'AMP003'	RC13MEH0041	21	-
Paramelitidae sp. 'AMP035'	RC13MEH0007	22	RR1
Paramelitidae sp. 'AMP037'	BC186	5	-
Wesniphargus sp. 'AMN004'	JW024	2	25
Neoniphargidae sp. 'B02'	JW021	3	31

* Formally listed as being of conservation significance

Nine of 16 key species have also been recorded from reference sites outside of the drawdown extent (Table 7-20). Three of these nine more widely-known species, *Ophisternon candidum*, *Nedsia hurlberti* and *Nedsia sculptilis*, are all Threatened fauna ranked Vulnerable under Schedule 3 of the BC Act, and although all three are also known from outside the drawdown extent, they are provided specific consideration in recognition of their elevated conservation status.

This leaves seven species which are currently known only from within the modelled extent of cumulative drawdown (Figure 7-15):

- the aquatic snail *Hydrobiidae* sp. 2;
- two ostracods; *Candoninae* sp. 'BOS541' and *Pilbaracandona* sp. 'BOS526';
- the copepod *Parastenocaris* sp. 'B28';
- the isopod *Haptolana* sp. 'B01'; and
- two amphipod species: *Paramelitidae* sp. 'AMP003' and *Paramelitidae* sp. 'AMP037'.

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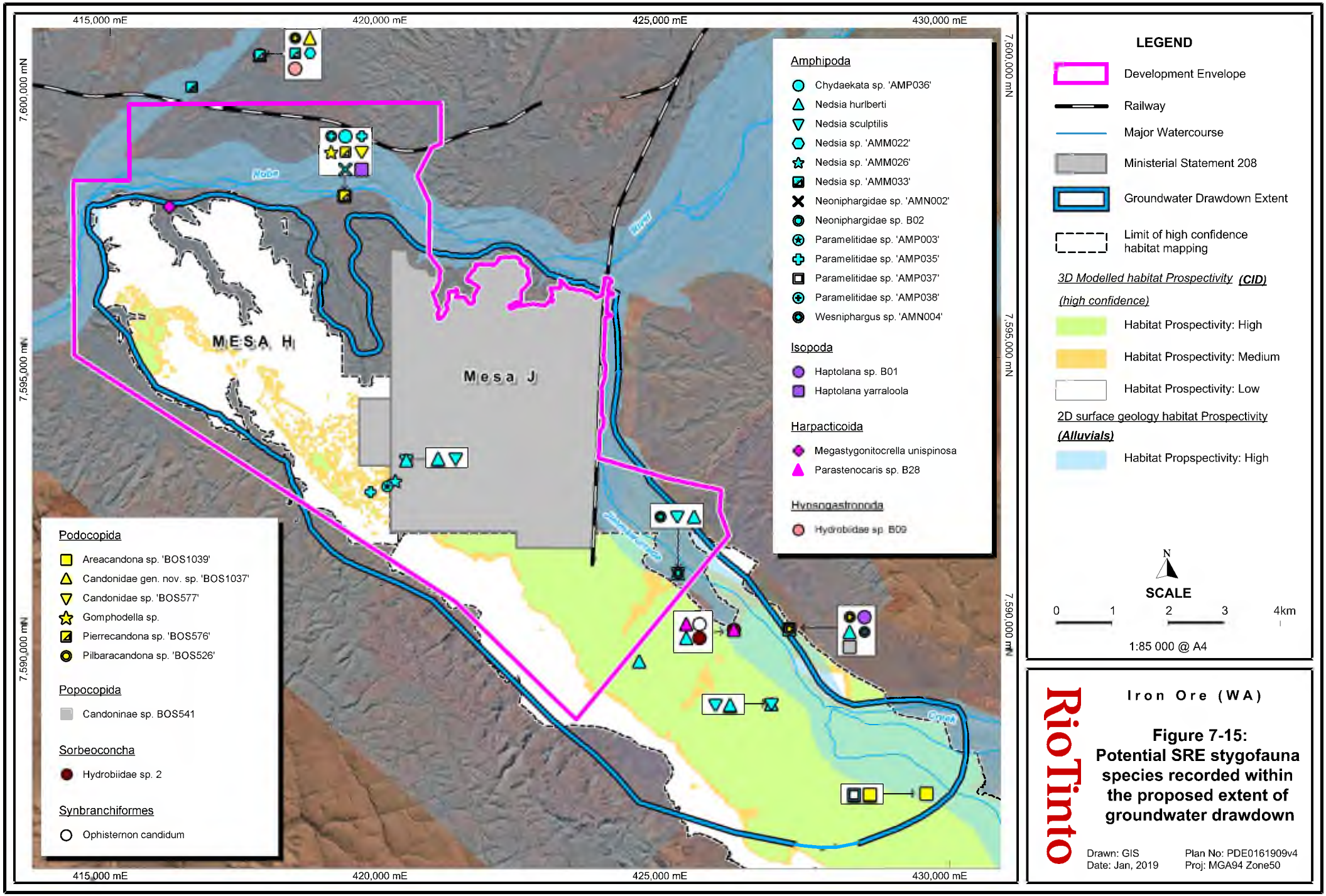


LEGEND

- Development Envelope
- Railway
- Major Watercourse
- Ministerial Statement 208
- Groundwater Drawdown Extent
- Limit of high confidence habitat mapping

3D Modelled habitat Prospectivity ***(CID)***

(high confidence)

- Habitat Prospectivity: High
- Habitat Prospectivity: Medium
- Habitat Prospectivity: Low

2D surface geology habitat Prospectivity ***(Alluvials)***

- Habitat Propspectivity: High

N

SCALE

0 1 2 3 4km

1:85 000 @ A4

Iron Ore (WA)

Figure 7-15: Potential SRE stygofauna species recorded within the proposed extent of groundwater drawdown

Drawn: GIS
Date: Jan, 2019

Plan No: PDE0161909v4
Proj: MGA94 Zone50

7.5.2.2 Indirect impacts

Mining activities other than mine pit excavation and groundwater abstraction which may impact stygofauna through temporary loss or degradation of habitat include:

- seepage from in-pit disposal of waste fines which has the potential to change groundwater chemistry and degrade stygofauna habitat; and
- hydrocarbon and wastewater spills which may result in a reduction in the quality of stygofauna habitat.

7.5.2.3 Cumulative impacts

Existing and foreseeable groundwater users in the vicinity of the Development Envelope are identified in Section 5 (Table 5-7) and include:

- the existing Mesa J Iron Ore Development:
    - Groundwater license allowing up to 30 GL/a to be abstracted from:
        - Southern Cutback borefield;
        - Pannawonica Town Water Supply; and
        - operational dewatering.
- the Revised Proposal;
- CWSP; and
- Yalleen Pastoral Station.

As discussed in Section 5, the operations will be integrated for Mesa J and H; abstraction from the existing Mesa J Iron Ore Development, the Southern Cutback Borefield and from the CWSP have been incorporated into the hydrological modelling, providing a cumulative hydrogeological context for impacts on stygofauna.

The abstraction rates from the pastoral station bores are likely to be negligible compared with the proposed abstraction rate for the Revised Proposal. Groundwater abstraction from the pastoral station bores are, therefore, unlikely to significantly impact stygofauna habitat.

7.5.3 Assessment of impacts

7.5.3.1 Direct impacts

Reduction in stygofauna habitat due to mine pit development and groundwater abstraction

Direct impacts on stygofauna species comprise both habitat removal where the mine pits extend BWT and the dewatering necessary to enable this to occur. While it is possible stygofauna may be able to actively respond to declining water table levels and move to habitat that remains viable, it is currently assumed that saturated habitat strata that are completely dewatered are no longer viable habitat and the individuals of species utilising those strata are conservatively considered to have been lost due to mortality. Where habitat strata have a substantial saturated thickness, and dewatering would only partially affect this; leaving connected viable habitat, the species would be likely to locally persist.

The habitat characterisation undertaken by Biota (2019b) and by the Proponent using 'Leapfrog' modelling (Figure 7-15) indicates stygofauna habitat is generally widespread within the Proposed Change Area and broader Study Area. The widespread nature of the alluvial and CID habitat and the confirmation that at least 16 of the species recorded in the drawdown impact area occur in reference sites or the wider Pilbara region, indicate that there is unlikely to be significant barriers to dispersal across the mapped high and medium habitat prospectivity areas.

Approximately 20 percent of the CID deposit at Mesa H currently lies below the water table and therefore only limited areas of the deposit provide stygofauna habitat pre-development as shown in Figure 7-12. As discussed in Section 7.5.1.2, hydrogeological test work indicates that the Mesa H CID Aquifer is in direct connection with the upstream Mesa J CID aquifer and the Jimmawurrada CID Aquifer. The Jimmawurrada CID Aquifer is also in connection with the upstream Bungaroo CID Aquifer and the overlying Jimmawurrada Alluvial Aquifer; and is recharged via throughflow from the Bungaroo valley and streamflow from the Jimmawurrada Creek during periods of high rainfall.

Figure 7-16 shows the extent and modelled prospectivity of stygofauna habitat pre-mining, during operation and post closure. The estimation of the habitat prospectivity takes into account the excavation of mine pits (permanent habitat removal) and groundwater abstraction (temporal habitat reduction). This figure shows connection of habitats is maintained throughout mining and closure.

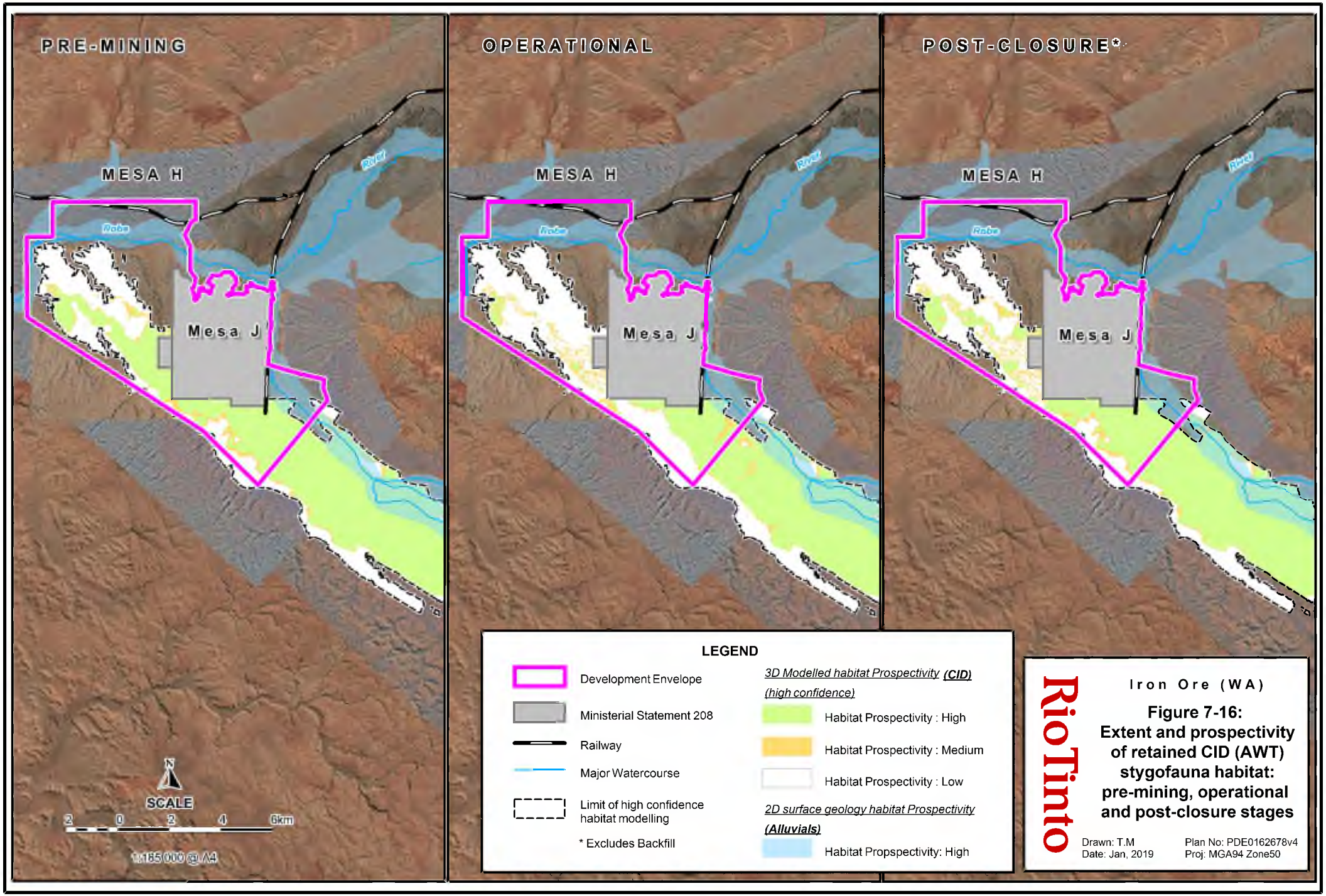
The downstream Robe River Alluvial Aquifer is an extensive aquifer present along the length of the Robe Valley passing in close proximity to Mesa H, of which Jimmawurrada Creek is a tributary. These aquifers are considered to represent high prospectivity stygofauna habitat (Biota 2019a, Figure 7-15). Recharge from the upstream Jimmawurrada Creek alluvial aquifer and Bungaroo CID aquifer is likely to carry stygofauna with it, resulting in stygofauna potentially being deposited in the Mesa H CID Aquifer or potentially dispersing from the Mesa H CID Aquifer into the Robe River Alluvial Aquifer during periods of high rainfall and water levels.

