



Environmental Management Plan

Mesa A Hub Revised Proposal

RTIO-HSE-0325456

Robe River Mining Co. Pty. Ltd.

152-158 St Georges Terrace, Perth

GPO Box A42, Perth WA 6837

December 2020

Disclaimer and Limitation

This Environmental Management Plan has been prepared by Rio Tinto's Iron Ore group (Rio Tinto), on behalf of Robe River Mining Co. Pty. Limited (the Proponent), specifically for the Mesa A Hub Revised Proposal. Neither the report nor its contents may be referred to without the express approval of Rio Tinto, unless the report has been released for referral and assessment of proposals.

Document Status					
Rev	Author	Reviewer/s	Date	Approved for Issue	
				To Whom	Date
A	Rio Tinto	Approvals, Ops Environment	July 2018		
1	Rio Tinto	GM West Angelas and Robe Valley	July 2018		
2	Rio Tinto		July 2018	EPA Services	July 2018
2.1	Rio Tinto		August 2018	EPA Services	August 2018
2.2	Rio Tinto		August 2018	EPA Services	August 2018
2.3	Rio Tinto		November 2018	EPA Services	November 2018
2.4	Rio Tinto	RTIO HSES	February 2019	EPA Services	March 2019
2.5	Rio Tinto	GM Robe Valley	February 2020	EPA Services	February 2020
2.6	Rio Tinto	Study Team, Environment Team, Approvals Team	June 2020		
3	Rio Tinto	GM Robe Valley	July 2020	EPA Services	July 2020
4	Rio Tinto	GM Robe Valley	December 2020	EPA Services	December 2020

SUMMARY

The Mesa A Hub Revised Proposal Environmental Management Plan (EMP) is submitted by Rio Tinto on behalf of Robe River Mining Co. Pty. Ltd. (the Proponent) in accordance with Ministerial Statement 1112 (MS 1112), and to meet relevant requirements of EPBC Act Approval 2016/7843. Table S1 summarises the relevant approvals and the purpose of this EMP. Table S2 presents the environmental criteria to measure achievement of the environmental outcomes and objectives to be met through implementation of this EMP.

Table S1: Summary of approvals and purpose of this EMP

Proposal title	Mesa A Hub Revised Proposal
Proponent	Robe River Mining Co. Pty. Ltd.
Ministerial Statement	MS 1112
EPBC Act approval	2016/7843
Purpose of this EMP	<p>This EMP fulfills the requirements of Conditions 5-1, 5-2 and 5-3 of MS 1112 in relation to management of environmental factors other than Subterranean Fauna and in turn meets the requirements of Conditions 2 and 3 of EPBC Act approval 2016/7843.</p> <p>The Mesa A Hub Revised Proposal 'Environmental Management Plan – Troglifauna' is presented as a separate document (RTIO-HSE-0335971) and fulfills Conditions 5-1, 5-2, 5-3, 6-1, 10-1 and 10-2 of MS 1112 in relation to management of troglifauna.</p>

Table S2: Environmental criteria to measure achievement of the environmental outcomes and objectives under MS 1112

Flora and Vegetation – Sand Sheet Vegetation (Robe Valley) Priority Ecological Community (PEC) EPA Objective: <i>To protect flora and vegetation so that biological diversity and ecological integrity are maintained</i>		
Outcome based provisions	Condition environmental outcome	The Proponent shall ensure there is no direct impact to the Sand Sheet Vegetation (Robe Valley) PEC as a result of implementation of the Proposal, other than existing and authorised disturbance
	Trigger criteria	<ol style="list-style-type: none"> 1. Clearing within 20 metres (m) of the boundary of the Sand Sheet Vegetation (Robe Valley) PEC, other than existing and authorised disturbance 2. Transect monitoring detects new high priority weed species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC 3. Quadrat monitoring detects new high priority weed species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC or an increase in number and/or extent of a previously detected high priority weed species
	Threshold criteria	<ol style="list-style-type: none"> 1. Clearing within the Sand Sheet Vegetation (Robe Valley) PEC, other than existing and authorised disturbance 2. High priority weed species becomes established and dominant within the Sand Sheet Vegetation (Robe Valley) PEC

Management based provisions	Condition environmental objective	The Proponent shall minimise indirect impacts due to the Proposal as far as practicable to the Sand Sheet Vegetation (Robe Valley) PEC so that the biological diversity and ecological integrity of the PEC are maintained
	Management targets	<ol style="list-style-type: none"> 1. Persistence of the four key species (<i>Corymbia zygophylla</i>, <i>Acacia tumida</i> var. <i>pilbarensis</i>, <i>Grevillea eriostachya</i> and <i>Triodia schinzii</i>) of the Sand Sheet Vegetation (Robe Valley) PEC 2. No decline in native species richness in the Sand Sheet PEC attributable to the Proposal, taking into account historical variation and reference site trends 3. No loss of immediate hydrological contributing area due to the Proposal, excluding existing and authorised disturbance, that affects surface water flow to the Sand Sheet Vegetation (Robe Valley) PEC
Flora and Vegetation – Priority 1 Flora EPA Objective: <i>To protect flora and vegetation so that biological diversity and ecological integrity are maintained</i>		
Management based provisions	Condition environmental objective	The Proponent shall manage the implementation of the Proposal to avoid where possible, and minimise direct and indirect impacts to <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61)
	Management Target	<ol style="list-style-type: none"> 1. Limit direct impacts on <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) due to implementation of the Proposal to no greater than predicted (5% of known records as represented in the Rio Tinto database) 2. Minimise potential indirect impacts of high priority weeds on <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61)
Terrestrial Fauna habitat – Conservation Significant Fauna Species; Ghost Bat (<i>Macroderma gigas</i>) and Northern Quoll (<i>Dasyurus hallucatus</i>) EPA Objective: <i>To protect terrestrial fauna so that biological diversity and ecological integrity are maintained</i>		
Outcome based provisions	Condition environmental outcome	The Proponent shall ensure there is no irreversible impact, as a result of the Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C Mining Exclusion Zones (MEZs), other than existing and authorised disturbance
	Early warning criteria	1. Disturbance, other than existing and authorised clearing, within 50 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 2-2
	Trigger criteria	<ol style="list-style-type: none"> 1. Vibration levels exceed 50 millimeters (mm/s) peak particle velocity at the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7 2. Disturbance of ≥ 5% of potential Northern Quoll denning habitat (comprising Breakaways and Gullies habitat and Rocky Slopes Habitat) in the MEZ of Mesa A, B or C, excluding existing disturbance and disturbance authorised prior to grant of MS 1112
	Threshold criteria	<ol style="list-style-type: none"> 1. Permanent structural damage to potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7 2. Disturbance, other than existing and authorised clearing, within 40 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 2-2 3. Disturbance of >10% of potential Northern Quoll denning habitat (comprising Breakaways and Gullies habitat and Rocky Slopes habitat) in

		the MEZ of Mesa A, B or C, excluding existing disturbance and disturbance authorised prior to grant of MS 1112
Inland Waters – Groundwater abstraction and riparian vegetation of the Robe River EPA Objective: <i>To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected</i>		
Outcome based provisions	Condition environmental outcome	The Proponent shall ensure that groundwater levels are maintained to ensure there is no impact to the health of riparian vegetation of the Robe River, as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal
	Trigger criteria	<ol style="list-style-type: none"> 1. Robe River groundwater level trends adjacent to the Mesa C deposit are significantly different to trends in the broader locality or reference sites 2. The area of decline below the MSAVI baseline 5th percentile for overstorey obligate phreatophytic canopy is 10% greater in the Robe River adjacent to the Mesa C deposit than in reference areas
	Threshold criteria	<ol style="list-style-type: none"> 1. There is a significant decline since baseline in the number and/or a change in composition of native perennial species relative to reference sites and groundwater level trends are significantly different to regional trends or reference sites, within the Robe River adjacent to the Mesa C deposit as a result of groundwater abstraction and/or dewatering associated with the Proposal
Inland Waters – Groundwater abstraction and riparian vegetation of Warrambo Creek EPA Objective: <i>To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected</i>		
Outcome based provisions	Condition environmental outcomes	The Proponent shall ensure that there is no irreversible impact to the health of riparian vegetation of Warrambo Creek as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal
	Early warning criteria	<ol style="list-style-type: none"> 1. Groundwater draw down equivalent to 1.5 m from baseline at the modelled 2 m draw down contour 2. The area of decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy is 10% greater within the potential impact area than in reference areas
	Trigger criteria	<ol style="list-style-type: none"> 1. Groundwater draw down equivalent to 2 m from baseline at the modelled 2 m draw down contour 2. The area of decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy is 20% greater within the potential impact area than in reference areas 3. Significant decline in number and/ or change in composition of native perennial species within the potential impact area since baseline, in comparison to reference sites
	Threshold criteria	<ol style="list-style-type: none"> 1. Decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy over 50% of potential impact area; trend continues over two or more consecutive dry season monitoring events; with no evidence of seasonal recovery; and outside of historical baseline variation, in comparison to reference sites 2. Over 50% of the potential impact area displays significant structural or compositional change to riparian vegetation since baseline, in comparison to reference sites

Inland Waters – Surplus water discharge and riparian vegetation of Warramboo Creek

EPA Objective: *To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected*

Outcome based provisions	Condition environmental outcome	The Proponent shall ensure that there is no irreversible impact to the health of riparian vegetation of Warramboo Creek as a result of surplus water discharge associated with implementation of the Proposal
	Early warning criteria	<ol style="list-style-type: none"> 1. Surface water expression present ≥ 6km downstream of the discharge point in Warramboo Creek under natural no-flow conditions 2. The area of decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy is 10% greater within the potential impact area than in reference areas
	Trigger criteria	<ol style="list-style-type: none"> 1. The area of decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy is 20% greater within the potential impact area than in reference areas 2. Significant decline in number and/ or change in composition of native perennial species within the potential impact area since baseline, in comparison to reference sites 3. Establishment of new high priority weed species at a potential impact site and/or downstream of the discharge extent, previously not detected within the Development Envelope
	Threshold criteria	<ol style="list-style-type: none"> 1. Decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy over 50% of potential impact area; trend continues over two or more consecutive dry season monitoring events; with no evidence of seasonal recovery; and outside of historical baseline variation, in comparison to reference sites 2. Over 50% of the potential impact area displays significant structural or compositional change to riparian vegetation since baseline, in comparison to reference sites

Table S3: Environmental criteria to measure achievement of the environmental outcomes and objectives under EPBC Act approval 2016/7843

EPBC Act listed threatened species – Ghost Bat (<i>Macroderma gigas</i>), Northern Quoll (<i>Dasyurus hallucatus</i>), Pilbara Leaf-nosed Bat (<i>Rhynonictis aurantia</i>) and Pilbara Olive Python (<i>Liasis olivaceus barroni</i>)		
Environmental outcome: Minimise impacts to EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) associated with implementation of the Action		
Management based provisions	Environmental objective	Manage threatening processes associated with implementation of the Action (i.e. implementation of the Proposal), where relevant to minimising impacts to EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python)
	Management targets	Management targets for threatening processes (fire, vehicle and machinery movements, fauna encounters/sightings, weed management, feral animal control, noise and vibration, dust and light) as detailed in Table 2-13, where relevant to EPBC Act listed threatened species
EPBC Act listed threatened species – Ghost Bat (<i>Macroderma gigas</i>)		
Management based provisions	Environmental objective	Improve knowledge of the Ghost Bat population in the Robe Valley, including its use of high value habitat and effects of noise and vibration, in order to assist in maintaining biological diversity and ecological integrity
	Management target	Ensure no significant long-term decline in the Ghost Bat population attributable to the Action (i.e. implementation of the Proposal)

Corporate endorsement

I hereby certify that to the best of my knowledge, the provisions within this Mesa A Hub Revised Proposal Environmental Management Plan are true and correct.

Name: 

Signed: Josh Bennett

Designation: General Manager Robe Valley

Date: 08.12.2020

Contents Page

SUMMARY

1.	CONTEXT, SCOPE AND RATIONALE	6
1.1	Mesa A Hub	6
1.2	Key environmental factors	10
1.3	Condition requirements	13
1.4	Rationale and approach	17
1.4.1	Survey and study findings	18
1.4.2	Key assumptions and uncertainties	29
1.4.3	Management approach	30
1.4.4	Rationale for choice of provisions	30
2.	EMP PROVISIONS	39
2.1	Requirements under MS 1112	39
2.1.1	Outcome-based and management-based provisions	39
2.1.2	Monitoring	52
2.1.3	Reporting	66
2.2	Requirements under EPBC Act approval 2016/7843	70
2.2.1	General provisions and monitoring in relation to threatening processes	70
2.2.2	Provisions specific to the Ghost Bat	75
2.2.3	Monitoring specific to the Ghost Bat	77
2.2.4	Reporting	78
3.	ADAPTIVE MANAGEMENT AND REVIEW OF THIS EMP	81
4.	STAKEHOLDER CONSULTATION	81
5.	REFERENCES	83

Tables

Table 1-1:	MS 1112 conditions for the Proposal relevant to this EMP	14
Table 1-2	EPBC Act Approval 2016/7843 conditions for the Proposal relevant to this EMP	17
Table 1-3:	Recorded potential Ghost Bat roost caves.....	20
Table 1-4:	Description of riparian vegetation units along Warrambo Creek (Rio Tinto detailed mapping).....	23
Table 1-5	Historically mined mesas in the Robe Valley with nearby records of Northern Quoll	35
Table 2-1:	EMP Provisions – Flora and Vegetation (Sand Sheet Vegetation (Robe Valley) PEC)	40
Table 2-2:	EMP Provisions – Flora and Vegetation (Priority 1 Flora).....	42
Table 2-3:	EMP Provisions – Terrestrial Fauna habitat (Ghost Bat and Northern Quoll).....	44
Table 2-4:	EMP Provisions – Inland Waters (groundwater abstraction and riparian vegetation of the Robe River).....	46
Table 2-5:	EMP Provisions – Inland Waters (groundwater abstraction and riparian vegetation of Warrambo Creek).....	48
Table 2-6:	EMP Provisions – Inland Waters (surplus water discharge and riparian vegetation of Warrambo Creek).....	50
Table 2-7:	Monitoring required to evaluate performance against the environmental outcome and to assess the effectiveness of management actions for the Sand Sheet PEC.....	54
Table 2-8:	Monitoring required to assess the effectiveness of management actions for the Priority 1 flora	57
Table 2-9:	Monitoring required to evaluate performance against the environmental outcome under MS 1112 for the Ghost Bat.....	58
Table 2-10:	Monitoring required to evaluate performance against the environmental outcome for the Northern Quoll.....	60
Table 2-11	Monitoring required to evaluate performance against the environmental outcomes for Inland Waters and riparian vegetation.....	65
Table 2-12:	Mesa A Hub Environmental Management Plan reporting table for MS 1112.....	67
Table 2-13:	EMP Provisions – General provisions for EPBC Act listed threatened species	71
Table 2-14:	EMP Provisions – EPBC Act listed threatened species (Ghost Bat).....	76
Table 2-15:	Monitoring required to assess the effectiveness of the management actions under EPBC Act approval 2016/7843 for the Ghost Bat.....	78
Table 2-16:	Mesa A Hub Environmental Management Plan reporting table for EPBC 2016/7843	79
Table 4-1:	Stakeholder consultation	81

Figures

Figure 1-1: Regional location.....	7
Figure 1-2: Development Envelope	8
Figure 1-3: Conceptual layout of the Proposal.....	9
Figure 1-4: Sand Sheet PEC generalised areas (as supplied by the DBCA).....	11
Figure 1-5: <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) records.....	12
Figure 1-6: Fauna habitats.....	21
Figure 1-7: Location of potential Ghost Bat roosts.....	22
Figure 1-8: Riparian vegetation of Warrambo Creek.....	25
Figure 1-9: Groundwater dependence zones along Warrambo Creek	27
Figure 1-10: Riparian vegetation of the Robe River.....	28
Figure 2-1: Weed monitoring areas relevant to <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61).....	43
Figure 2-2: Potential diurnal/maternal Ghost Bat roost dimensions and buffers	45
Figure 2-3: Sand Sheet PEC immediate hydrological contributing areas for annual disturbance reconciliation	55
Figure 2-4: Quadrat and dust monitoring locations for the Sand Sheet PEC.....	56
Figure 2-5: Indicative camera and trap locations for Northern Quoll monitoring	61
Figure 2-6: Established riparian vegetation monitoring areas for the Robe River adjacent to Mesa C.....	63
Figure 2-7: Established riparian vegetation monitoring areas for Warrambo Creek.....	64

Appendices

Appendix 1: Weed species lists	
Appendix 2: MSAVI baseline for Robe River and Warrambo Creek	
Appendix 3: NVIS level IV structural classes and integration with Aplin structural classes, for assessment of Warrambo Creek riparian vegetation	

Abbreviations and terminology

Abbreviation/Term	Description
ACAR	Annual Compliance Assessment Report
AWT	Above Water Table
BWT	Below Water Table
CEO	The Chief Executive Office of the Department of the Public Service of the State responsible for the administration of section 48 of the <i>Environmental Protection Act 1986</i> , or their delegate
CID	Channel Iron Deposit
Commonwealth Department	The Australian Government agency responsible for administration of the <i>Environment Protection and Biodiversity Conservation Act 1999</i>
Development Envelope	The Development Envelope as defined by Ministerial Statement 1112 that applies to the Revised Proposal and contains the indicative Revised Proposal footprint of the mine and associated infrastructure.
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environmental Regulation
EC	Electrical Conductivity
EMP	Environmental Management Plan
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERD	Environmental Review Document
Established (introduced weed species)	An introduced (weed) species that has grown to maturity and reproduced, producing a viable second generation of individual plants signifying persistence at a given location
GIS	Geographical Information System
GL	Giga litre
High priority (introduced weed species)	Introduced (weed) species as defined by: <ul style="list-style-type: none"> Any plant declared under section 22(2) of the <i>Biosecurity and Agriculture Management Act 2007</i> Any plant listed as a Weed of National Significance http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/ Any plant listed in the Department of Parks and Wildlife (2013) <i>Ecological impact and invasiveness ratings from the Department of Parks and Wildlife Pilbara region species prioritisation process 2014</i> spreadsheet and its updates https://www.dpaw.wa.gov.au/plants-and-animals/plants/weeds/156-how-do-we-manage-weeds
Irreversible impact	An impact resulting in a permanent loss of environmental value(s), or where intensive and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)
MSAVI	Modified Soil Adjusted Vegetation Index
MEZ	Mining Exclusion Zone
m	Metre
mm/s	Millimetres per second
MNES	Matter of National Environmental Significance

Abbreviation/Term	Description
PEC	Priority Ecological Community
Permanent structural damage to a Ghost Bat roost cave	Damage that negatively impacts the integrity of the cave and microclimate such that future Ghost Bat use of the site is prevented
Proponent	Robe River Mining Co. Pty. Ltd.

1. CONTEXT, SCOPE AND RATIONALE

1.1 Mesa A Hub

The Mesa A Hub is located approximately 43 km west of Pannawonica in the Pilbara region of Western Australia (WA) (Figure 1-1).

The Proponent (Robe River Mining Co. Pty. Ltd.) manages and operates the Mesa A Hub Revised Proposal (the Proposal) as approved by MS 1112 under Part IV of the *Environmental Protection Act 1986* (EP Act). The Proposal is also managed and operated as the 'Extension of Mesa A Warrambo Iron Ore Project' approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC Act approval 2016/7843).