Based on data from groundwater bores and drillholes, the Jimmawurrada Creek Alluvial Aquifer is up to 40 m deep in the centre of the channel (thalweg). The cumulative modelled drawdown of 9 m (14 mbgl) in this area, would retain a significant portion of saturated habitat. Moreover, an extended dry period (H3 'Uncertainty run 2' (Rio Tinto 2019a)), could result in a water table lowering of ~18 mbgl, which, based on the Jimmawurrada Alluvial Aquifer channel depth, would still enable retention of connected saturated habitat. Modelling using 'Leapfrog' software within the footprint of the groundwater drawdown extent estimates that volumetrically, approximately 64% of saturated Robe River – Jimmawurrada Alluvial Aquifer habitat would be retained. Even during an extended dry period, and taking into account seasonal water table lows, approximately 44% of habitat is estimated to remain (Table 7-21, Rio Tinto 2019a).

Table 7-21: Modelled Alluvium Aquifer saturated thickness within potential impact areas

Timing	Saturated Volume in m^3	% remaining saturated alluvium
Pre-mining	176,900,000	100%
Current	116,650,000	66
2030 (base case)	113,710,000	64
2030 ('uncertainty run 2', 50% reduction of groundwater inflow from Jimmawurrada Creek as a result of an extended dry period)	91,162,000	52
2030 ('uncertainty run 2' + lowest seasonal level)	77,526,000	44

Given the evidence indicating connection of the Mesa H CID Aquifer with extensive high prospectivity habitat outside of the impact area (discussed below) and the small proportion of available stygofauna habitat represented by the Mesa H CID Aquifer, it is considered that while the Proposed Change may reduce available habitat, this is unlikely to significantly affect the ecological integrity of stygofauna habitat in the Proposed Change Area.


PRE-MINING
OPERATIONAL
POST-CLOSURE*
MESA H
Mesa J
Robe
River
LEGEND
Development Envelope
Ministerial Statement 208
Railway
Major Watercourse
Limit of high confidence habitat modelling
* Excludes Backfill
3D Modelled habitat Prospectivity (CID) (high confidence)
Habitat Prospectivity : High
Habitat Prospectivity : Medium
Habitat Prospectivity : Low
2D surface geology habitat Prospectivity (Alluvials)
Habitat Propspectivity: High
SCALE
2 0 2 4 6km
1:165000 @ A4
RioTinto
Iron Ore (WA)
Figure 7-16:
Extent and prospectivity of retained CID (AWT) stygofauna habitat: pre-mining, operational and post-closure stages
Drawn: T.M
Date: Jan, 2019
Plan No: PDE0162678v4
Proj: MGA94 Zone50

Loss of individuals and changes to assemblages due to mine pit development and groundwater abstraction

Mine pit excavation and groundwater abstraction will result in the direct loss of individuals.

Fifteen of the 31 species known to occur within the dewatering extent have been commonly recorded elsewhere within the wider Pilbara bioregion (Biota 2019b). While individuals of these species will be impacted by the mine pits and dewatering, no changes to their conservation status would be expected given their wider distributions.

There are 16 species that are either potential SRE species or of listed conservation significance. Nine of these 16 key receptors have been recorded from Reference sites outside of the drawdown extent (Table 7-20). The seven remaining species which are currently known only from within the modelled extent of cumulative drawdown include the aquatic snail *Hydrobiidae* sp. 2, two ostracods; *Candoninae* sp. 'BOS541' and *Pilbaracandona* sp. 'BOS526', the copepod *Parastenocaris* sp. 'B28', the isopod *Haptolana* sp. 'B01', and two amphipod species: *Paramelitidae* sp. 'AMP003' and *Paramelitidae* sp. 'AMP037'.

Three of these seven species (*Candoninae* sp. 'BOS541', *Pilbaracandona* sp. 'BOS526' and *Haptolana* sp. 'B01') were recorded from the same site: JW024 (Figure 7-17). The stygofauna habitat in the vicinity of JW024 comprises a sequence of saturated alluvium associated with Jimmawurruda Creek approximately 17 m in thickness from the pre-mining water table down to the underlying CID (Figure 7-17). Allowing for some uncertainty in modelling, approximately 5 – 15 m of alluvium is expected to remain saturated below watertable in the area where *Candoninae* sp. 'BOS541', *Pilbaracandona* sp. 'BOS526' and isopod *Haptolana* sp. 'B01' have been recorded (Figure 7-17). In the unlikely event that these species are restricted in distribution to this very small locality, the retention of 5 – 15 m of saturated habitat will ensure that refugia habitat remains for these species at the time of peak dewatering for the Revised Proposal. This site will also remain hydraulically connected to saturated alluvium habitat along the length of Jimmawurrada Creek (Figure 7-17). Therefore, it is considered that there is a low risk to these three potentially restricted species and they are likely to continue to persist within the remaining habitat throughout mine dewatering.

Two of the other potentially restricted species were also recorded from the same site on Jimmawurrada Creek: *Hydrobiidae* sp. 2 and *Parastenocaris* sp. 'B28', both of which are historical records from site JW023 (Table 7-20). JW023 is less than 1 km from JW024 (discussed above) and is in the same alluvial habitat setting along Jimmawurrada Creek (Figure 7-17). This habitat at JW023 will be subject to the maximum cumulative groundwater drawdown for the Revised Proposal (including the existing operations) of approximately 9 m from the pre-mining water table, however a refugial habitat of saturated alluvium of approximately 5 m thickness will still remain for the two species during the peak period of the groundwater drawdown (estimated at around 2030), which will again be hydraulically connected along the length of Jimmawurrada Creek. Again, the retention of saturated thickness at the site and the continuous connection along Jimmawurrada Creek alluvial aquifer indicates that these species are likely to continue to persist within the remaining habitat throughout mine dewatering.

This leaves the amphipod species *Paramelitidae* sp. 'AMP003' and *Paramelitidae* sp. 'AMP037' as the last two species currently known only from the drawdown extent. Both are only known from a single impact site and both may be more substantially affected by the predicted drawdown than the previously described five taxa:

- *Paramelitidae* sp. 'AMP003' would be the most substantially affected, having been recorded from site RC13MEH0041 within the proposed mine pit area, which will be subject to approximately 21 m drawdown in the water table (Figure 7-15, Table 7-19) and direct habitat removal from the Mesa H mine pit development. Given the location of the site beneath the Mesa H landform, it appears likely that this species occurs at least within the CID aquifer.
- *Paramelitidae* sp. 'AMP037' was recorded at the southeast limits of the modelled drawdown extent at site BC186, which is expected to be drawn down by approximately 5 m below the pre-mining water table (Figure 7-15, Table 7-19). This site intersects the alluvial aquifer of the Jimmawurrada – Bungaroo Creek system.

The EPA acknowledges that habitat may be used as a surrogate for inferring distributional boundaries of potentially restricted taxa (EPA 2016a and 2016b). Where a habitat type that supports a species is continuous then the extent of that habitat may be used to infer the likely presence of that species in the same habitat. The EPA also acknowledges that taxa with greater known distributions may act as surrogates to infer the distributions of poorly sampled species (EPA 2016a and 2016b).

With the exception of the singleton *Paramelitidae* sp. 'AMP037', every other species recorded from site BC186 is more widely distributed within the Robe River valley. As these taxa span a range of body sizes, morphologies and ecologies, their locally widespread distributions do not indicate any evidence of local barriers to fauna dispersal and gene flow for stygofauna, which by inference would also apply to *Paramelitidae* sp. 'AMP037' at the same site (Biota 2019b).

Direct Impacts on Conservation Significant Species

Individuals of the Threatened (Vulnerable) amphipods *Nedsia hurlberti* and *Nedsia sculptilis* will not be directly impacted by the proposed Mesa H mine pits, however will be impacted by the Revised Proposal, with approximately 20 m of groundwater drawdown predicted at JW011A where both species have been historically recorded (Table 7-20).

At site JW021 and JIMDR094 on Jimmawurrada Creek where the other records of *Nedsia hurlberti* and *Nedsia sculptilis* are located, stratigraphic cross-sections combined with hydrogeological modelling show that drawdown below pre-mining water table levels will be approximately 9 m, translating to up to 14 mbgl (or potentially up to 18 mbgl during an extended dry period). Based on the alluvial depths and extent in Jimmawurrada Creek, between 10 – 22 m of alluvium is expected to remain saturated during the period of maximum drawdown, even during an extended dry period (Figure 5-15, Figure 7-17). While the alluvial aquifer is likely to be the primary habitat for the species, the underlying Jimmawurrada CID aquifer also provides habitat for stygofauna.

While *Nedsia hurlberti* and *Nedsia sculptilis* species are listed as Threatened – Vulnerable under Schedule 3 at State level, they also occur more widely, both in the west Pilbara and as far afield as Barrow Island (Biota 2019b).

The current records of the two species from Mesa H are in addition to those used by DBCA to assign the species' conservation listing, and the local impact on individuals arising from the Proposed Change would therefore not alter their current conservation status.

The third conservation significant species, the Blind Cave Eel (*Ophisternon candidum;* Threatened - Vulnerable), occurs along Jimmawurrada Creek (four sites) and the Robe River (Biota 2019a, 2019b and WRM 2019 in prep.), in addition to five other sites in the

broader locality (Figure 7-18) (Biota 2019a). The ecology and distribution of the species is poorly understood (Biota and Helix 2014), but the surveys and related investigations completed for the Proposed Change have substantially improved the overall knowledge base for the species in the west Pilbara (Moore *et al.* 2018 as cited in Biota 2019a). Specimen records and eDNA evidence now indicate the species occurs not only within the Bungaroo Creek alluvial aquifer (Biota 2009b), but also in the Jimmawurrada Creek and Robe River alluvial aquifers, including in the hyporheic zone gravels in the Robe River (Biota 2019b; WRM 2019 in prep., TrEnD Laboratory 2018 [Figure 7-18]).

Spatially, there are five sites in the Study Area where the species has been recorded that are outside of the Revised Proposal drawdown extent (Figure 7-18). Similar to other stygofauna species, the records of the Blind Cave Eel show a high spatial correlation to the High prospectivity stygofauna habitat units. Taking account of the confirmed record locations, the distribution of this habitat suggests that suitable connected habitat for the species occurs along the length of the Robe River catchment including the Jimmawurrada Creek and Bungaroo Creek tributaries (Figure 7-18). It is notable that one of the Reference site eDNA records for the species came from the Control site sampled by Biota (2019a): this site was a surface water pool on the Robe River and consistently yielded eDNA detections for the species from multiple replicate samples (and from both the qPCR and metabarcoding eDNA methodologies). This suggests that the species utilises shallow groundwater habitats in the alluvial sequence of the Robe River, including the phreatic zone, and this could contribute to maintenance of gene flow and population connectivity within the species' overall range. This theory is consistent with the Robe River alluvium hypotheses of Moore *et al*. (2018) and is supported by the subsequent and recent collection of an additional specimen from the phreatic zone of the Robe River during aquatic fauna sampling in gravels adjacent to a surface pool in the river (WRM 2019 in prep.).

In addition, one of the Reference sites (Figure 7-18) is part of the Pannawonica town bore field, which is subject to a low level of groundwater drawdown itself, being pumped at sustainable yield for water supply (Rio Tinto 2016d). This alluvial aquifer habitat has been abstracted from since 1981 (Rio Tinto 2016d), which is indicative of both the significant recharge capacity of the Robe River alluvial aquifer and, by inference, that the *Ophisternon candidum* is at least tolerant to this level of groundwater impact in the medium term (with the borefield having been in operation for 37 years at the time the recent eDNA record was obtained; Biota 2019a).

Even within the drawdown extent, the alluvial aquifer habitat of Jimmawurrada Creek where Blind Cave Eel occurs is subject to the same predictions as those noted above for *Nedsia hurlberti* and *N. sculptilis*: that is, when considered vertically, there will be a saturated thickness remaining along the length of the creek even at the peak of groundwater drawdown for the project predicted in 2030. Figure 7-18 shows the sites where Blind Cave Eel has been recorded (both physical records and eDNA) along Jimmawurrada Creek, illustrating that a continuous and connected saturated alluvium habitat up to 40 m thick will remain within the system at the peak of dewatering. This is in addition to the underlying saturated CID, which may also provide potential refuge habitat for the species (Figure 7-17).