The Proposal includes:

- Mine pits:
 - Above water table (AWT) mining at Mesa A, Mesa B and Highway/Tod Bore
 - AWT and below water table (BWT) mining at Warrambo and Mesa C
- Mineral waste management including but not limited to backfilling, out-of-pit waste dumps, low grade ore dumps, topsoil and subsoil stockpiles.
- Processing facilities including but not limited to a wet processing plant, waste fines storage facilities and reverse osmosis plant.
- Support facilities including but not limited to workshops, power supply infrastructure, hydrocarbon storage, laydown areas, laboratory, offices and waste water treatment plants.
- Installation of infrastructure such as tracks, utilities, telecommunications, monitoring stations and abandonment bunds in the Mining Exclusion Zones (MEZs) at Mesas A, B and C.
- Surface water management infrastructure including but not limited to diversion drains, levees and culverts.
- Linear infrastructure including but not limited to heavy vehicle and light vehicle access roads, pipelines and power (including sub-stations) and communications distribution networks.
- Water supply bore field at Warrambo and associated infrastructure.
- Dewatering and associated infrastructure at Warrambo and Mesa C.
- Management of surplus water including use in processing, use on-site, passive recharge via completed mine pits and controlled discharge to Warrambo Creek.
- Transport of mined and processed ore to Rio Tinto's port operations at Dampier and/or Cape Lambert via existing rail infrastructure.
- Accommodation village and associated infrastructure at Mesa A.

The Development Envelope and the conceptual layout for the Proposal are shown in Figure 1-2 and Figure 1-3 respectively.

This EMP will be implemented subject to approval by the CEO.



LEGEND

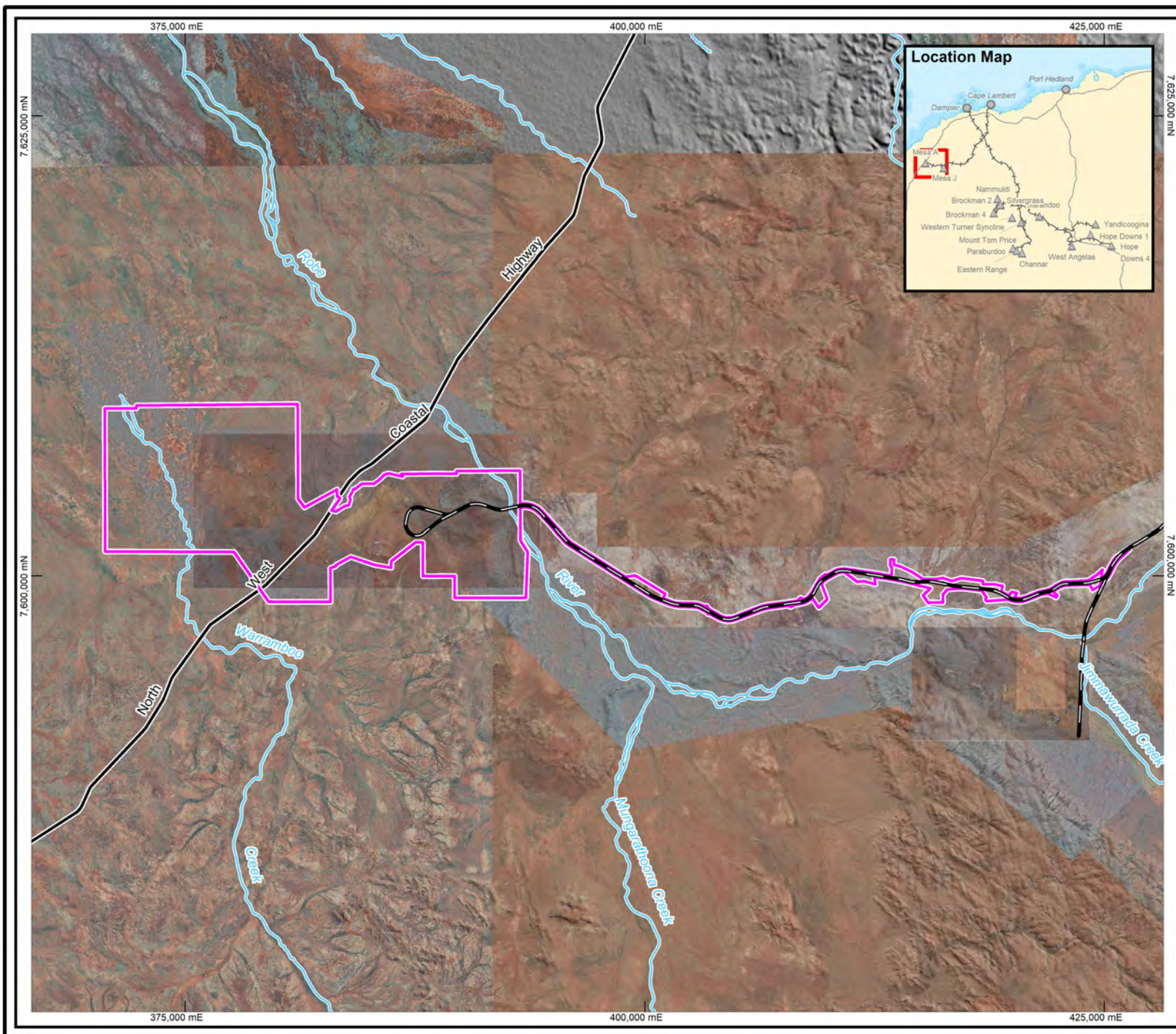
-  Rio Tinto Mine
-  Rio Tinto Port
-  Deposit
-  Town
-  Rio Tinto Railway
-  Highway
-  Major Road
-  National Park

Rio Tinto

Iron Ore (WA)

Figure 1-1: Regional Location

Drawn: GIS Team Plan No: PDE0149312v1
Date: February, 2018 Proj: MGA 94 (Zone 50)



Location Map

LEGEND

- Development Envelope
- Rio Tinto Railway
- Highway
- Major Watercourse



SCALE



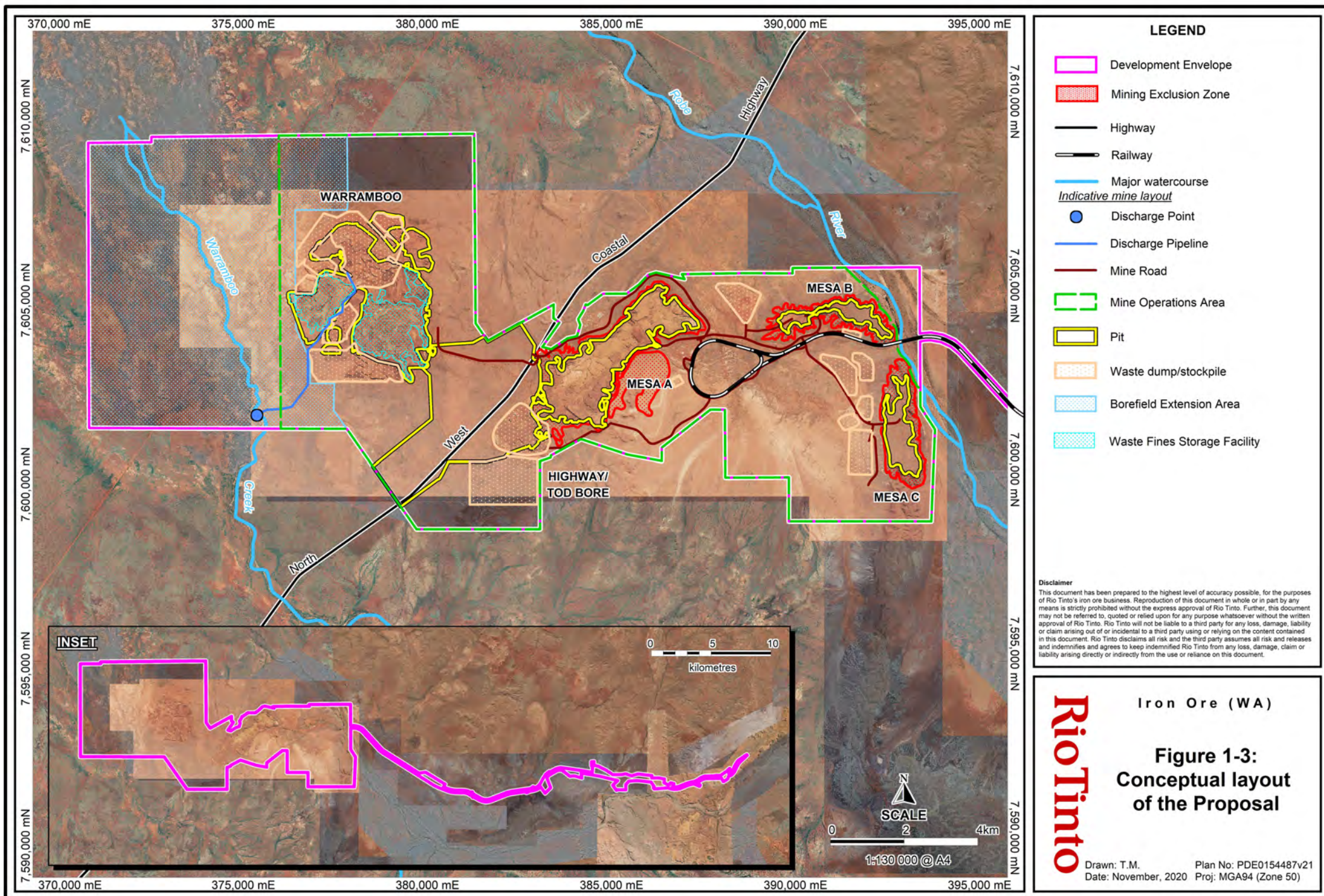
Disclaimer
This document has been prepared to the highest level of accuracy possible, for the purposes of Rio Tinto's iron ore business. Reproduction of this document in whole or in part by any means is strictly prohibited without the express approval of Rio Tinto. Further, this document may not be referred to, quoted or relied upon for any purpose whatsoever without the written approval of Rio Tinto. Rio Tinto will not be liable to a third party for any loss, damage, liability or claim arising out of or incidental to a third party using or relying on the content contained in this document. Rio Tinto disclaims all risk and the third party assumes all risk and releases and indemnifies and agrees to keep indemnified Rio Tinto from any loss, damage, claim or liability arising directly or indirectly from the use or reliance on this document.

Rio Tinto

Iron Ore (WA)

Figure 1-2: Development Envelope

Drawn: T.Murphy
Date: Jan, 2020
Plan No: PDE0161695v4
Proj: MGA94 (Zone 50)



1.2 Key environmental factors

Management of the following key environmental factors is included in this EMP:

- Flora and Vegetation;
- Terrestrial Fauna; and
- Inland Waters.