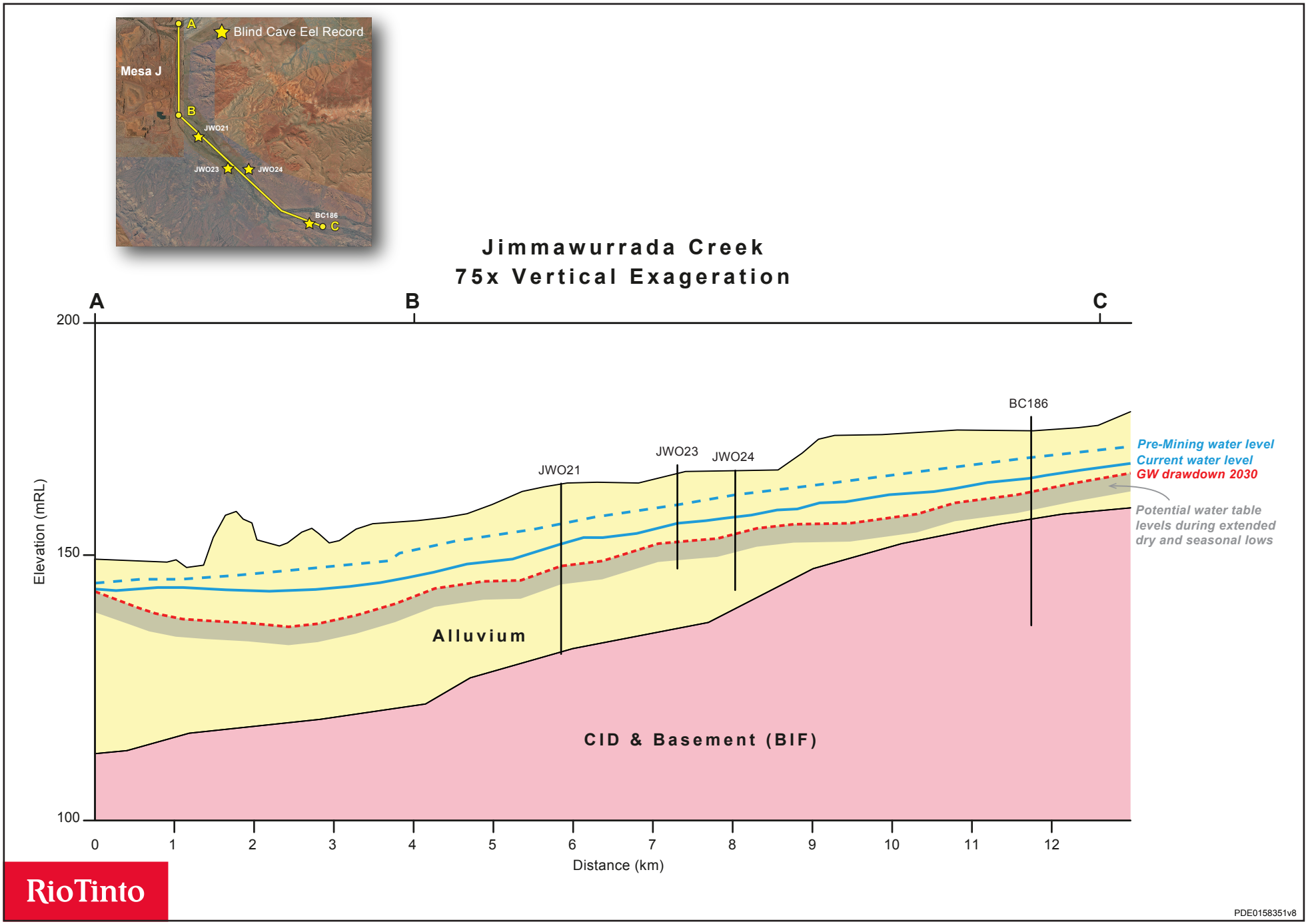
Conservatively, at the peak of groundwater drawdown, a 6.5 km section of Jimmawurrada Creek is modelled to be impacted by ~ 9 m of drawdown from the baseline water table levels (~14 m water table change from baseline during an extended dry and seasonal water table low). It is expected that even with limited saturated thickness of saturated alluvial habitat retained within this area, seasonal rainfall and larger cyclonic events will continue to enable connectivity of the aquifer and also periodically recharge water table levels.

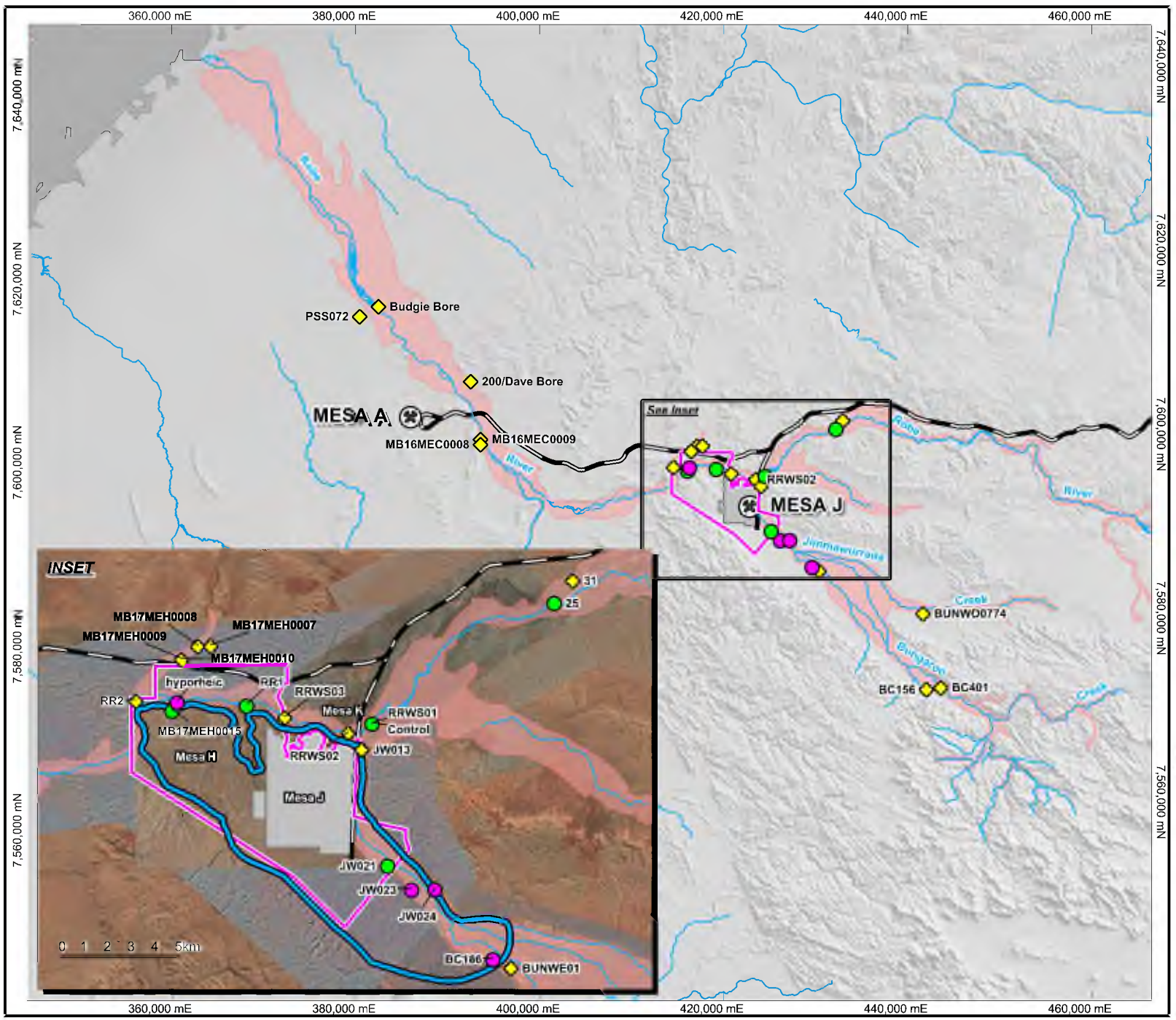
In summary:

- Four of the known sites where *Ophisternon candidum* occurs are currently affected by groundwater drawdown, and will be subject to further groundwater drawdown of between 1 m to a temporary peak of 9 m from the current water table (~14 mbgl) in Jimmawurrada Creek. Even during an extended dry period and taking into account seasonal water table lows, an estimated 10 – 22 m of saturated alluvium in the centre of the Jimmawurrada Creek Alluvial Aquifer is expected to remain connected and provide refuge during peak drawdown (Figure 7-17).
- There are a further five known sites where the species occurs within the Robe Valley that are outside of the drawdown extent (or within the range of natural water table fluctuation), including along the Robe River.
- The species may be tolerant of groundwater abstraction based on its persistence within the aquifer that supports the Pannawonica town bore field.
- Note the distributions of the known records, and habitat mapping with a strong evidence base from the broader stygal assemblage (Section 7.4), indicate it is likely that the species is distributed more widely along the Robe River catchment alluvial aquifer (Biota 2019b) and is not restricted to the Development Envelope.

The above evidence suggest that while some individuals of the species may be directly impacted by the groundwater drawdown, the species is expected to remain locally represented within the Study Area, in addition to its possible occurrence further along the connected alluvial aquifer habitats of the Robe River and further afield at Cape Range (Biota 2019b). However, the impacts to Blind Cave Eel are considered to comprise an increased risk of temporary habitat reduction due to cumulative groundwater drawdown during operations. Given the current limited status of knowledge of this species, there is uncertainty regarding the area of risk, the degree of habitat modification and the range and sensitivity of the species. Therefore, this risk is proposed to be offset to enhance further research into the understanding of the occurrence and range of this species (Section 13.3).

Figure 7-17: Longitudinal cross-section along Jimmawurrada Creek area, showing pre-mining water table, predicted maximum drawdown from the proposal in 2030 (dashed in red) and alluvial stygofauna habitats that will remain saturated (below the red dashed line)





LEGEND

- Development Envelope
- Ministerial Statement 208
- Mine
- Railway
- Major Watercourse
- Blind Cave Eel eDNA
- Confirmed Eel Record
- Sample Site
- Potential Blind Cave Eel habitat

Data Source: Regional 1:250K geology GSWA - DMIRS and RTIO Mesa J Mapping 1:5000 (Nov 2003)

Groundwater Drawdown

- Drawdown Extent

N

SCALE

0 10 20 30km

1:600 000 @ A4

Rio Tinto

Iron Ore (WA)

Figure 7-18: Blind Cave Eel records and potential habitat in the wider locality

Drawn: M.Swebbs
Date: Jan, 2019

Plan No: PDE0159201v5
Proj: MGA94 Zone50

Geospatial Information and Mapping

7.5.3.2 Indirect impacts

Degradation of habitat due to mining related activities

Waste fines storage

Seepage from in-pit disposal of waste fines has the potential to change the local groundwater chemistry and degrade stygofauna habitat.

Waste fines generated as a result of wet processing of Mesa H ore will be located into existing WFSF's in-pit at Mesa J. Based on results of monitoring around the Mesa J WFSF (refer Section 7.4.2) it is anticipated that the proposed additional waste fines generated from Mesa H will result in increases in analytes such as salinity, nitrogen, nitrate, NOx and zinc in the immediate vicinity of the WFSF. During operations, these changes in groundwater chemistry are likely to be mainly confined to the cone of depression generated by the production bores at Mesa J / Southern Cutback Borefield and much of the affected groundwater will be recirculated through the process plant.

Given that seepage from the WFSF will be mainly confined to the cone of depression in Mesa J from the Mesa J production bores, and the Southern Cutback Borefield during operations and that this cone of depression represents a small proportion of broader available connected stygofauna habitat, it is considered that during operations, the Proposed Change is unlikely to significantly affect the ecological integrity of the stygofauna habitat in the CID aquifer.

Additional modelling is underway to examine the fate of water seepage from the WFSF and its effect on groundwater chemistry at closure. Placement of waste fines into the WFSF will cease prior to closure. There will then be a limited period of time where seepage occurs from the waste fines until the WFSF dries out through a combination of evaporation and seepage, at which stage rehabilitation of the WFSF will be undertaken. Given the limited period of time required for 'drain-down' of the WFSF at closure and the connected stygofauna habitat available in the Proposed Change Area and surrounds, including the Jimmawurrada CID area, it is considered that at closure, the Proposed Change is unlikely to significantly affect the ecological integrity of the stygofauna habitat provided by the Jimmawurrada CID and the Jimmawurrada and Robe River Alluvial Aquifers.

Hydrocarbon and wastewater spills

The potential exists for groundwater to be degraded by spills of hydrocarbons or wastewater. Hydrocarbons will be handled, stored and disposed of in accordance with legal requirements. Hydrocarbon storage will be inspected on a regular basis to identify any maintenance requirements. Hydrocarbon and spill management procedures are expected to effectively mitigate the risk of contamination.

7.5.3.3 Cumulative impacts

The existing and foreseeable groundwater users in the vicinity of the Development Envelope are identified in Section 5.5.4. Cumulative groundwater abstraction from the Revised Proposal, and the existing operations including the Mesa J Iron Ore Development (including the Southern Cutback Borefield) and the CWSP have been integrated into the groundwater modelling for the Proposed Change and so the assessment of impacts in Section 7.5.3.1 therefore incorporates the existing and proposed impacts as described in Section 5. The pastoral station and the Pannawonica town drinking water supply bores are unlikely to significantly impact stygofauna habitat as the abstraction rates are likely to be low relative to the size of the aquifer and relative to the groundwater abstraction rates associated with the Proposed Change.

No other existing or proposed mining operations that would contribute to cumulative impacts on stygofauna occur in the vicinity of the Proposed Change Area.

7.5.4 Mine closure

The Mesa J Hub Closure Plan (Rio Tinto 2018a) is an integrated closure plan encompassing the existing Mesa J and Mesa K operations, together with the inclusion of the Proposed Change, in order to optimise closure outcomes. The plan is an update to and supersedes previous closure plans for the existing Mesa J and K Operations.

Following cessation of dewatering at Mesa H, the groundwater levels in the Mesa J and Mesa H mining areas will recover until a balance is reached between groundwater inflows and groundwater outflows. Backfilled pit voids will enable groundwater levels to eventually recover to pre-development levels. Complete aquifer recovery is predicted to take between 50 and 60 years, however, the large majority of the drawdown along the Robe River and Jimmawurrada Creek is expected to recover 90% of the drawdown after the first or second significant rainfall events (Rio Tinto 2019a). The post closure stygofauna habitat prospectivity within the Study Area is shown in Figure 7-16. A closure task has been identified to assess the potential for seepage from the WFSF from the Mesa J Iron Ore Development. This will ensure any seepage from the facility is considered in terms of any potential impact to groundwater chemistry and subterranean habitats.

7.5.5 Mitigation

Mitigation strategies to address the potential impacts and predicted outcomes are presented in Table 7-22.

The Mesa J Hub EMP (Appendix 6) addresses the key environmental factors which were determined by the EPA as being relevant to the appropriate management of dewatering, surface water discharge, conservation significant vegetation communities, fauna and subterranean fauna species associated with the Mesa J Hub. The EMP identifies:

- mitigation strategies proposed to minimise impacts to significant environmental values;
- the environmental criteria that the Proponent will use to monitor performance of the mitigation strategies to ensure environmental objectives are met;
- trigger criteria, threshold criteria, trigger level actions and threshold contingency actions aligned with the overall management approach; and
- the management actions that will be implemented in response to monitoring results.

The EMP for stygofauna focusses on maintaining viable and connected habitat via the monitoring of groundwater levels and water quality, given the inherent sampling limitations in the subterranean environment. Trigger and threshold criteria, have been developed to ensure that whilst a reduction in habitat via ground water level changes is expected, that significant areas of stygofauna habitat are still retained over the life of the mine. The ongoing persistence of connected stygofauna habitat (>44% alluvium aquifer saturated thickness) was a key consideration when defining these criteria; changes to groundwater levels are readily measurable and is part of the causal relationship between mining and impacts on stygofauna. These triggers and thresholds are supplemented by ongoing stygofauna monitoring (including specific monitoring for the Blind Cave Eel) throughout the life of mine to confirm if any changes in assemblages are apparent as a result of Proposed Change, as measured by stygofauna capture rates compared to baseline data and ongoing presence of the Blind Cave Eel.

Table 7-22: Mitigation Measures and Predicted Outcomes for Stygofauna

Potential impacts	Mitigation to address potential impacts	Residual impact	Assessment of significance	Offset required?
EPA objective: ***To protect subterranean fauna so that biological diversity and ecological integrity are maintained.***				
Direct impacts: Reduction in stygofauna habitat, loss of individuals and changes to assemblages due to mine pit development and groundwater abstraction	The following key management strategies will be implemented to manage impacts to stygofauna as a result of indirect impacts: **Avoid:** Water will be sourced from the existing Southern Cutback Borefield, within current licence limits and avoiding the requirement for a new borefield impact area. Placing waste fines in-pit at Mesa J avoids the need to disturb a previously undisturbed area and reduces seepage risk into stygofauna habitat at Mesa H. **Minimise:** Dewatering will be minimised to that required to access the BWT resource. Water from mine dewatering will be used on site where possible to minimise the requirement for additional groundwater abstraction for operational water supply. Groundwater abstraction will be within the current approved licence limits and groundwater levels will be monitored to ensure impacts remain within the predicted range of drawdown. Water levels within the semi-permanent and permanent pools of the Robe River during active mine dewatering will be monitored and the Proponent will cease dewatering below the 120 m RL in the adjacent Mesa H Pit 7 should water table levels exceed predictions during active dewatering water during dry periods and resume mining once a stream flow event occurs. The use of a thickener is proposed to be used for the WFSF, specifically to optimise water recovery and reduce the overall water demand by approximately 30% from the Southern Cutback Borefield and thus reduce cumulative drawdown in the Jimmawurrada Creek alluvial aquifer and the underlying CID aquifer.	The Proposed Change will result in impacts to stygofauna habitat and communities, including 3 conservation significant species listed as Threatened -Vulnerable under Schedule 3 of the BC Act (two Amphipods: *Nedsia hurlberti* and *Nedsia sculptilis*; and the Blind Cave Eel: *Ophisternon candidum*). *Nedsia hurlberti* and *Nedsia sculptilis* occur more widely, both in the west Pilbara and as far afield as Barrow Island and their conservation status is unlikely to be affected. The Blind Cave Eel will be impacted by a reduction in habitat through groundwater abstraction and associated groundwater drawdown.	Approximately 20 percent of the CID deposit at Mesa H currently lies below the water table and therefore only limited areas of the deposit is suitable as stygofauna habitat. The Proposed Change will result in the loss of individuals and reduction in this available habitat from the proposed groundwater drawdown and pit excavation. However, the available habitat connects to other primary stygofauna habitat comprising the Jimmawurrada CID aquifer to the south-east, which is also in connection with the overlying Jimmawurrada Creek alluvial aquifer. Given the extent and connectivity to other primary stygofauna habitat, it is unlikely the Proposed Change will significantly affect the ecological integrity of the stygofauna habitat or the diversity and ecological integrity of stygofauna assemblages in the Mesa H area. Similarly, at Jimmawurrada, the available stygofauna habitat is well connected to other extensive primary stygofauna habitat outside the impact areas. Studies indicate that the CID aquifer underlies and is connected with the Jimmawurrada Creek alluvial aquifer, and the Jimmawurrada Creek aquifer is a tributary into the Robe River alluvial aquifer. The Jimmawurrada CID aquifer is also connected to the upstream Bungaroo CID aquifer. Given this extent of available habitat and the connectivity, in particular in areas such as the Robe River Alluvial Aquifer which is not expected to be significantly impacted by the Proposed Change, it is considered that although the Proposed Change will result in the localised reduction of habitat and potential loss of individuals across a	Yes. The Proponent proposes the provision of two environmental offsets for Stygofauna. • an environmental offset at the offset rate of $1,500 per hectare for the direct impact as a result of groundwater drawdown to 'Zone 3' of the Jimmawurrada Creek alluvial aquifer within areas with other environmental values: i.e. PEC (Stygofauna community of the Bungaroo Aquifer). • Provision of $1 M of funding for further research into the occurrence and range of the Blind Cave Eel.

Potential impacts	Mitigation to address potential impacts	Residual impact	Assessment of significance	Offset required?
	Surplus water generated from mine pit dewatering will be used onsite in the first instance to supply water for operational purposes. Only surplus water exceeding the operational requirements will be discharged to local ephemeral tributaries of the Robe River, which may periodically temporarily increase habitat for stygofauna in the alluvial aquifers downstream of the discharge points. The location of surplus discharge points will be optimised to reduce the potential for impacts to significant environmental values or areas considered to be at higher risk from the effects of groundwater drawdown, including along Jimmawurrada Creek (near the Southern Cutback Borefield) and the permanent pools of the Robe River (contingency only). **Rehabilitation:** BWT pits will be backfilled enabling recovery of groundwater levels and stygofauna habitats following cessation of groundwater abstraction and to prevent the formation of pit lakes (and associated changes in water quality). Hydrocarbon storage and handling facilities will be decommissioned at closure.	The Proposed Change will result in the loss of individuals and reduction in available stygofauna habitat at Mesa H and Jimmawurrada from the proposed groundwater drawdown and pit excavation.	12 km section of Jimmawurrada CID and alluvial aquifers (greatest drawdown impact across a 6.5 km stretch), habitat connectivity will continue to be retained and it is unlikely to significantly affect the ecological integrity of stygofauna and their broader habitat and distribution. After the mitigation hierarchy has been applied, including the reduction of water abstraction by the use of a thickener and consideration of extensive, connected stygofauna habitat at Jimmawurrada, the Proponent considers that the residual impact associated with the groundwater drawdown within the Priority 1 PEC is significant for the Stygofauna component of the Subterranean Fauna factor and warrants an offset. In addition, given the current limited status of knowledge of the Blind Cave Eel, there is uncertainty regarding the area of risk of groundwater drawdown, the degree of habitat modification and the range and sensitivity of the species. Therefore, this risk is proposed to be offset to enhance further research into the understanding of the occurrence and range of this species. Given the proposed mitigation and offsets, the Proponent considers that the Proposed Change can be managed to meet the EPA's objective for Subterranean Fauna.	
Indirect impacts: Degradation of habitat due to mining-related activities Seepage from in-pit disposal of waste fines and hydrocarbon spills have the potential to degrade stygofauna habitat.	The following key management strategies will be implemented to manage potential indirect impacts to stygofauna habitat: **Avoid:** Placing fines in-pit at existing Mesa J WFSF reduces seepage risk to stygofauna habitat at Mesa H. **Minimise**: Hydrocarbons will be handled, stored and disposed of in accordance with legal requirements. Hydrocarbon storage will be inspected on a regular basis to identify any	The Proposed Change will result in no new WFSF areas and seepage will mainly be captured in the cone of depression from groundwater abstraction. No significant impact on stygofauna	Based on results of monitoring around the Mesa J waste fines TSF it is anticipated that the additional waste fines from Mesa H into these facilities will result in increases in analytes such as salinity, nitrogen, nitrate, NOx and zinc in the immediate vicinity of the WFSF. During operations the seepage from the WFSF will be mainly confined to the cone of depression from the Mesa J borefield and Southern Cutback Borefiled representing disturbance to a small proportion of available stygofauna habitat.	No. The Proponent considers that the potential impacts can be managed and the residual impact is not considered to be significant and therefore does not warrant the

Potential impacts	Mitigation to address potential impacts	Residual impact	Assessment of significance	Offset required?
	maintenance requirements. Spill response procedures will be followed to contain and clean-up any hydrocarbon spills. **Rehabilitation:** Any hydrocarbon spills will be contained, and Hydrocarbon storage and handling facilities will be decommissioned at closure. **Other legislation:** Compliance with the requirements of the *Contaminated Sites Act 2003* if contamination occurs.	habitat is expected from hydrocarbon storage or handling.	Groundwater abstraction will cease prior to closure. Following cessation of groundwater abstraction, there will be a limited period of time when the TSF 'drains-down' and seepage from the WFSF will not be re-circulated through the wet processing plant. Given the extensive stygofauna habitat available around the Study Area and the limited period of time required for 'drain-down' of the WFSF at closure, it is considered that the Proposed Change is unlikely to significantly affect the ecological integrity of the stygofauna habitat provided by the alluvial aquifers. The Proponent considers that the potential impacts can be managed to meet the EPA's objective for this factor.	application of offsets.

7.6 Predicted Outcome

The key Subterranean Fauna values identified in the Development Envelopment that are considered relevant to the Proposed Change are:

- Significant troglofauna habitat:
  - the Priority 1 PEC, the *Subterranean invertebrate community of pisolitic hills in the Pilbara* occurs across Mesa H; and
  - the Priority 1 PEC, the *Subterranean invertebrate community of mesas in the Robe Valley region*, occurs across Mesa J in the Development Envelope.
- Troglofauna taxa:
  - Potential SRE troglofauna taxa.
- Significant stygofauna habitat:
  - The Priority 1 PEC Stygofauna community of the Bungaroo Aquifer.
- Stygofauna taxa:
  - potential SRE stygofauna taxa; and
  - conservation significant stygofauna species:
    - *Nedsia hurlberti* (Threatened – Vulnerable under Schedule 3 of the BC Act);
    - *Nedsia sculptilis* (Threatened – Vulnerable under Schedule 3 of the BC Act); and
    - *Ophisternon candidum,* Blind Cave Eel (Threatened - Vulnerable under the EPBC Act and Schedule 3 of the BC Act).

The key predicted outcomes for the Subterranean Fauna values outlined above are:

- Clearing of up to 9.2 ha and 788.1 ha of the Priority 1 PECs, the *Subterranean invertebrate community of mesas in the Robe Valley region* and the *Subterranean invertebrate community of pisolitic hills in the Pilbara* respectively.
- Disturbance to troglofauna habitat (conservatively including disturbance from waste dumps) at Mesa H as a result of the Proposed Change will be limited to 50% by volume of connected pre-mining habitat.
- Direct impact over a 12 km stretch of the Jimmawurrada Creek Alluvial Aquifer, with the greatest impact across a 6.5 km stretch (‘Zone3’), impacting the stygofauna PEC.
- Biological diversity and ecological integrity of the troglofauna communities are expected to be maintained given:
  - the troglofauna habitat present is connected and extends beyond the proposed impact areas; and
  - monitoring evidence also indicates that the existing MEZ at the analogous Mesa A Operations is functioning as intended, in protecting the ecological integrity of troglofauna habitat and assemblages.

- Biological diversity and ecological integrity of the stygofauna communities are expected to be maintained given:
    - the extent and connectivity of stygofauna habitat at Mesa H and Jimmawurrada to other primary stygofauna habitat beyond the proposed impact areas, including the extensive Robe River Alluvial Aquifer and upstream CID aquifer; and
    - the maintenance of between 10 – 22 m of saturated thickness of the Jimmawurrada Creek alluvial habitat aquifer, and >40% habitat even during peak drawdown (and including consideration of extended dry periods and seasonal water table lows) in the impact areas.