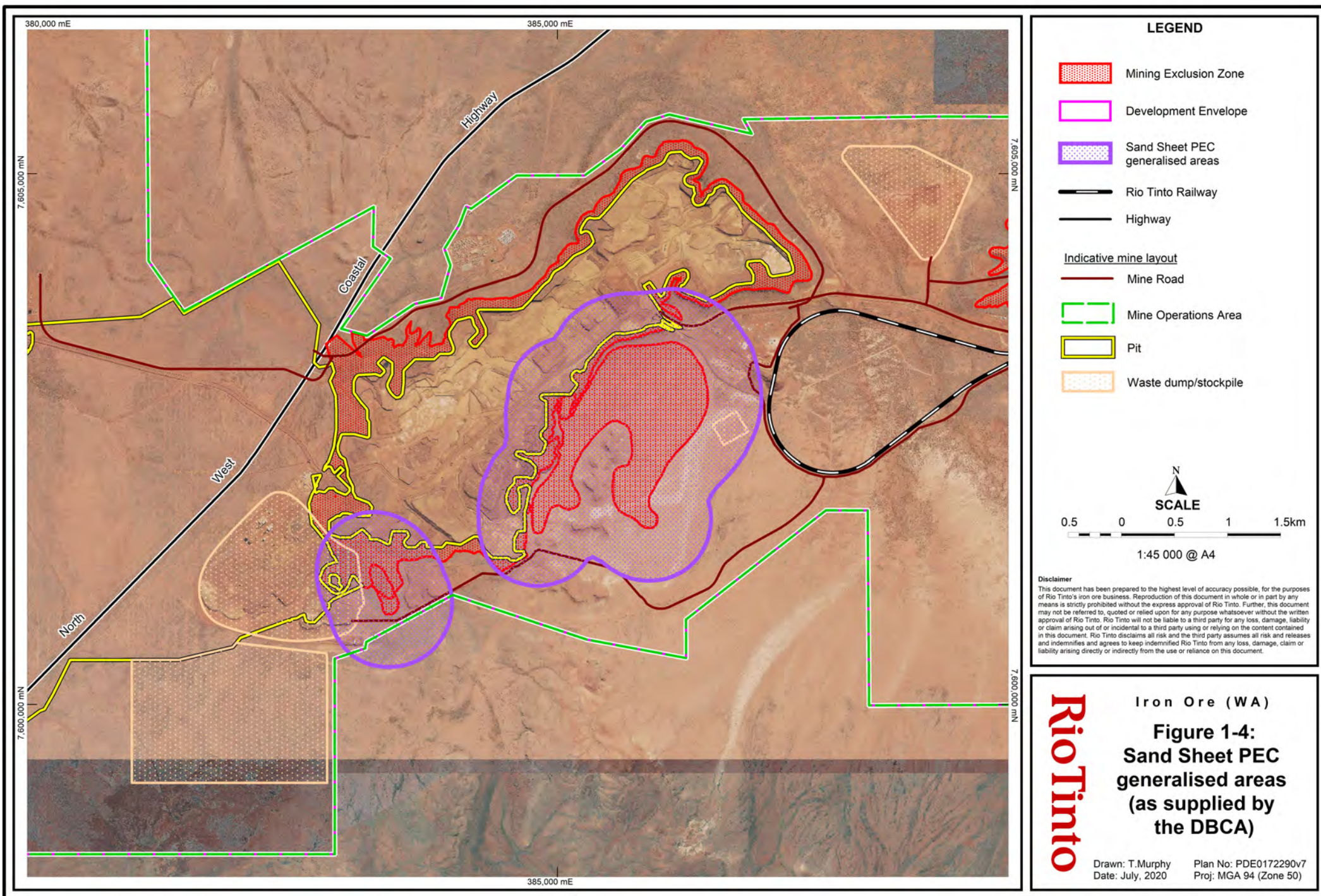
Management of troglofauna values associated with the Proposal is addressed separately in the 'Mesa A Hub Revised Proposal Environmental Management Plan - Troglofauna' (RTIO-HSE-0335971).

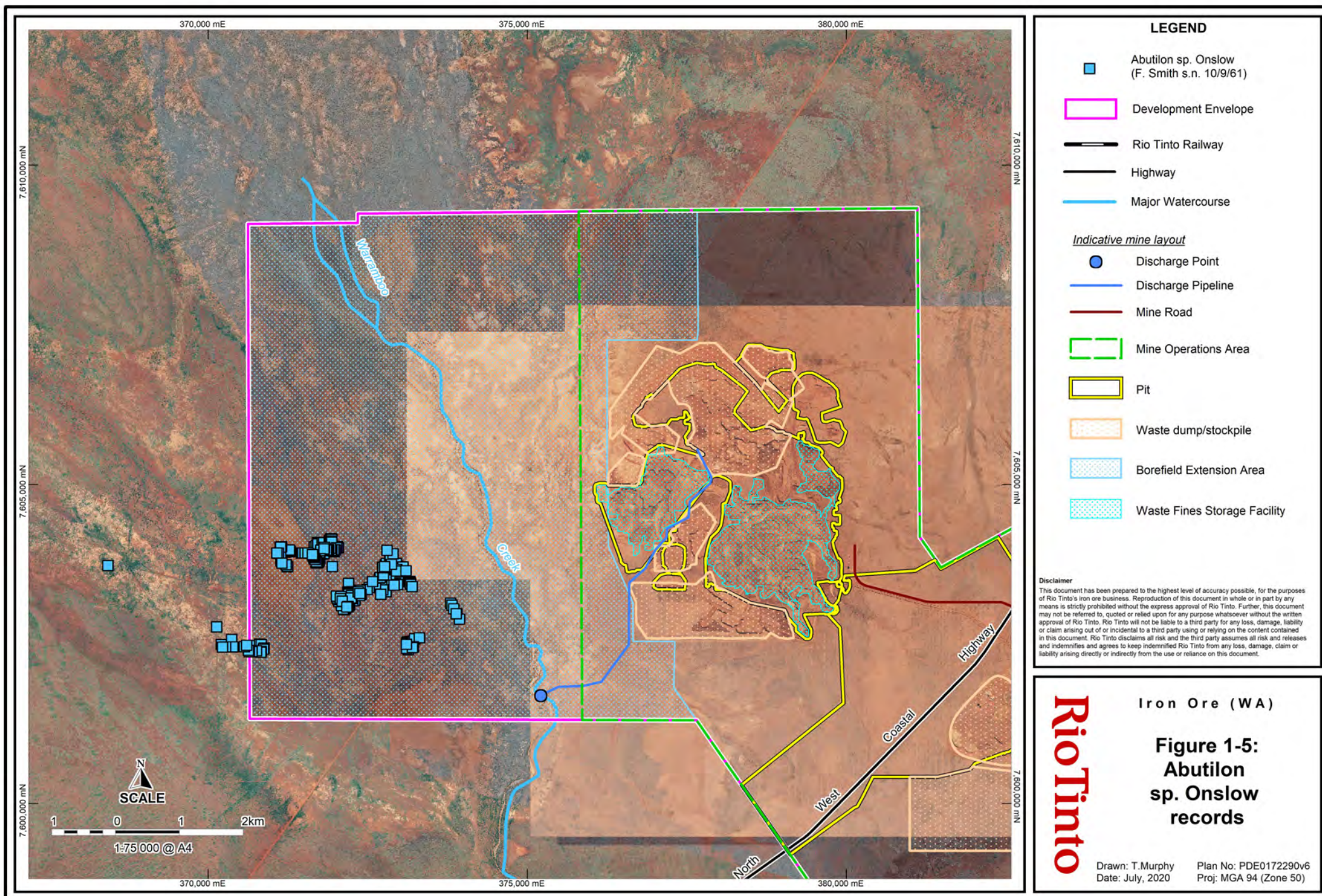
Flora and Vegetation

The Priority 3 Sand Sheet Vegetation (Robe Valley) Priority Ecological Community (Sand Sheet PEC) is located immediately adjacent to the south-eastern boundary of Mesa A as indicated by the mapped Sand Sheet PEC generalised areas (Figure 1-4). This PEC is of regional conservation significance as both a habitat and vegetation type that is atypical for the locality. It is the most northern expression of this vegetation type in the Carnarvon Basin and is poorly represented in the Pilbara Region and unrepresented in the reserve system. Two representations of the Sand Sheet PEC occur within the Development Envelope; one of approximately 147 ha and one of 7 ha.

Potential impacts of the Proposal on the Sand Sheet PEC include degradation of vegetation due to unauthorised disturbance, changes in surface hydrology, ingress of weeds and dust deposition.

Poorly-known flora taxa that have been recorded from one or a few locations which are potentially at risk (i.e. occurrences are either very small or on lands not managed for conservation) may be listed as Priority 1 flora taxa. The Priority 1 taxon *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) was recorded within the western portion of the Development Envelope, specifically the Warramboo Borefield extension area (Figure 1-5). It is predicted that the Proposal will impact up to 5% of known records of this species (Rio Tinto database). Potential impacts to this species include inadvertent clearing of additional individuals and potential indirect impacts due to weeds.





Terrestrial Fauna

The Breakaways and Gullies habitat in the Development Envelope provides roost and denning habitat for the Ghost Bat and Northern Quoll respectively and the Major River/Creek habitat provides foraging and dispersal habitat for these species. Potential impacts of the Proposal on the Ghost Bat and the Northern Quoll are:

- Direct impacts due to loss or fragmentation of habitat, including breeding, foraging and dispersal habitat, due to clearing;
- Indirect disturbance to high value habitat (potential diurnal/maternal Ghost Bat roosts) due to noise, vibration, dust and light; and
- Indirect impacts to foraging habitat in the Major River/Creek habitat due to groundwater drawdown and surplus water discharge.

Inland Waters and riparian vegetation

Riparian ecosystems occur along the Robe River and Warrambo Creek in and adjacent to the Development Envelope. The riparian vegetation of Warrambo Creek includes facultative phreatophytic species (i.e. species that utilise groundwater for a portion of their water requirements, but can also satisfy their water requirements through stored soil water reserves). Riparian vegetation of the Robe River differs from Warrambo Creek due to the dominance of obligate phreatophytic species along some sections of the river.

Hydrogeological assessment indicates there is limited hydraulic connectivity between the Mesa C Channel Iron Deposit (CID) Aquifer and the adjacent Robe River alluvial aquifer. Consequently, drawdown of groundwater levels within the Mesa C CID aquifer to enable BWT mining is not expected to result in observable changes to groundwater levels within the adjacent Robe River alluvium.

Groundwater drawdown in the Yarraloola aquifer beneath the ephemeral Warrambo Creek has the potential to result in loss or degradation of riparian vegetation as declines in groundwater levels and the associated capillary fringe may cause a decline in tree health or even tree death due to the groundwater levels being beyond the riparian root systems, thereby reducing their drought tolerance.

Dewatering of the Warrambo deposit will generate surplus water. Surplus water management will include use on site, passive recharge via completed mine pits and surface discharge to Warrambo Creek. Discharge of surplus water to the ephemeral Warrambo Creek has the potential to impact riparian vegetation via waterlogging, increased recruitment, community structural changes and ingress/proliferation of weeds along Warrambo Creek up to 8 km downstream of the discharge point.

1.3 Condition requirements

The Proposal was assessed under Part IV of the EP Act and under the EPBC Act. Conditions, as per MS 1112, and EPBC Act approval 2016/7843 relevant to this EMP are identified in Table 1-1 and Table 1-2 respectively.

Table 1-1: MS 1112 conditions for the Proposal relevant to this EMP

Condition		Section in EMP
5	Condition Environmental Management Plan	
5-1	The Proponent shall prepare, to the satisfaction of the CEO, a Condition Environmental Management Plan(s) within six (6) months of this Statement being issued. This plan shall demonstrate that the environmental outcomes specified in conditions 7-1, 9-1, 10-1 and 11-1 and the environmental objectives specified in conditions 7-2, 8-1 and 10-2 will be met.	NA
5-2	For outcome based provisions, the Condition Environmental Management Plan shall: <ul style="list-style-type: none"> (1) specify the environmental outcomes to be achieved, as specified in condition 5-1; (2) specify trigger criteria that must provide an early warning that the threshold criteria may not be met; (3) specify threshold criteria to demonstrate compliance with the environmental outcomes specified in condition 5-1. Exceedance of the threshold criteria represents non-compliance with these conditions; (4) specify monitoring to determine if trigger criteria and threshold criteria are exceeded; (5) specify trigger level actions to be implemented in the event that trigger criteria have been exceeded; (6) specify threshold contingency actions to be implemented in the event that threshold criteria are exceeded; and (7) provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that condition 5-1 has been met over the reporting period in the Compliance Assessment Report required by condition 3-6. 	Table 2-1 through Table 2-6
5-3	For management based provisions, the Condition Environmental Management Plan shall: <ul style="list-style-type: none"> (1) specify the environmental objectives to be achieved, as specified in condition 5-1; (2) specify management actions to meet the environmental objective; (3) specify management targets; (4) specify monitoring to determine if management targets are being met; and (5) provide the format and timing for the reporting of monitoring results against management targets to demonstrate that condition 5-1 has been met over the reporting period in the Compliance Assessment Report required by condition 3-6. 	Table 2-1 through Table 2-6
5-4	After receiving notice in writing from the CEO that the Condition Environmental Management Plan satisfies the requirements of condition 5-1, 5-2 and 5-3, the Proponent shall: <ul style="list-style-type: none"> (1) implement the Condition Environmental Management Plan, or any subsequent approved versions; and (2) continue to implement the Condition Environmental Management Plan until the CEO has confirmed by notice in writing that the Proponent has demonstrated the outcomes and objectives specified in condition 5-1 have been met. 	N/A

Condition		Section in EMP
5-5	<p>In the event that monitoring, tests, surveys or investigations indicate exceedance of threshold criteria specified in the Condition Environmental Management Plan, the Proponent shall:</p> <ol style="list-style-type: none"> (1) report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified; (2) implement the threshold level contingency actions specified in the Condition Environmental Management Plan within 24 hours and continue implementation of those actions until the CEO has confirmed by notice in writing that it has been demonstrated that the threshold criteria are being met and the implementation of the threshold contingency actions is no longer required; (3) investigate to determine the cause of the threshold criteria being exceeded; (4) investigate to provide information for the CEO to determine potential environmental harm that occurred due to the threshold criteria being exceeded; and (5) provide a report to the CEO within twenty-one (21) days of the exceedance being reported as required by condition 5-5(1). The report shall include: <ol style="list-style-type: none"> (a) details of threshold contingency actions implemented; (b) the effectiveness of the threshold contingency actions implemented, against the threshold criteria; (c) the findings of investigations required by condition 5-5(3) and 5-5(4); (d) measures to prevent the threshold criteria being exceeded in the future; (e) measures to prevent, control or abate the environmental harm which may have occurred; and (f) justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes would continue to be met. 	Table 2-1 through Table 2-6
5-6	<p>In the event that monitoring, tests, surveys or investigations indicate non-achievement of management target(s) specified in the Condition Environmental Management Plan, the Proponent must:</p> <ol style="list-style-type: none"> (1) report the non-achievement in writing to the CEO within seven (7) days of the non-achievement being identified; (2) investigate to determine the cause of the management targets not being achieved; (3) provide a report to the CEO within twenty-one (21) days of the non-achievement being reported as required by condition 5-6(1). The report must include: <ol style="list-style-type: none"> (a) cause of non-achievement of management targets; (b) the findings of investigation required by condition 5-6(2); (c) details of revised and/or additional management actions to be implemented to prevent non-achievement of the management target(s); and (d) relevant changes to Proposal activities. 	N/A
5-7	<p>The Proponent:</p> <ol style="list-style-type: none"> (1) may review and revise the Condition Environmental Management Plan, or (2) shall review and revise the Condition Environmental Management Plan as and when directed by the CEO. 	N/A
5-8	<p>The Proponent shall implement the latest revision of the Condition Environmental Management Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 5-1, 5-2 and 5-3.</p>	N/A

Condition		Section in EMP
7	Flora and Vegetation – Sand Sheet Vegetation (Robe Valley) Priority Ecological Community	
7-1	<p>The Proponent shall manage the implementation of the Proposal to meet the following environmental outcome:</p> <p>(1) The Proponent shall ensure there is no direct impact to the Sand Sheet Vegetation (Robe Valley) Priority Ecological Community delineated in Figure 4 of Schedule 1 as a result of implementation of the Proposal, other than existing and authorised disturbance.</p>	Table 2-1
7-2	<p>The Proponent shall manage implementation of the Proposal to meet the following environmental objective:</p> <p>(1) The Proponent shall minimise indirect impacts due to the Proposal as far as practicable to the Sand Sheet Vegetation (Robe Valley) Priority Ecological Community delineated in Figure 4 of Schedule 1 so that the biological diversity and ecological integrity of the Priority Ecological Community are maintained.</p>	Table 2-1
8	Flora and Vegetation – Priority Flora	
8-1	<p>The Proponent shall manage implementation of the Proposal to meet the following environmental objective:</p> <p>(1) Avoid where possible, and minimise direct and indirect impacts to <i>Abutilon</i> sp. Onslow (F.Smith s.n. 10/9/61).</p>	Table 2-2
8-2	To meet the requirements of condition 8-1, the Proponent must conduct a pre-clearance survey for <i>Abutilon</i> sp. Onslow (F.Smith s.n. 10/9/61) to inform the final alignment of infrastructure in the Warrambo Borefield extension area.	Table 2-2
8-3	The Proponent must include the results of the survey required by condition 8-2 in the Compliance Assessment Report required by condition 3-6 to demonstrate that impacts to <i>Abutilon</i> sp. Onslow (F.Smith s.n. 10/9/61) are not greater than predicted.	Table 2-2
9	Terrestrial Fauna Habitat – Conservation Significant Fauna Species; Ghost Bat (<i>Macroderma gigas</i>) and Northern Quoll (<i>Dasyurus hallucatus</i>)	
9-1	<p>The Proponent shall manage the implementation of the Proposal to meet the following environmental outcome:</p> <p>(1) The Proponent shall ensure there is no irreversible impact, as a result of the Proposal, to 'breakaways and gullies' habitat retained in the escarpments of Mesa A, Mesa B and Mesa C Mining Exclusion Zones, other than existing and authorised disturbance.</p>	Table 2-3
11	Inland Waters	
11-1	<p>The Proponent shall manage implementation of the Proposal to meet the following environmental outcomes:</p> <p>(1) The Proponent shall ensure that groundwater levels are maintained to ensure there is no impact to the health of riparian vegetation of the Robe River, as a result of groundwater abstraction and/or dewatering associated with the implementation of the Proposal.</p> <p>(2) The Proponent shall ensure that there is no irreversible impact to the health of riparian vegetation of Warrambo Creek as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal.</p> <p>(3) The Proponent shall ensure that there is no irreversible impact to the health of riparian vegetation of Warrambo Creek as a result of surplus water discharge associated with implementation of the Proposal.</p>	Table 2-4 through Table 2-6

Table 1-2 EPBC Act Approval 2016/7843 conditions for the Proposal relevant to this EMP

Condition		Section in EMP
2	To minimise impacts to EPBC Act listed threatened species, the approval holder must comply with Condition 5 (Condition Environmental Management Plan(s)), Condition 9 (Terrestrial Fauna habitat – Conservation Significant Fauna Species; Ghost Bat (<i>Macroderma gigas</i>) and Northern Quoll (<i>Dasyurus hallucatus</i>)) and Condition 11 (Inland Waters) of the Western Australia approval where relevant to EPBC Act listed threatened species.	N/A
3	<p>The Condition Environmental Management Plan(s), specified in Condition 2 above, must include environmental outcomes and objectives related to the mitigation and management of the following threatening processes:</p> <ul style="list-style-type: none"> (a) fire (b) vehicle and machinery movements (c) fauna encounters/sightings (d) weed management (e) feral animal control (f) noise and vibration (g) dust and light <p>where relevant to EPBC Act listed threatened species. For 3.(f) noise and vibration, the Condition Environmental Management Plan(s) must include monitoring of the EPBC Act listed Ghost Bat (<i>Macroderma gigas</i>) and include a management target to ensure no significant long-term decline in the Ghost Bat population attributable to the Action for the purposes of Condition 4.</p>	Table 2-13 and Table 2-14
4	<p>To minimise impacts to EPBC Act listed Ghost Bat (<i>Macroderma gigas</i>), the approval holder must:</p> <ul style="list-style-type: none"> (a) if the Action results in permanent structural damage to a Ghost Bat roost (other than nocturnal roost MBS-05 at Mesa B), or a failure to meet the management target established in Condition 3, Conditions 17 and 18 will apply in respect of that result. If the structural damage cannot be remedied the Proponent must provide an offset proposal to the Department for approval within two months. (b) implement a Mining Exclusion Zone and Blast Management Plan to minimise potential impacts to roosting Ghost Bats from noise and vibration associated with mining activities (with the exception of nocturnal roost MBS-05 at Mesa B). 	Table 2-14

1.4 Rationale and approach

This EMP addresses environmental factors (and relevant environmental outcomes and objectives) which were determined by the EPA as being relevant to the management of conservation significant flora and vegetation, fauna species (including EPBC Act listed threatened species), groundwater abstraction and surface water discharge associated with the Proposal. This EMP also addresses threatening processes where relevant to the EPBC Act listed threatened species.