After the mitigation hierarchy has been applied (Table 7-15 and Table 7-22), including retention of connected habitat through designation of a MEZ and saturated stygofauna habitat, the Proponent considers that the residual impact associated with the clearing of the Priority 1 PECs the *Subterranean invertebrate community of mesas in the Robe Valley region,* the *Subterranean invertebrate community of pisolitic hills in the Pilbara* PEC; and cumulative, temporal drawdown impact to the Jimmawurrada Creek Alluvial Aquifer containing records of the Blind Cave Eel within the *Stygofaunal Community of the Bungaroo Aquifer* PEC are significant and warrant offsets. In addition, given the current limited status of knowledge of the Blind Cave Eel, there is uncertainty regarding the area of risk of groundwater drawdown, the degree of habitat modification and the range and sensitivity of the species. Therefore, this risk is proposed to be offset to enhance further research into the understanding of the occurrence and range of this species. The proposed offsets are discussed in Section 13.

Given the proposed mitigation and offset, the Proponent considers that the Proposed Change can be managed to meet the EPA's objective for Subterranean Fauna.

8. TERRESTRIAL FAUNA

This section describes the terrestrial fauna that occur within the Proposed Change Area, provides an assessment of the potential impacts of the Proposed Change to conservation significant fauna, proposed mitigation measures and the predicted outcome for terrestrial fauna.

8.1 EPA Objective

The EPA applies the following objective from the Statement of Environmental Principles, Factors and Objectives (2018c) in its assessment of proposals that may affect terrestrial fauna:

- To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

8.2 Policy and Guidance

8.2.1 EPA Policy and Guidance

The following State and Commonwealth policy and guidance documents have been considered in the assessment of terrestrial fauna:

- EPA (2018c) Statement of Environmental Principles, Factors and Objectives;
- EPA (2016i) Environmental Factor Guideline: Terrestrial Fauna;
- EPA (2016j) Technical Guidance: Sampling methods for terrestrial vertebrate fauna (the content in this Technical Guidance has not yet been updated from the technical report of the EPA and the then Department of Environment and Conservation issued in September 2010 and titled 'Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment');
- EPA (2016k) Technical Guidance: Terrestrial Fauna Surveys (the content in this Technical Guidance has not yet been updated from EPA Guidance Statement No. 56 issued in June 2004)
- EPA (2016l) Technical Guidance: Sampling of short range endemic invertebrate fauna (the content in this Technical Guidance has not yet been updated from EPA Guidance Statement No. 20 issued in May 2009);
- EPA (2017a) Instructions on how to prepare *Environmental Protection Act 1986 Part IV* Environmental Management Plans; and
- DMP and EPA (2015) Guidelines for Preparing Mine Closure Plans.

8.2.2 Other Policy and Guidance

- Survey guidelines for Australia's threatened mammals (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC] 2011a);
- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b);
- Survey guidelines for Australia's threatened bats (DEWHA 2010);
- Commonwealth Listing Advice on Northern Quoll (*Dasyurus hallucatus*) (Threatened Species Scientific Committee [TSSC] 2005);
- Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (DSEWPaC 2012a);
- Approved Conservation Advice on *Ophisternon candidum* (Blind Cave Eel) (DEWHA 2008a);
- Approved Conservation Advice on *Liasis olivaceus barroni* (Olive Python (Pilbara subspecies)) (DEWHA 2008b);
- Conservation Advice for *Macroderma gigas* (Ghost Bat). (TSSC 2016a);

- Conservation Advice for *Rhinonicteris aurantia (Pilbara form)* (Pilbara Leaf-nosed Bat) (TSSC 2016b);
- WA Environmental Offsets Policy (Government of WA 2011);
- WA Environmental Offsets Guidelines (Government of WA 2014b);
- Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC/ARMCANZ 2000);
- National Recovery Plan for the Northern Quoll (Hill and Ward 2010);
- Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (DSEWPaC 2011c);
- Commonwealth Listing Advice on ten species of Bats (TSSC 2001);
- Threat abatement plan for predation by the European red fox (DEWHA 2008); and
- Threat abatement plan for predation by feral cats (Department of the Environment [DoE] 2015).

8.3 Environmental Scoping Document

Table 8-1 summarises where the requirements of the ESD are addressed in this section.

Table 8-1: Requirements of the ESD for Terrestrial Fauna

Task number	Requirement of ESD	Section number
25	Provide a desktop review and analysis of all surveys of the Development Envelope undertaken in accordance with EPA Policy and Assessment, survey guidelines for Australia's threatened animals.	Section 8.4
26	The study should include: • a justification of how those surveys are relevant and representative of the Development Envelope and if they were carried out using methods consistent with the EPA policy • a comprehensive listing of vertebrate fauna and SRE invertebrate fauna known or likely to occur in the habitats present, and identification of conservation significant fauna species likely to occur in the area.	Section 8.4
27	Conduct Level 2 terrestrial fauna and SRE invertebrate surveys in areas not previously surveyed that are likely to be directly or indirectly impacted as a result of the Proposal. Surveys are to be undertaken in accordance with technical guidance statements and, where available, species-specific survey guidelines for relevant species listed under the WC Act and the EPBC Act.	Section 8.4
28	Conduct additional targeted surveys for conservation significant fauna that are known to or likely to occupy habitats in the Development Envelope if demonstrated to be required based on the results of the desktop study and Level 2 surveys.	Section 8.4
29	Specify MNES being assessed as part of the accredited assessment.	Section 8.4 and 12
30	Investigate and provide a description of any potential bat populations and habitat (including foraging habitat) in the Development Envelope, and potential impacts from the Proposal.	Section 8.4 and 8.6

Task number	Requirement of ESD	Section number
31	For each relevant conservation significant species, including MNES (Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat, and Ghost Bat) recorded or likely to occur within the Development Envelope, provide where possible: • baseline information on their distribution (including known occurrences), ecology, and habitat preferences at the site level • information on the conservation value of each habitat type from a local and regional perspective; • if a population of a conservation significant species is present on the site, its size and the importance of that population from a local and regional perspective • maps illustrating the known recorded locations of conservation significant species and short-range endemic invertebrates in relation to the proposed disturbance and areas to be impacted.	Section 8.4.5, 8.4.8 and 8.6
32	Identify the fauna habitat types within and outside the areas of impact. Consider habitat types that provide important ecological function within the Development Envelope.	Section 8.4
33	Discuss known existing threats to conservation significant species, whether or not attributable to the Proposal, with reference to relevant impacts from the Proposal (including taking into consideration any relevant guidelines, policies, plans and statutory provisions).	Section 8.5 and 8.6
34	Provide a detailed description of the potential direct, indirect and cumulative impacts to conservation significant species within the Development Envelope on a local and regional scale. Propose areas of key significance that may be considered for mine exclusion zones (including cave habitats, rocky outcrops and pools).	Section 8.5 and 8.6
35	For all conservation significant species that are not likely to be impacted by the Proposal, but for which suitable habitat is present, demonstrate that an impact on the species will not or is unlikely to occur.	Section 8.4.4
36	Discuss proposed objectives, management, monitoring and mitigation methods to be implemented demonstrating that the design of the Proposal has addressed the mitigation hierarchy to avoid and minimise impacts to terrestrial fauna.	Section 8.9
37	Develop a conservation significant fauna management plan to apply to the Proposal. The objective of the plan is to ensure the protection of threatened species that will be impacted by the Proposal and their habitat within the Development Envelope.	Appendix 6

Task number	Requirement of ESD	Section number
38	Prepare a Mine Closure Plan consistent with DMP and EPA *Guidelines for Preparing Mine Closure Plans* (2015), which addresses the need for progressive rehabilitation of habitat for conservation significant species.	Appendix 7
39	Predict the inherent and residual impacts before and after applying the mitigation hierarchy and identify whether the residual impacts are significant by applying the Significant Residual Impact Model in the WA Environmental Offsets Guideline.	Section 8.9 and 8.10
40	Quantify any significant residual impacts by completing the Offset Template, spatially defining the habitat area for each significant fauna species that will be disturbed as a result of the proposal (excluding the approved Mesa J Operation) and propose an appropriate offsets package that demonstrates application of the WA Environmental Offsets Policy and Guideline.	Section 8.9 and 8.10
41	Demonstrate and document in the ERD how the EPA's objective for this factor can be met.	Section 8.9 and 8.10

8.4 Receiving Environment

8.4.1 Project setting

The Pilbara bioregion is a major centre for biodiversity within WA and provides some key habitat types for fauna. This appears to be related to the diversity of geological, altitudinal and climatic elements in the region, as well as being a function of its location (Biota 2011b). The Pilbara is located in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions, and is also an area of transition for fauna (Kendrick 2001 as cited in Biota 2011a).

The Robe Valley hosts a number of habitats important for terrestrial fauna; in particular, mesa landforms, which are prominent features in the Robe Valley landscape supporting significant terrestrial fauna habitats, including MNES. Mesa H forms escarpments to the south and east of the Robe River and lies immediately to the west of Mesa J Iron Ore Development which has retained an escarpment along its northern margin, adjacent to the Robe River, for the purposes of retaining environmental and heritage values, including important fauna habitat.

Four terrestrial MNES species have been recorded in the Proposed Change Area; Northern Quoll, Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat.

The Proposed Change Area includes the ephemeral Robe River and a portion of Jimmawurrada Creek which is a tributary of the Robe River. These watercourses provide shelter, dispersal and foraging habitat for terrestrial fauna. The Robe River also contains numerous semi-permanent pools within the Proposed Change Area, with permanent pools around Yeera Bluff occurring on the western side of the Proposed Change.

The Robe River and Jimmawurrada Creek have been affected by decades of pastoral grazing activities. Surplus water discharge from the Mesa J Iron Ore Development has been discharging into Jimmawurrada Creek and West Creek since 1993. A portion of Jimmawurrada Creek has also been exposed to groundwater drawdown in the vicinity of the Southern Cutback Borefield and the CWSP (Refer to Section 5).

The Proponent has undertaken annual biophysical and ecological monitoring of the Robe River pools since 1991. This long-term monitoring project includes aquatic fauna, channel

/ pool morphology, riparian / bank condition, weeds, water flows and water quality both upstream and downstream of the existing Mesa J Iron Ore Development. The results of the survey indicate that changes in ecological conditions of the pools are primarily the result of seasonal and annual variation in rainfall and subsequent river flows. Extreme natural events (flooding and dry spells) have been found to have an overriding influence on conditions in the watercourses (Streamtec 2017). To date, there have been no detectable changes in the aquatic ecology of the Robe River that could be attributed to mining operations, despite long term surplus water discharge programs and mining at Mesa J.

8.4.2 Terrestrial fauna studies

Systematic terrestrial fauna surveys have been undertaken in the Robe Valley area around Mesa J since 1991, progressively extending to Mesa A – Warramboo, covering an area in excess of 72,400 ha. The combined coverage of these surveys provides a considerable knowledge base of the terrestrial fauna present in the Robe Valley and provides context for the area covered by the Proposed Change Area. Surveys were also conducted specifically for this Proposed Change comprising a two-phase terrestrial fauna assessment by Astron Environmental during 2015 – 2016 and additional targeted fauna surveys (Appendix 11).

The annual monitoring of Robe River pools undertaken by Streamtec is ongoing with the most recent survey undertaken in April 2017. Results from the monitoring were consistent with previous years as no statistically significant changes to the ecology of the pool systems beyond natural variability has been detected (Streamtec 2017).

Level 2 field surveys were undertaken in accordance with the requirements of the Environmental Protection Authority (EPA) Guidelines relevant at the time of the surveys, and are considered adequate including:

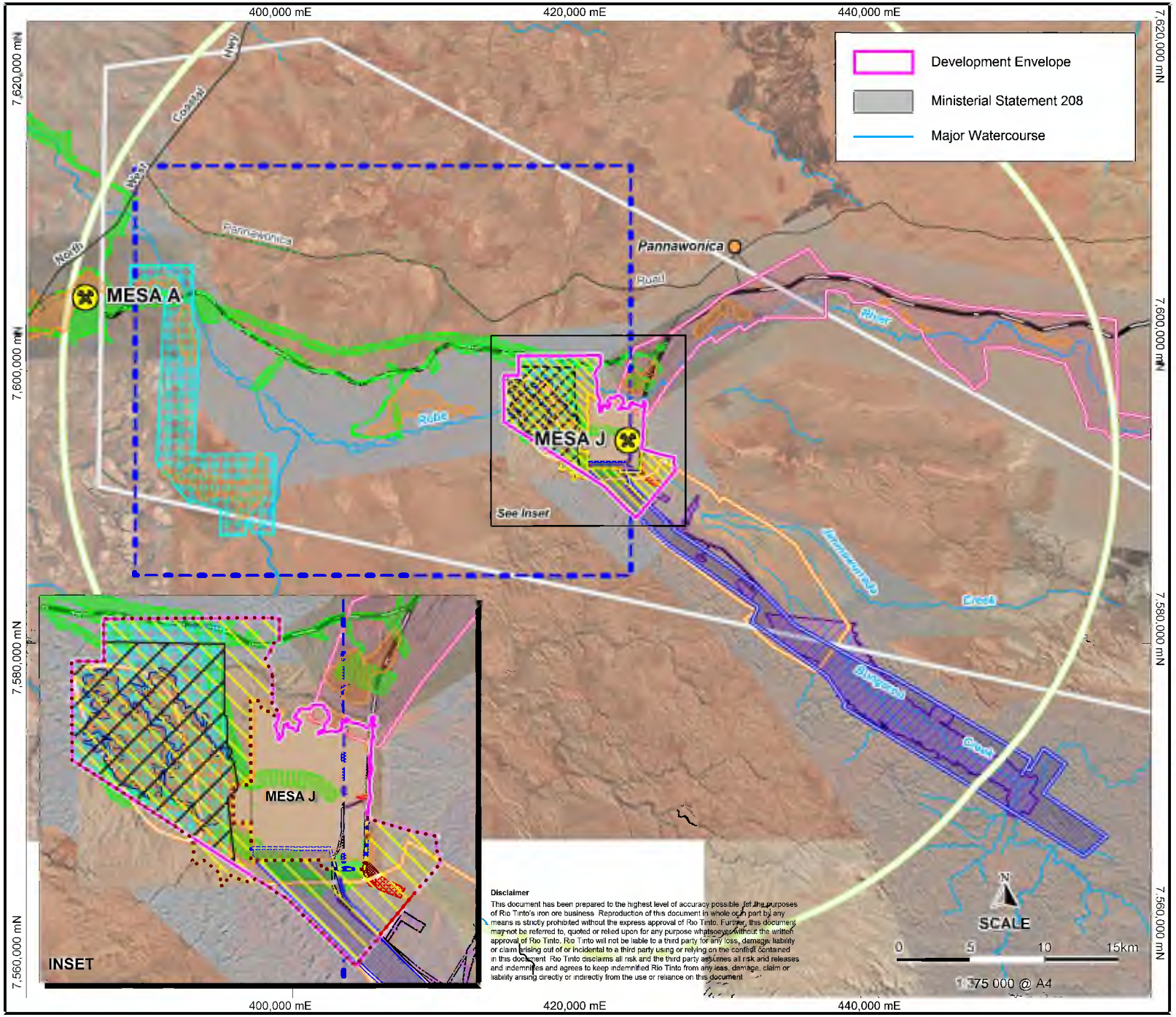
- Position Statement No. 3 (EPA 2002);
- Technical Guidance - Subterranean Fauna Surveys (EPA 2016g);
- Technical Guidance - Sampling Methods for Terrestrial Fauna (Environmental Protection Authority 2016j); and
- Technical Guidance - Terrestrial Fauna Surveys (EPA 2016k).

Table 8-2 summarises the key, recent terrestrial fauna surveys most relevant to the Proposed Change and Figure 8-1 and Figure 8-2 outline their extent, as well as the extent of other historical surveys. The most recent of these studies are provided in Appendix 11. Targeted surveys for key conservation significant species (excluding the Ghost Bat) were not conducted for the reasons outlined in Section 8.4.2.1.

Table 8-2: Summary of Supporting Terrestrial Fauna Surveys

Survey report	Summary	Survey Date
Non-aquatic		
Mesa H – Targeted Night Parrot Fauna Assessment, September 2017. Astron (2017b)	A targeted, systematic field survey for the Night Parrot including autonomous recording units and motion sensitive cameras. No individual sightings, vocal calls or any other signs of the Night Parrot were recorded during the current targeted survey from 12 nights of Autonomous Recording Units recordings and eight camera trap nights.	September 2017
Mesa H – Desktop Mesa Façade Assessment October 2017. Astron (2017c)	A mesa façade ecological assessment for the Mesa H deposit, to provide data on the ecological value of mesa facades to assist in determining which facades or sections of mesa facades should be retained. The area assessed totalled 446.8 ha.	October 2017
Mesa H Ghost Bat, Macroderma gigas – Contextual Study September 2017. Astron (2017d)	Contextual analysis of Ghost Bat within the vicinity of the Mesa H survey area, to identify significant habitats for Ghost Bat and discuss habitat in a local and regional context.	September 2017
Mesa H Level 2 Fauna Assessment 2016. Astron (2017e)	A two-phase Level 2 vertebrate and SRE invertebrate fauna assessment in October 2015 and May 2016 in the Mesa H Development Envelope which is approximately 4,839 ha in size, including some adjacent areas. The survey mapped fauna habitats and recorded species present including conservation significant species, using trapping grids, avifauna surveys, motion sensitive cameras, acoustic bat surveys, active foraging, targeted searches and nocturnal spotlighting.	October 2015 and May 2016
Robe Valley Mesa A to Mesa 2405A, impact of mining on Ghost bat presence and activity, April 2017, including assessment of caves on Mesas F and G. Bat Call WA (2017a)	An assessment of the impact on Ghost bat populations of open cut iron ore mining in the Robe River valley including categorisation of the status of mesas, measurement of mesa areas and perimeters, counting of caves and lengths of facades measures, review of previous studies and detailed assessments of all identified caves and shelters on mesas B, C, F, G and H. The study was conducted in July 2016 and April 2017.	April 2017
Robe Valley Mesa H, Ghost bat roost cave assessment, April 2017. Bat Call (2017b)	A targeted assessment of bat conservation values at Mesa H including visual assessment of cave environments and an extensive search for Ghost bat presence, including roosting bat. Presence of guano and middens were recorded.	April 2017
Robe Valley Mesas Fauna Survey. Biota (2011b)	A single phase Level 2 fauna survey of a study area encompassing Mesas B, C, D, E, F, H and I to assess significant conservation significant fauna values including vertebrate and SRE fauna.	March 2011

Survey report	Summary	Survey Date
Aquatic		
Mesa H Project Baseline Aquatic Ecosystem Survey Dry Season Sampling 2016. WRM (2018)	Baseline aquatic ecosystem sampling of the Robe River system (post dry season) upstream and downstream of the Mesa H project area, including assessment of permanent pools, and assessment of water quality and sampling for micro invertebrates, hyporheic fauna, macroinvertebrates and fish.	October 2017
Aquatic Ecosystems Study - April 2017 Streamtec (2017)	An annual biophysical / ecological survey of the Robe River conducted in April 2017, as part of an on-going commitment to assess environmental impacts of mine development at Mesa J on the adjacent and downstream aquatic ecosystem of the river (largely the permanent, 'refugial' pools). This monitoring includes a long-term assessment of aquatic fauna (i.e. aquatic macroinvertebrates and fish), channel / pool morphology, riparian / bank condition, weeds, water flows and water quality, and has been conducted annually since 1991 (i.e. before mining at Mesa J).	April 2017
Mesa H Project Baseline Aquatic Ecosystem Survey Wet Season Sampling 2016. WRM (2017)	Baseline aquatic ecosystem sampling of the Robe River system (post wet season) upstream and downstream of the Mesa H project area, including assessment of permanent pools, and assessment of water quality and sampling for micro invertebrates, hyporheic fauna, macroinvertebrates and fish.	April / May 2016



Historical Surveys

- Biota Environmental Sciences, 2006: Fauna Habitats and Assemblages
- Biota Environmental Sciences, 2007: Seasonal Fauna Survey
- Biota Environmental Sciences, 2010: Seasonal Fauna Survey
- Astron Environmental Sciences, 2011: NVCP Fauna Survey
- Astron Environmental Services, 2014: L1 Flora, Vegetation & Fauna Assessment
- Biologic Environmental Survey, 2014: MNES Targeted Survey (NQ, GB, PLNB, POP)
- Astron Environmental Services, 2015c: Fauna Assessment
- Astron Environmental Services, 2015d: Fauna Assessment

Proposed Change Area Specific Surveys

- Biota Environmental Sciences, 2011b: Robe Valley Mesas Fauna Survey
- Astron Environmental Services, 2017b: Targeted Night Parrot
- Astron Environmental Services, 2017c: Mesa Facade Assessment
- Astron Environmental Services, 2017d: Mesa H Ghost Bat Contexual Study - Desktop Assessment
- Astron Environmental Services, 2017d: Mesa H Ghost Bat Contexual Study - Targeted Survey
- Astron Environmental Services, 2017e: L2 Fauna Assessment
- Bat Call 2017a: Mesa A - 2405A Ghost Bar Assessment
- Bat Call 2017b: Mesa H Ghost Bat roost cave assessment

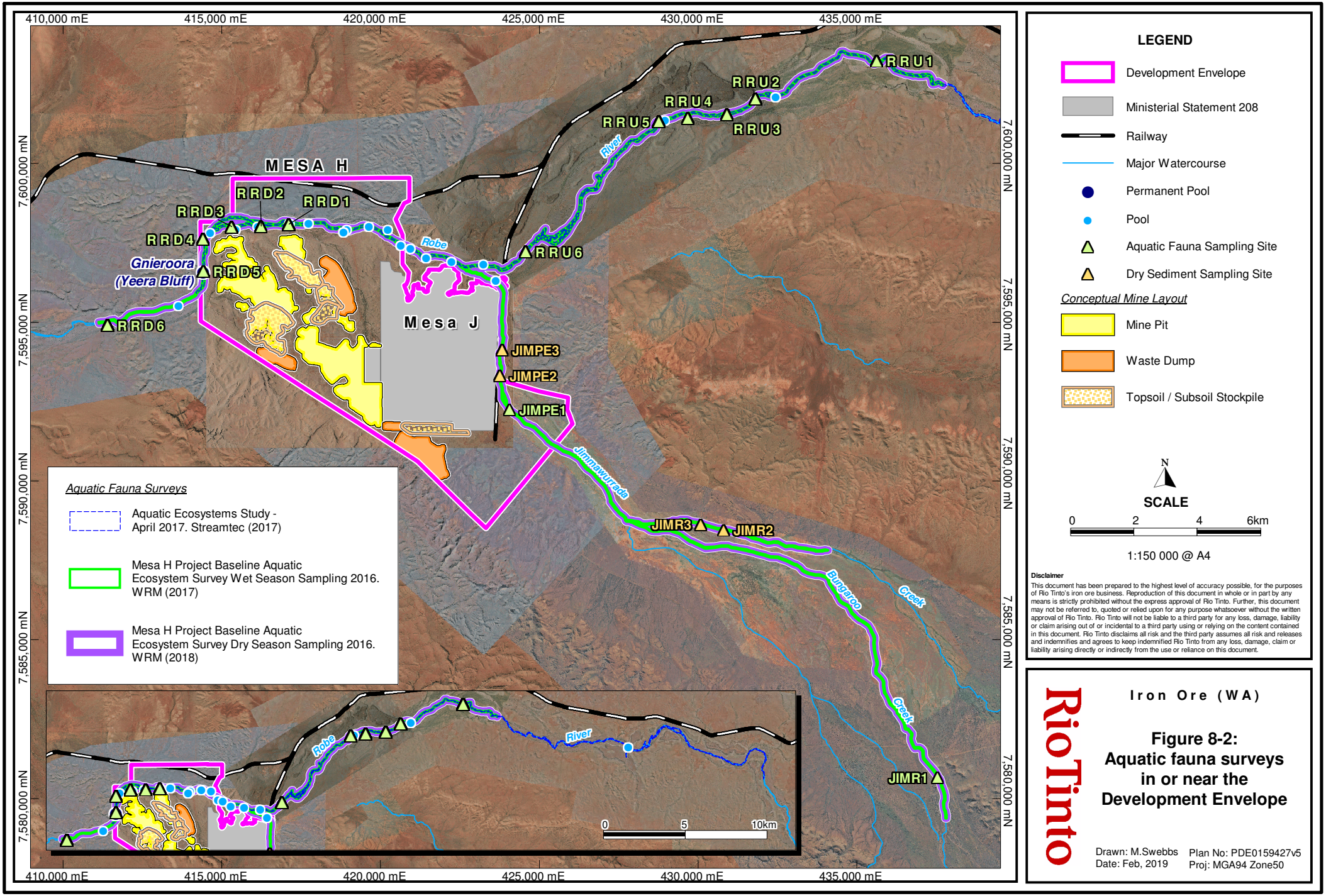
RioTinto

Iron Ore (WA)

Figure 8-1: Terrestrial fauna surveys in or near the Development Envelope

Drawn: M.Swebbs
Date: Mar, 2019

Plan No: PDE0155755v7
Proj: MGA94 Zone50



LEGEND

- Development Envelope
- Ministerial Statement 208
- Railway
- Major Watercourse
- Permanent Pool
- Pool
- Aquatic Fauna Sampling Site
- Dry Sediment Sampling Site

Conceptual Mine Layout

- Mine Pit
- Waste Dump
- Topsoil / Subsoil Stockpile

N

SCALE

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Rio Tinto

Iron Ore (WA)

Figure 8-2: Aquatic fauna surveys in or near the Development Envelope

Drawn: M.Swebbs
Date: Feb, 2019

Plan No: PDE0159427v5
Proj: MGA94 Zone50

8.4.2.1 Targeted surveys for conservation significant fauna

Specific targeted surveys have been undertaken in the Development Envelope for the Ghost Bat, given the presence of several roosts in the Proposed Change Area and throughout the Robe Valley. Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python have also been surveyed adequately, although not in specific targeted surveys, targeted techniques have been used for these species across numerous surveys which overlap with the Development Envelope as described below.