Results of baseline surveys, monitoring and a number of assumptions and uncertainties inform the management approach for meeting the environmental outcomes and objectives stated in conditions 7, 8, 9 and 11 of MS 1112, and the requirements of EPBC Act approval 2016/7834 conditions 2, 3 and 4.

The identified triggers, thresholds, management targets and response actions are aligned with the overall management approach. Monitoring data are used to evaluate compliance with the trigger and threshold criteria to achieve the environmental outcomes. Management targets are used to assess whether the management actions are effective in meeting the environmental objectives.

1.4.1 Survey and study findings

a) Flora and Vegetation (Sand Sheet PEC)

One vegetation unit in the Development Envelope, the Priority 3 Sand Sheet Vegetation (Robe Valley) Priority Ecological Community (Sand Sheet PEC), is considered to be of regional significance. The Sand Sheet PEC is located immediately adjacent to the south-eastern boundary of the existing Mesa A/Warramboos Iron Ore Project (Figure 1-4) and comprises *Corymbia zygophylla* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* high shrubland over *Triodia schinzii* hummock grassland. This PEC is considered to be of regional conservation significance as both a habitat and vegetation type that is atypical for the locality. It is the most northern expression of this vegetation type in the Carnarvon Basin and is poorly represented in the Pilbara Region and unrepresented in the reserve system. It supports many plant species at their northern limits or which exist as disjunct populations (Department of Parks and Wildlife 2014).

Two representations of the Sand Sheet PEC occur within the Mesa A Hub Development Envelope; one of approximately 147 ha and one of 7 ha. These representations each have a mapped generalised area of 411 ha and 136 ha respectively.

Monitoring of the Sand Sheet PEC has been conducted since 2008 and is designed to assess the potential impacts of the mining operations on the Sand Sheet PEC. To date, the monitoring has involved assessing permanent flora quadrats, documenting flora species occurring in the PEC, locating flora of conservation significance, recording introduced species and mapping vegetation condition and other disturbance. Comparison of species richness between the Sand Sheet PEC and reference sites and further analysis of vegetation cover changes have also formed part of the monitoring program since 2017.

In December 2018, a natural bushfire burnt through the majority of the Sand Sheet PEC. The most recent survey conducted prior to the fire was Astron (2018a). Monitoring results from Astron (2018a) indicate that the condition of the Sand Sheet PEC vegetation in 2018 ranged from Excellent to Poor. Senescence was observed in several species in 2018, and previous years. Senescence was particularly prevalent in *Acacia tumida* var. *pilbarensis* and *Triodia schinzii*. The presence of 'medium' or 'medium' – 'low' dust cover, weed species (principally Buffel Grass, **Cenchrus ciliaris*), signs of cattle and historical clearing were responsible for the lower condition rating in some areas of the Sand Sheet PEC.

Astron (2018a) noted that on-ground monitoring results showed a decline in the vegetation cover in the Sand Sheet PEC since the initial 2008 monitoring and specifically, senescence of *Acacia tumida* var. *pilbarensis*, *Triodia schinzii* and *Acacia trachycarpa* has been noted during monitoring within the Sand Sheet PEC since 2015 (Biota 2016, Astron 2018a). Analysis of the data showed that the decline in cover amongst the monitored quadrats does not appear to be associated with proximity to the mine footprint. The decline in vegetation cover corresponded with a transition within the Robe Valley from above average rainfall conditions to more average rainfall between 2012 and 2016. However, analysis of the data does not show a direct correlation between vegetation cover and rainfall in the 12 months prior to each survey. This may be due to the presence of local groundwater retaining clay layers beneath parts of the Sand Sheet which undergo periodic cycles of replenishment and decline, allowing some species intermittent access to retained water. If groundwater anomalies are at least partly driving the observed changes in the Sand Sheet PEC, then the observed inter-annual to decadal scale changes in rainfall patterns are likely to be responsible for a substantial proportion of the changes observed. In addition, altered surface water flow patterns and altered fire regime (i.e. excluding fire driven reductions in biomass) as a result of the Mesa A/Warramboos Iron Ore Project may have contributed to the observed decline in vegetation cover. Monitoring conducted in 2016 following above average rainfall in the four months prior to the survey noted recruitment of *Acacia tumida* var. *pilbarensis* (Biota 2016). Seedlings and saplings of *Acacia tumida* var. *pilbarensis* were also noted in the majority of monitoring quadrats in 2017 and 2018 (Astron 2018a).

Buffel Grass (**Cenchrus ciliaris*) was the only weed species recorded during the 2018 monitoring survey. Six weed species have been recorded in the Sand Sheet PEC since 2008 (Appendix 1), with five out of the six recorded in the 2016 monitoring (Biota 2016). Buffel Grass is the most common weed species, and is most prevalent in the south-east section of the Sand Sheet PEC (Biota 2016). As Buffel Grass is known to be an aggressive competitor, the more favourable climatic conditions in 2009, 2011, 2013, 2015 and 2016 would likely have contributed to the spread of this weed within the Sand Sheet PEC (Biota 2016). The Yarraloola Pastoral Station Lease co-exists with the State Agreement Mineral Lease in the Mesa A Hub. Cattle movements associated with operation of the pastoral station are also likely assisting with the spread of Buffel Grass within the Sand Sheet PEC.

Flora and Vegetation (Priority 1 flora)

Abutilon sp. Onslow (F. Smith s.n. 10/9/61) is a Priority 1 taxon known to occur across a restricted range of 135 km, on coastal plains near the Onslow township, in the south-western Pilbara (WAH 2019). The Rio Tinto database currently contains records of 1,284 individuals. However, it is likely this species is under-collected and its distribution extends further than currently represented.

Surveys of the Development Envelope in the Warrambo Borefield extension area recorded 1,241 individuals of this species (Stantec 2018) (Figure 1-5). *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) has been recorded on sand plains, in association with an open hummock grassland dominated by *Triodia* sp. Peedamulla (A.A. Mitchell PRP 1636) and an overstorey of *Acacia ancistrocarpa* and *Acacia bivenosa* (Stantec 2018). Vegetation of this type occurs over approximately 1,500 ha of the Development Envelope and similar habitat extends 10 km to the north-west (Stantec 2018).

Abutilon sp. Onslow (F. Smith s.n. 10/9/61) was most commonly recorded along disturbed access tracks following above average rainfall, suggesting this species readily germinates following disturbance, and that it relies on rainfall events to germinate and proliferate in the landscape (Stantec 2018).

b) Terrestrial Fauna (Ghost Bat and Northern Quoll)

Ghost Bats

Roost sites used permanently by Ghost Bats are generally deep natural caves with a relatively stable temperature of 23-28°C and humidity above 50%. Individuals require a range of cave sites and move between roosts seasonally or according to weather conditions. The most significant habitats in the Development Envelope for the species are the Breakaways and Gullies habitat and the Major River/Creek habitat (Figure 1-6); these areas represent potential roosting and foraging habitat. Habitat loss through impact or disturbance to roost sites, specifically caves that play a role in breeding activities (maternal roosts), and nearby areas is seen as a key risk to this species' conservation status.

Targeted Ghost Bat cave assessments conducted by Bat Call WA (2016, 2017) confirmed the presence and foraging of Ghost Bats around the perimeters of Mesa B and Mesa C. A Ghost Bat population of 15 to 20 individuals was estimated to be present in the Mesa A Hub area. The results of Bat Call WA (2016, 2017) were included in the Environmental Review Document (ERD). Further work conducted by Biologic (in prep.) identified additional caves with potential to be Ghost Bat roosts as well as identifying potential for two caves previously classified as nocturnal roosts to be classified as a potential diurnal/maternal roost (MCC-05) and a potential diurnal roost (MCC-04). Combined records from Bat Call WA (2016, 2017) and Biologic (in prep.) identifying potential diurnal/maternal roosts, potential diurnal roosts, nocturnal roosts and caves of unknown status (inaccessible at the time of survey) are shown in Table 1-3 and Figure 1-7.