Northern Quoll

In addition to the Level 2 fauna survey for the Proposed Change (Astron 2017e), numerous surveys, comprising targeted surveys and monitoring (including ongoing monitoring) have been undertaken for the Northern Quoll within the Development Envelope and across the broader Robe Valley. These include:

- Mesa H Landform:
    - Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo (Biota 2006c);
    - Mesa J Tail Track Extension Vegetation, Flora and Fauna Survey (Astron 2011);
    - Robe Valley Mesa's Fauna Survey (Biota 2011b);
    - Mesa H - Level 1 Flora, Vegetation and Fauna Assessment (Astron 2014);
    - Yarraloola - Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat Targeted Survey (Biologic 2014); and
    - Yandicoogina Threatened Species Offset Plan (TSOP) – Northern Quoll monitoring.
- Outside and overlapping with the Development Envelope:
    - Bungaroo Trial Pit and Transport Corridor to Mesa J, Near Pannawonica: Fauna Assemblage Seasonal Survey (Biota 2007c);
    - Greater Bungaroo Seasonal Fauna Survey (Biota 2010b);
    - Middle Robe and East Deepdale Level 2 Fauna Assessment (Astron 2016d); and
    - Bungaroo Iron Ore Mine and Infrastructure Project Level 2 Fauna Survey (Astron 2016e).

The Biologic (2014) survey comprised a targeted survey for the Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat, covering the entire Development Envelope as shown in Figure 8-1.

A Northern Quoll monitoring program has been established and monitoring is continuing across Yarraloola Station, as part of the Land Management Area of the Yandicoogina TSOP, undertaken in partnership with the DBCA. The Land Management Area for this program encompasses the entirety of the Mesa H landform, and a significant portion of the Proposed Change Area.

In addition to the existing Northern Quoll monitoring program as part of the TSOP, ongoing monitoring within the Development Envelope and across the Robe Valley is proposed to be implemented as part of the EMP.

Pilbara Leaf-nosed Bat

The Pilbara Leaf-nosed Bat was targeted during the Astron (2017e) survey using 14 bat SM2 detector locations in the Proposed Change Area for a total of 27 recording nights. The species was also surveyed during the Level 1 survey of Mesa H in 2014 (Astron 2014). Further monitoring for this species by Rio Tinto was undertaken at an additional 66 locations over 144 nights. Under the Commonwealth survey guidelines, a minimum of 16 detector nights from four nights is recommended. From both the Level 2 fauna surveys and

an additional ongoing monitoring, a total of 171 recording nights have been conducted within the Survey Area, well beyond the minimum requirement.

The Mesa H Bat Call WA surveys and Astron (2017e) Ghost Bat targeted regional sampling included active searches of caves with some prospectivity of supporting roosts for either Ghost Bats or Pilbara Leaf-nosed Bats; if the zoologists had found Pilbara Leaf-nosed Bats or roosts then these records and roosts would have also been recorded during the targeted Ghost Bat surveys.

Pilbara Olive Python

Currently no specific referral guidelines are appropriate to this species. Under the Commonwealth survey guidelines for the Pilbara Olive Python, nocturnal road cruising and targeted searching for this species within suitable habitat is deemed appropriate. These survey methods were employed during the Level 2 fauna survey by Astron (2017e). A total of 1,800 minutes (30 hours) of nocturnal spotlighting was undertaken which is considered more than adequate in detecting this species (Astron 2017e).

8.4.3 Fauna habitats

Seven broad-scale fauna habitat types have been recorded in the Proposed Change Area (Astron 2017e) comprising a total area of 4,839 ha. These include: *Riverine, Drainage Line, Gorge, Breakaway, Rocky Hills, Low Hills and Slopes, Loamy / Stony Plain* habitats as described in Table 8-3 and depicted in Figure 8-3.

The habitat types identified within the Proposed Change Area are not restricted at the local, sub-regional or regional scale.

The following habitats are considered to be of elevated significance:

- **Gorge and Breakaway habitats** collectively comprise approximately 2% of the Proposed Change Area and are considered the most significant for fauna, in particular conservation significant fauna; and the deeply incised gorges are considered important as refugia locally (Astron 2017e).
    - Breakaway habitat is a common feature of the Pilbara but as they tend to be narrow, linear features, they represent a small proportion of the total land area (Astron 2017e). The breakaways within the Development Envelope were largely associated with the mesa facades and contain numerous crevices, caves and overhangs; which provide sheltered microhabitats for terrestrial fauna.
    - Gorge habitat is the most restricted in the survey area. Whilst gorges are a common feature of the Pilbara, they tend to be narrow, linear features, and represent a small proportion of the total land area (Astron 2017e). They also represent important shelter or roosting habitat. Deep caves and semi-permanent rock pools were recorded in this habitat type which can provide refuge for fauna during harsh dry seasonal conditions.
    - In summary, the Gorge and Breakaway habitats provide:
        - important shelter or roosting habitat for bats of conservation significance, including the Pilbara Leaf-nosed Bat and Ghost Bat
        - potential denning and foraging habitat for the Northern Quoll
        - potential breeding / denning habitat for the Pilbara Olive Python; and
        - refugia, sheltered microhabitats and food resources for vertebrate fauna assemblages in general and for invertebrate groups that support SREs.

Caves and shelters considered likely to support Ghost bats (Bat Call 2017b) are identified in Section 8.4.5.2 and further described in Section 8.6.3.

- **Riverine Habitat** is delineated along the ephemeral Robe River and comprises 143 ha of the Proposed Change Area. It is considered to be of high importance to fauna species providing a range of ecological values to a broad suite of species (Astron 2017e).
    - The habitat generally comprises narrow, linear riparian woodlands, with vegetation being denser, taller and more diverse than the adjacent Drainage Line habitat. In the Proposed Change Area, this habitat unit is dominated by *Melaleuca argentea*, *Eucalyptus camaldulensis* and *Eucalyptus victrix*.
    - A significant feature of the Riverine habitat is the presence of semi-permanent and permanent pools along the Robe River (see Figure 5-6 in Section 5.4.4).
    - In summary, the Riverine habitat provides:
        - an important source of water to fauna in a largely dry landscape; permanent and semi-permanent water bodies provide drinking opportunities for a range of species and attract prey for predators;
        - a range of micro niches for vertebrate fauna for shelter and foraging, including the Pilbara Olive Python;
        - foraging sites for Ghost Bats, Pilbara Leaf-nosed Bats, Pilbara Olive Pythons and the Northern Quoll;
        - potential ecological corridors / dispersal routes for the Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat and Ghost Bat to traverse various habitats;
        - habitat for a range of aquatic fauna; and
        - areas likely to support SREs.

The remaining habitats and habitat features recorded within the Proposed Change Area are considered to be well represented in the Robe Valley and the Pilbara bioregion and are not considered to be of elevated significance. This includes the Drainage Line habitat of Jimmawurrada Creek which contains riparian vegetation and provides:

- a seasonal source of water to fauna in a largely dry landscape;
- suitable seasonal habitat for fauna of conservation significance;
- a potential dispersal route for the Northern Quoll;
- habitat for a range of aquatic fauna; and
- areas with a moderate potential to support SREs.

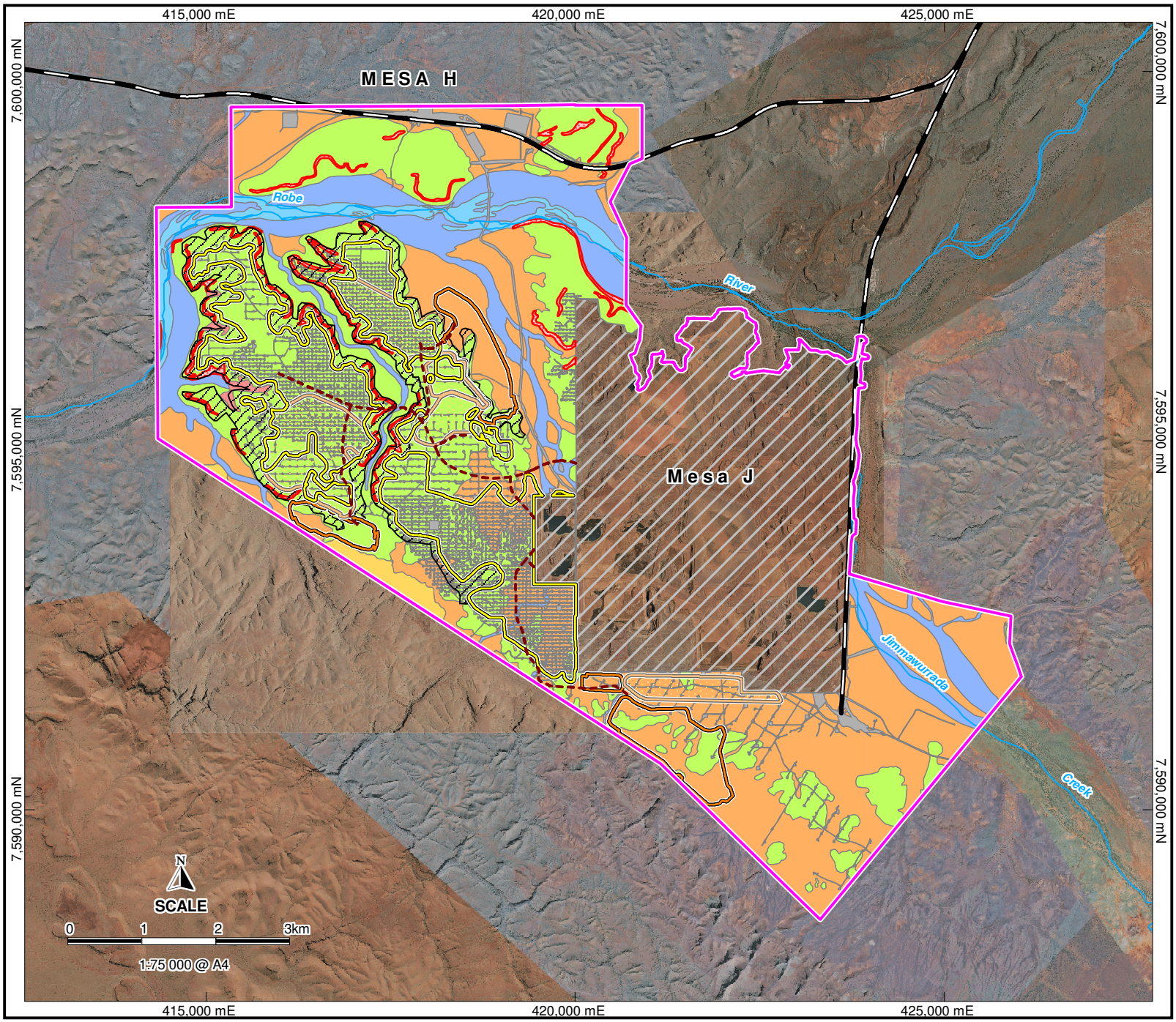
Areas of previously disturbed habitat were prevalent in the Low Slopes and Hills habitat on the mesa plateau and Loamy / Stony Plains habitat, in the form of exploration drill pads and associated tracks.

Habitat condition was assessed based on the presence of disturbances, using condition ratings suggested by Thompson and Thompson (2010). Loamy / Stony Plains habitat ranged from disturbed to very good condition, with some areas heavily affected by cattle grazing and Buffel grass. All other habitats were in good to high quality condition. Rocky Hills, Breakaway and Gorge habitats were generally in high quality condition (Astron 2017e).

The majority of Drainage Line and Riverine habitats were in poor to very good condition due to weed infestation associated with decades of pastoral activities (Astron 2017e).

Table 8-3: Fauna Habitats Mapped in the Proposed Change Area (Astron 2017e)

Habitat	Description and information	Extent in Proposed Change Area	Distribution	Potential to support fauna, including conservation significant species	Likelihood to support SREs
Riverine	Densely vegetated riparian zones of the Robe River often associated with permanent and semi-permanent water bodies on stony soils.	143 ha	Limited to linear isolated pockets of riparian vegetation adjacent to Drainage Line habitat.	High value to wide spectrum of fauna species. Moderate value to target MNES species as they are likely to forage and traverse in this habitat type.	Moderate
Drainage Line	Broad open valley floor of the Robe River on stony plains.	582 ha	Widespread. Commonly recorded in the Pilbara region.	Moderate value to wide spectrum of fauna species. Low value to target MNES species due to lack of refugia or shelter.	Moderate
Gorge	Deep often rocky gorges, sometimes with ephemeral, semi-permanent pools.	14.65 ha	A common feature in the Pilbara; however, as it occurs as narrow linear features, this habitat type represents a small proportion of the total land area. Most restricted habitat type in the Proposed Change Area.	Primary high value habitat for target MNES. Significant refugia/shelter sites. Supports diversity of fauna.	High
Breakaway	Breakaway or ridge line, usually associated with the Mesa façade, falling away to steep scree slope or drainage line.	83.5 ha	Common feature in Pilbara; however, occurs as narrow linear features, representing small proportion of land area. Associated with mesa landforms.	High value to target MNES as they are likely to roost and den within this habitat type.	High
Rocky Hills	Stony hills on high ranges with dissected valleys and gorges.	49.7 ha	Common and widespread throughout the Pilbara.	Moderate value for target MNES as they are likely to traverse and forage in this habitat type.	Moderate
Low Hills and Slopes	Low stony hills and slopes with dissected valleys and drainage on stony soils.	1,879 ha	Most common habitat type in the Proposed Change Area and widespread and common in Pilbara region.	Low value to target MNES.	Low to Moderate
Loamy / Stony Plain	Low-lying undulating loamy to stony plain within Robe valley floor.	1,712 ha	Second most common habitat in the Proposed Change Area and widespread and common in the Pilbara region.	Low value to target MNES.	Low
Disturbed	Cleared areas from mining and pastoralism activities.	372 ha	N/A	Little value as fauna habitat.	N/A
Mesa J	Existing mining operations	1,802 ha	N/A	Little value as fauna habitat	N/A



LEGEND

- Development Envelope
- Ministerial Statement 208
- Railway
- Major Watercourse

Conceptual Mine Layout

- Mine Pit
- Waste Dump
- Topsoil / Subsoil Stockpile
- Haul Road
- Mining Exclusion Zone

Fauna Habitat

- Breakaway
- Loamy/stony plain
- Gorge
- Rocky hills
- Riverine
- Low hills and slopes
- Drainage Line
- Disturbed

Rio Tinto

Iron Ore (WA)

Figure 8-3: Fauna Habitats mapped in the Development Envelope

Drawn: M.Swebbs
Date: Feb, 2019

Plan No: PDE0152730v7
Proj: MGA94 Zone50

8.4.4 Terrestrial vertebrate fauna occurrence

Astron (2017e) recorded a total of 169 vertebrate fauna species within the Proposed Change Area during the survey, including two amphibians, 55 reptiles, 85 birds and 27 mammals (including four introduced species). The fauna species assemblage recorded during the current survey is considered typical of the Hamersley Range sub region extending from near Pannawonica to Mt Brockman as well as a subset of typical fauna assemblages across the Pilbara bioregion (Astron 2017e). The trapping effort of Astron (2017e) is shown in Figure 8-4. Survey sampling sites for the Night Parrot are shown in Figure 8-5.