Table 1-3: Recorded potential Ghost Bat roost caves

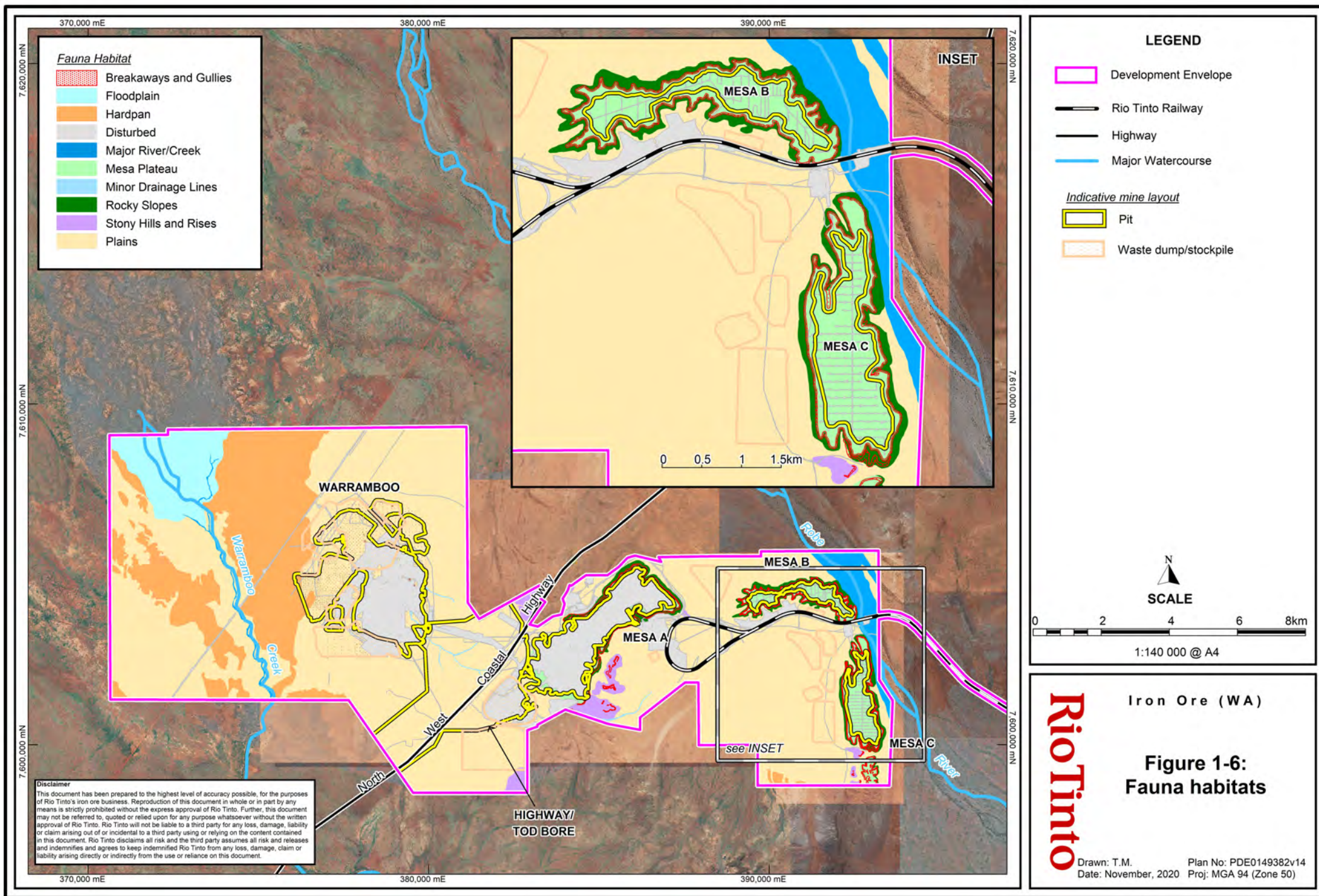
Mesa	Number of potential diurnal/maternal roosts	Number of potential diurnal roosts	Number of nocturnal roosts	Number of inaccessible caves (unknown Ghost Bat roost status)
Mesa A	-	-	2	-
Mesa B	1 (MBC-05)	-	12	1
Mesa C	3 (MCC-02, MCC-05, CRMC02)	4 (MCC-04, CRMC09, CRMC10, CRMC11)	9	3

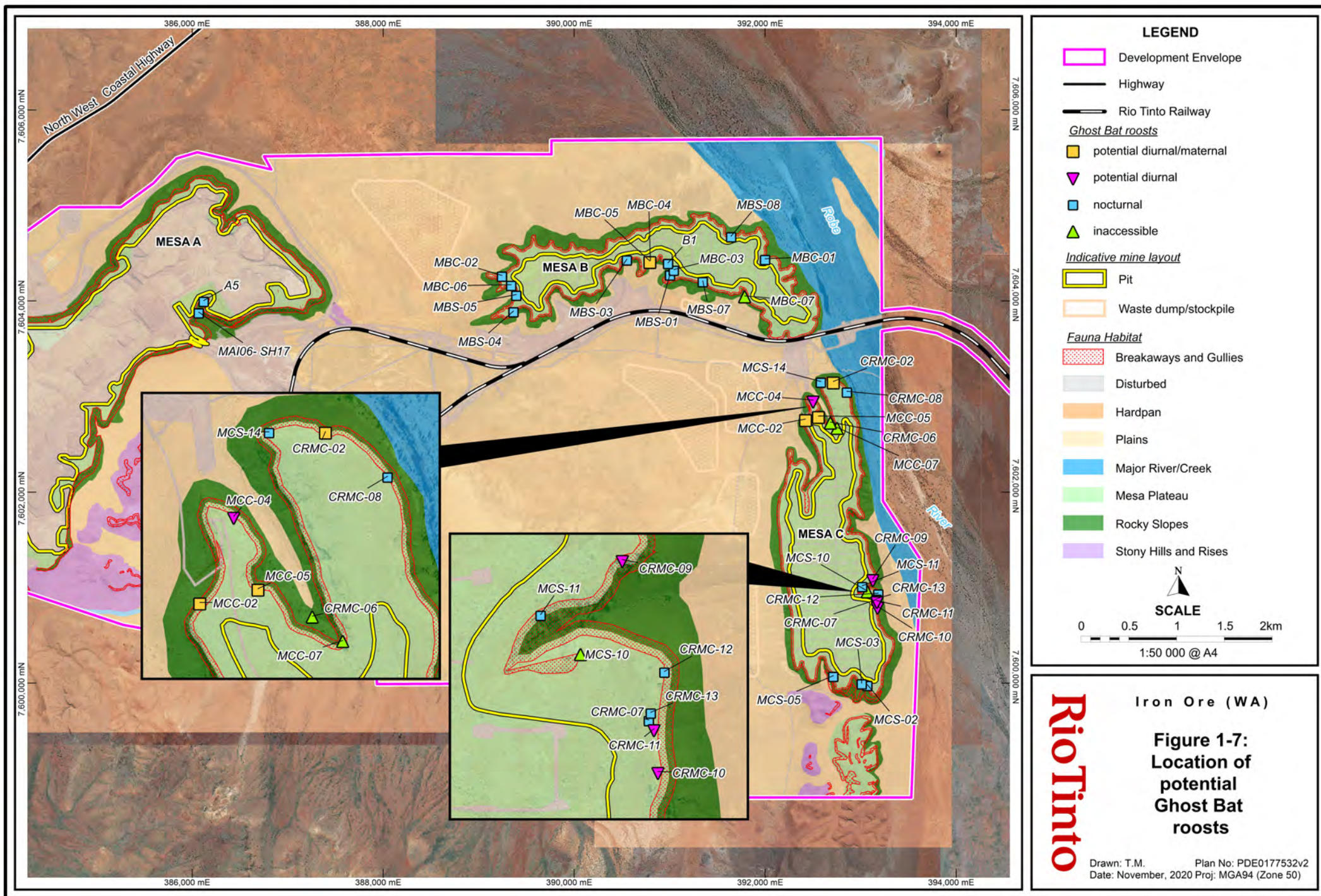
Northern Quoll

In the Pilbara, the Northern Quoll favours rocky gorges, breakaways and hills, usually of high relief and often along drainage lines for denning purposes. Adjacent plains and vegetated areas provide habitat suitable for foraging and dispersal of young (Van Dyck and Strahan 2008), but are considered to be of less importance for the species' conservation (DSEWPaC 2011). The rocky facades of the mesa landforms are important sources of shelter, food and moisture for this species.

The most important habitats in the Mesa A Hub area for the Northern Quoll are considered to be the Breakaways and Gullies and Major River/Creek habitats (Figure 1-6), which provide high value denning/shelter habitats associated with caves and rocky overhangs and/or enhanced foraging opportunities due to the availability of water (MWH 2015a).

MWH (2015a) recorded evidence of the Northern Quoll at 23 sites in the Mesa A Hub area, across Mesa Plateau, Rocky Slopes, Stony Hills and Rises, and Major River/Creek habitats. Previous surveys for the Mesa A/Warrambo Iron Ore Project recorded Northern Quoll on the Mesa B escarpment and in a cave and gorge at Mesa A (Biota 2005a, 2006a) and an additional 92 records are known within 50 km of the Mesa A Hub area, with the nearest approximately 2 km to the south of the Mesa A Hub area (Biota 2011).





c) Inland Waters and riparian vegetation

Flora and vegetation surveys for the original Mesa A/Warrambo Iron Ore Project were conducted across the Mesa A/Warrambo Development Envelope, including the infrastructure corridor (Biota 2005b, 2006b). The most recent Level 2 flora and vegetation surveys were conducted across the area encompassing the Warrambo borefield extension in the west to Mesa C in the east (MWH 2016, Stantec 2018). The most recent surveys did not include the infrastructure corridor as changes to the infrastructure corridor were not required.

Riparian ecosystems occur along the Robe River and along Warrambo Creek in and adjacent to the Development Envelope. The most recent surveys included quadrats, relevés, mapping of vegetation units and targeted searches for conservation significant flora, vegetation condition assessment and identification of introduced species. Riparian vegetation monitoring transects were established during the baseline surveys¹ (MWH 2016, Astron 2018b). A targeted riparian vegetation survey of the Robe River from Pannawonica to the North West Coastal Highway was also conducted (Rio Tinto 2017). This survey mapped the nature and distribution of groundwater dependent vegetation along the Robe River to assess likely sensitivity to hydrological changes.

Warrambo Creek

Surveys of Warrambo Creek to support the environmental impact assessment of the Mesa A Hub Proposal recorded 81 native taxa and four introduced taxa, with no Declared Rare Flora, Threatened Ecological Communities or PECs recorded. Warrambo Creek is an ephemeral, low to moderate sized Pilbara Creek system which supports the facultative phreatophytic species *Eucalyptus camaldulensis* subsp. *refulgens*, *Eucalyptus victrix* and *Corymbia candida*. Mapping of the riparian vegetation along Warrambo Creek was undertaken by Rio Tinto using high resolution aerial photography. Five vegetation units considered to be of moderate local significance were delineated as listed in Table 1-4 and shown in Figure 1-8. These vegetation units generally align with those of the most recent flora and vegetation assessment of the Warrambo area (Stantec 2018).