Of the 169 vertebrate fauna species, six species of conservation significance were recorded, including species listed under the EPBC Act and / or the BC Act, together with species listed as Priority species by the DBCA (Table 8-4).

A desktop assessment identified one further species of conservation significance considered to have a high likelihood of occurring (Blind Snake), ten species with moderate likelihood of occurring and a further 13 with a low likelihood of occurring within the Proposed Change Area. Species considered to have a low likelihood of occurring are identified in Astron (2017e) and not addressed any further in this document.

Further detail of records and habitat preferences of conservation significant (non-aquatic) vertebrate fauna is provided in Section 8.4.5 and depicted in Figure 8-6.

It should be noted that pitfall traps for vertebrate fauna were not installed in the Breakaway habitat type for logistical reasons, owing to the lack of soil to dig pitfalls into (Astron 2017e), however this is not considered to be a limitation of the survey. The use of pitfall traps during Level 2 fauna surveys is generally designed to target small to medium ground-dwelling reptiles and mammals, particularly reptiles in the context of the Pilbara region. No conservation significant reptilian species occur within the Breakaway habitat type and specifically within the Development Envelope. To sample the Breakaway fauna habitat and record potential species of conservation significance, the site was sampled systematically through other accepted methods (i.e. wire cages traps and aluminium Elliot box traps). Two sites (site RVMP 12,252 trapping nights; site RVMP 16,518 trapping nights) combined for a total of 770 trap nights were surveyed within this habitat type (Astron 2017e).

The conservation significant mammals expected to occur within this habitat type include the Northern Quoll and potentially the Long-tailed Dunnart, which would have been captured via other accepted methods which were used (i.e. wire cages traps and aluminium Elliot box traps). In addition, other non-systematic fauna methods such as diurnal and nocturnal searching, opportunistic records and targeted searches facilitated the recording of the fauna assemblage for this habitat type and generally supplemented the species which would have been recorded through pitfall trapping (Astron 2017e).

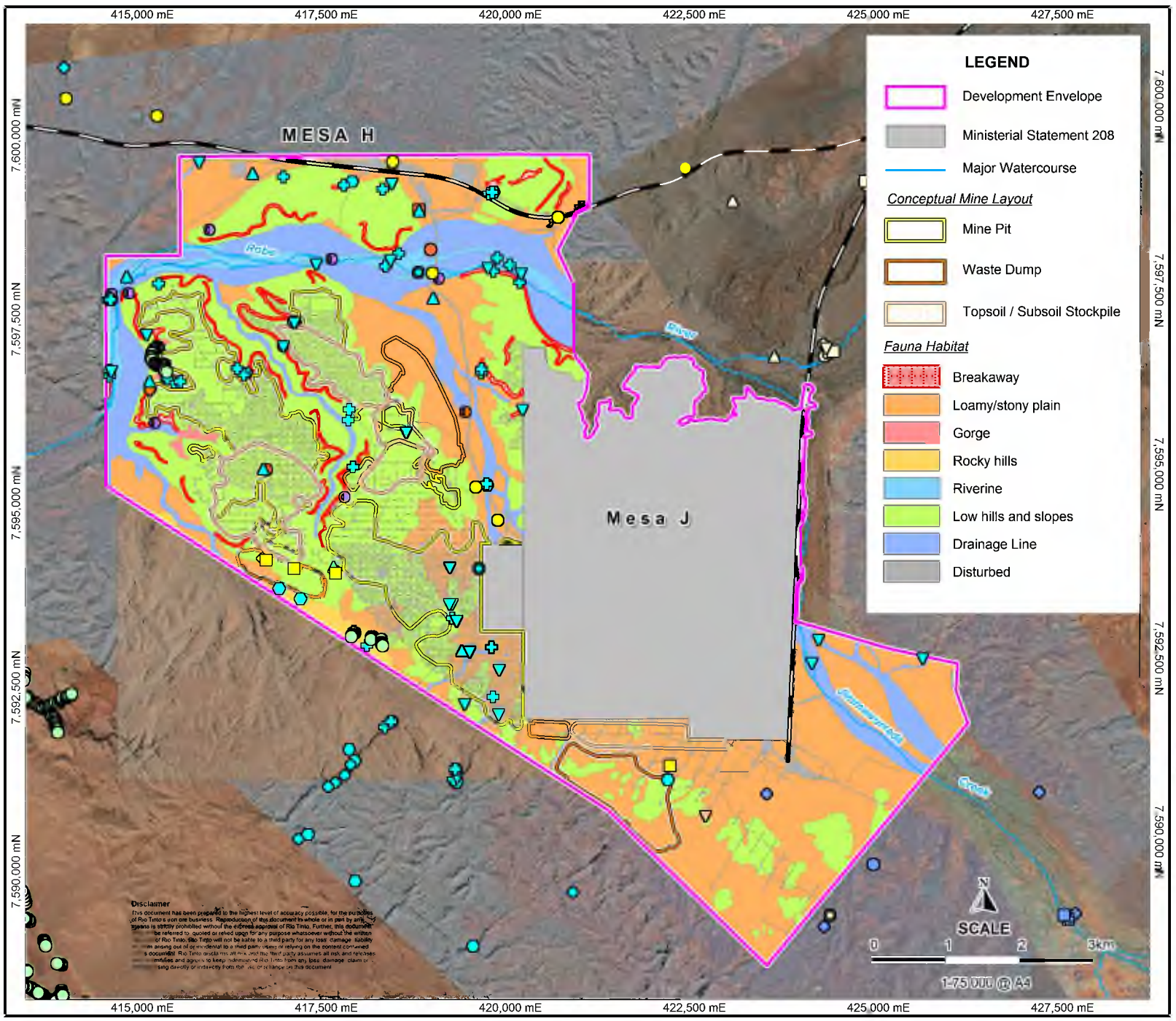
Table 8-4: Records and Likelihood of Occurrence of Conservation Significant (Non-Aquatic) Vertebrate Fauna Species

Name	Conservation status		Records within Proposed Change Area	Public database records	Preferred habitat	Habitat occurrence in the Proposed Change Area	Likelihood of occurrence
	State	Commonwealth					
Northern Quoll *Dasycercus hallucatus*	Schedule 2	Endangered	Four trap captures and 22 recorded on camera at 14 sites plus scats and tracks (Astron 2017e).	Y	Rocky hills, gorges, mesas, high and low plateaus, low slopes and stony plains with spinifex.	Y	Recorded
Pilbara Olive Python *Liasis olivaceus barroni*	Schedule 3	Vulnerable	One individual and two scats (Astron 2017e).	Y	Escarpments, deep gorges, water holes and rock piles associated with permanent pools in rocky areas.	Y	Recorded
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*	Schedule 3	Vulnerable	Multiple calls recorded in vicinity of Robe River and along southern boundary of Proposed Change Area (Astron 2017e).	Y	Deep caves with high humidity and stable temperatures, water courses, riparian vegetation, hummock grassland and sparse tree and shrub savannah.	Y	Recorded
Ghost Bat *Macroderma gigas*	Schedule 3	Vulnerable	Nine nocturnal and two diurnal roosts recorded as well as calls and scats (Astron 2017e, Bat Call 2017b).	Y	Rocky gorges and breakaways with caves and crevices.	Y	Recorded
Lined Soil-crevice Skink *Notoscincus butleri*	Priority 4	N/A	One recorded (Astron 2017e).	Y	Spinifex areas near creek and river margins.	Y	Recorded

Name	Conservation status		Records within Proposed Change Area	Public database records	Preferred habitat	Habitat occurrence in the Proposed Change Area	Likelihood of occurrence
	State	Commonwealth					
Western Pebble Mound Mouse *Pseudomys chapmani*	Priority 4	N/A	Five inactive mounds (Astron 2017e). One inactive mound previously recorded by Astron (2014) and one from Biota (2006c).	Y	Gentle slopes of rocky ranges where the ground is covered by stony mulch and vegetated by hard spinifex, with sparse overstorey of eucalypts and scattered shrubs.	Y	Recorded
Blind Snake *Anilios ganei*	Priority 1	N/A	Previously recorded in vicinity of survey area (Astron 2017e)	Y	Moist gorges and gullies and potentially occurs over stony habitats.	Y	Highly likely
Fork-tailed Swift *Apus pacificus*	Schedule 5	Migratory	Nil	N	Largely aerial independent of the terrestrial environment.	Y	Moderately likely
Letter-winged Kite *Elanus scriptus*	Priority 4	N/A	Nil	Y	Arid inland regions and permanent water.	Y	Moderately likely
Australian Painted Snipe *Rostratula benghalensis (sensu lato)*	Schedule 2	Endangered	Nil	Y	Range of wetland habitats.	Y	Moderately likely
Common Sandpiper *Actitis hypoleucos*	Schedule 5	Migratory	Nil	Y	Coastline and inland areas, most common northern and western Australia.	Y	Moderately likely

Name	Conservation status		Records within Proposed Change Area	Public database records	Preferred habitat	Habitat occurrence in the Proposed Change Area	Likelihood of occurrence
	State	Commonwealth					
Sharp-tailed Sandpiper *Calidris acuminata*	Schedule 5	Migratory	Nil	Y	Fresh or brackish wetlands, most commonly in coastal areas but also occurs inland.	Y	Moderately likely
Wood Sandpiper *Tringa glareola*	Schedule 5	Migratory	Nil	Y	Well vegetated, shallow, freshwater wetlands.	Y	Moderately likely
Common Greenshank *Tringa nebularia*	Schedule 5	Migratory	Nil	Nil	Variety of inland and sheltered coastal wetland habitats.	Y	Moderately likely
Oriental Pratincole *Glareola maldivarum*	Schedule 5	Migratory	Nil	Y	Plains, floodplains, grasslands and bare areas.	Y	Moderately likely
Long-tailed Dunnart *Sminthopsis longicaudata*	Priority 4	N/A	Nil	Nil	Rocky and stony soils with hummock grasses and shrubs.	Y	Moderately likely
Short-tailed Mouse *Leggadina lakedownensis*	Priority 4	N/A		Y	Sandy soils and cracking clays.	Y	Moderately likely

* Public database records include the results of NatureMap and WA Museum database searches in a 40 km radius and the EPBC Protected Matters Search Tool in a 50 km radius. Note that 40 km is the largest possible search area for NatureMap and the WA Museum.



Systematic and non-systematic terrestrial vertebrate fauna trapping sites

Historical

Astron, 2014
- Anabat

DoPW, 2015
- Cage trap

Astron, 2015c
- Habitat Assessment

Biota, 2010b
- Anabat
- Elliott trap
- Harp trap
- Pit Trap (Dry)

Biota, 2006c
- Elliott trap
- Funnel Trap
- Pit Trap (Dry)

Astron, 2015d
- Camera (active)
- Echolocation recording
- Nocturnal Search
- Targeted searches
- Trap sites
- Trapping grid

Biota, 2011b
- Anabat
- Elliott trap
- Funnel Trap
- Pit Trap (Dry)

Proposed Change Area

Astron, 2017e
- Accoustic recording
- Camera (active)
- Habitat Assessment
- Spotlighting Survey
- Trapping Grid **
- Targeted Searches

*** includes Cage traps, Elliot traps, Pitfall traps and Funnel traps*

Rio Tinto

Iron Ore (WA)

Figure 8-4: Systematic and non-systematic terrestrial vertebrate fauna trapping sites in or near the Development Envelope

Drawn: M.Swebbs
Date: Mar, 2019

Plan No: PDE0155777v7
Proj: MGA 94 Zone 50

Geospatial Information and Mapping