Table 1-4: Description of riparian vegetation units along Warrambo Creek (Rio Tinto detailed mapping)

Vegetation Unit	Vegetation Description
EvCcAtpAccA	<i>Eucalyptus victrix</i> and <i>Corymbia candida</i> mid to low open woodland with scattered <i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Acacia coleii</i> var. <i>coleii</i> and <i>Acacia ancistrocarpa</i> tall sparse shrubland, over <i>Eriachne benthamii</i> , * <i>Cenchrus ciliaris</i> , <i>Eulalia aurea</i> and <i>Dichanthium fecundum</i> mid tussock grassland
EcrEvCcAtAs	<i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> , <i>Eucalyptus victrix</i> and <i>Corymbia candida</i> mid to low woodland, over <i>Acacia trachycarpa</i> and <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> tall to mid sparse shrubland, over <i>Triodia epactia</i> open hummock grassland over * <i>Cenchrus ciliaris</i> , <i>Eulalia aurea</i> and <i>Eriachne benthamii</i> sparse tussock grassland
EcrAtAanTe	<i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> mid woodland over <i>Acacia trachycarpa</i> and <i>Acacia ancistrocarpa</i> tall open shrubland over <i>Triodia epactia</i> mid open hummock grassland

¹ Groundwater abstraction of <3 GL/year from the Warrambo borefield has been underway since 2008 to supply water to the Mesa A/Warrambo Iron Ore Project. Riparian vegetation monitoring data recorded from the Warrambo area, therefore, do not strictly represent the baseline. However, Astron (2020a) concluded there is currently no indication of decline in riparian vegetation in relation to groundwater drawdown. For ease, data collected from the Warrambo area prior to implementation of the Mesa A Hub Proposal are referred to as 'baseline data'.

Vegetation Unit	Vegetation Description
EcAanAtrAbAtuTe	<i>Corymbia candida</i> and <i>Eucalyptus victrix</i> low open woodland (with scattered <i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i>), over <i>Acacia ancistrocarpa</i> , <i>Acacia trachycarpa</i> , <i>Acacia bivenosa</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> tall to mid open shrubland, over <i>Triodia epactia</i> open to sparse hummock grassland
EcrAtAanAtTe	<i>Eucalyptus camaldulensis</i> subsp. <i>refulgens</i> mid woodland over <i>Acacia trachycarpa</i> , <i>Acacia ancistrocarpa</i> and <i>Acacia tumida</i> var. <i>pilbarensis</i> tall open shrubland over <i>Triodia epactia</i> mid open hummock grassland

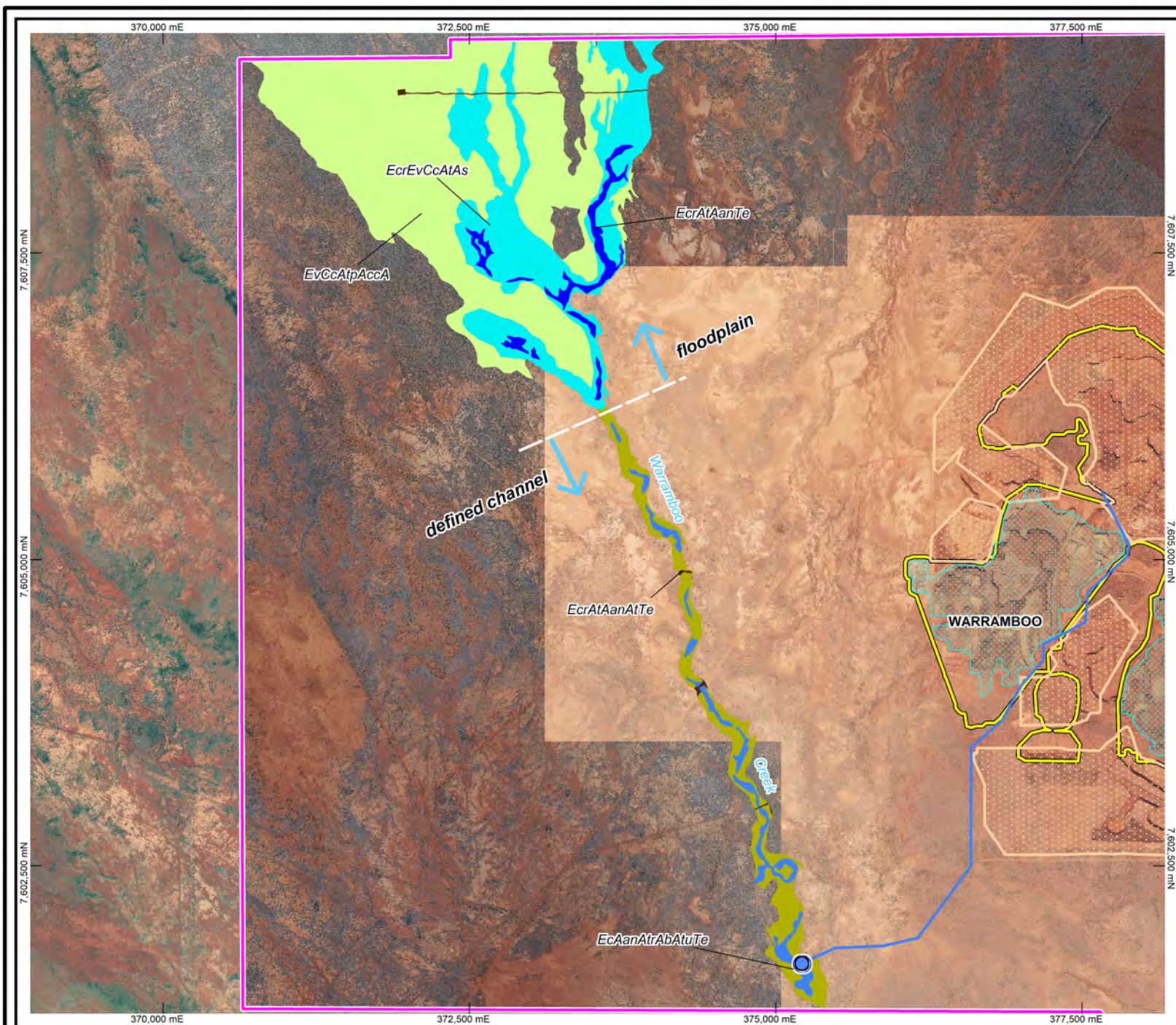
The utilisation of groundwater by vegetation depends on the species present, recent depth to groundwater and the historical depth to groundwater. Figure 1-9 shows the estimated existing groundwater depth contours and the modelled groundwater drawdown contours for the broader aquifer at the completion of BWT mining. In the floodplain downstream of the defined channel of Warrambo Creek (Zone 1) there is low to moderate potential for phreatophytic species to access groundwater in the broader aquifer. In the defined channel of Warrambo Creek adjacent to the borefield extension (Zone 2), there is low potential for phreatophytes to access groundwater in the broader aquifer; phreatophytes in this area may access groundwater in the broader aquifer but any access is likely to be minimal due to the existing groundwater table being 14-20 m below ground level. Upstream of the borefield (Zone 3) there is negligible potential for phreatophytes to access groundwater in the broader aquifer as the existing groundwater table is >20 m below ground level.

Robe River

Riparian vegetation communities associated with the Robe River adjacent to Mesas B and C are represented by the vegetation units ChAbAtrTw and EcEvMgAtrCvas mapped by MWH (2016) and are considered to be of high local significance. Subsequent detailed mapping of the riparian vegetation of the Robe River from the North West Coastal Highway to near Pannawonica recorded *Melaleuca argentea*, *E. camaldulensis* subsp. *refulgens* and *E. victrix* adjacent to Mesas B and C (Figure 1-10) (Rio Tinto 2017).

Drawdown of groundwater levels within the Mesa C CID aquifer is not expected to result in observable changes to groundwater levels within the adjacent Robe River alluvial aquifer and hence impacts to riparian vegetation as a result of implementation of the Proposal are unlikely.

Two semi-permanent pools are present in the Robe River adjacent to Mesa B. No observable changes to these pools are expected as a result of implementation of the Proposal. Permanent pools associated with the Robe River and Mungarathoona Creek (a tributary of the Robe River) are present outside the Development Envelope with the closest pools located approximately 4 km to the north and 8 km to the south-east of the Development Envelope. Numerous semi-permanent and permanent pools are present further upstream in the Robe River. Vegetation surrounding these pools is typically dominated by obligate phreatophytic vegetation which requires constant access to groundwater. Vegetation is dominated by dense *M. argentea* open forests, accompanied by scattered and at times co-dominant *E. camaldulensis* over mixed shrub, sedge, grass and herbaceous species. In the vicinity of the Mesa A Hub, these associations often occur on and near the edges of the Robe River, often close to mesa breakaways and rock walls, where either adjacent (often porous) lithologies help maintain shallow water tables, or shallow water tables coincide with the main low-flow channel of the Robe River.



LEGEND

- Development Envelope
- Rio Tinto Railway
- Highway
- Indicative mine layout
- Discharge Point
- Discharge Pipeline
- Pit
- Waste dump/stockpile
- Waste Fines Storage Facility



SCALE

0.5 0 0.5 1 1.5

1:45 000 @ A4

Disclaimer

This document has been prepared to the highest level of accuracy possible, for the purposes of Rio Tinto's iron ore business. Reproduction of this document in whole or in part by any means is strictly prohibited without the express approval of Rio Tinto. Further, this document may not be referred to, quoted or relied upon for any purpose whatsoever without the written approval of Rio Tinto. Rio Tinto will not be liable to a third party for any loss, damage, liability or claim arising out of or incidental to a third party using or relying on the content contained in this document. Rio Tinto disclaims all risk and the third party assumes all risk and releases and indemnifies and agrees to keep indemnified Rio Tinto from any loss, damage, claim or liability arising directly or indirectly from the use or reliance on this document.

Rio Tinto

Iron Ore (WA)

**Figure 1-8:
Riparian vegetation
of Warrambo Creek**

Drawn: T.M.
Date: July, 2020

Plan No: PDE0161697v5
Proj: MGA 94 (Zone 50)

Vegetation Unit Legend

- EcAanAtrAbAtuTe**

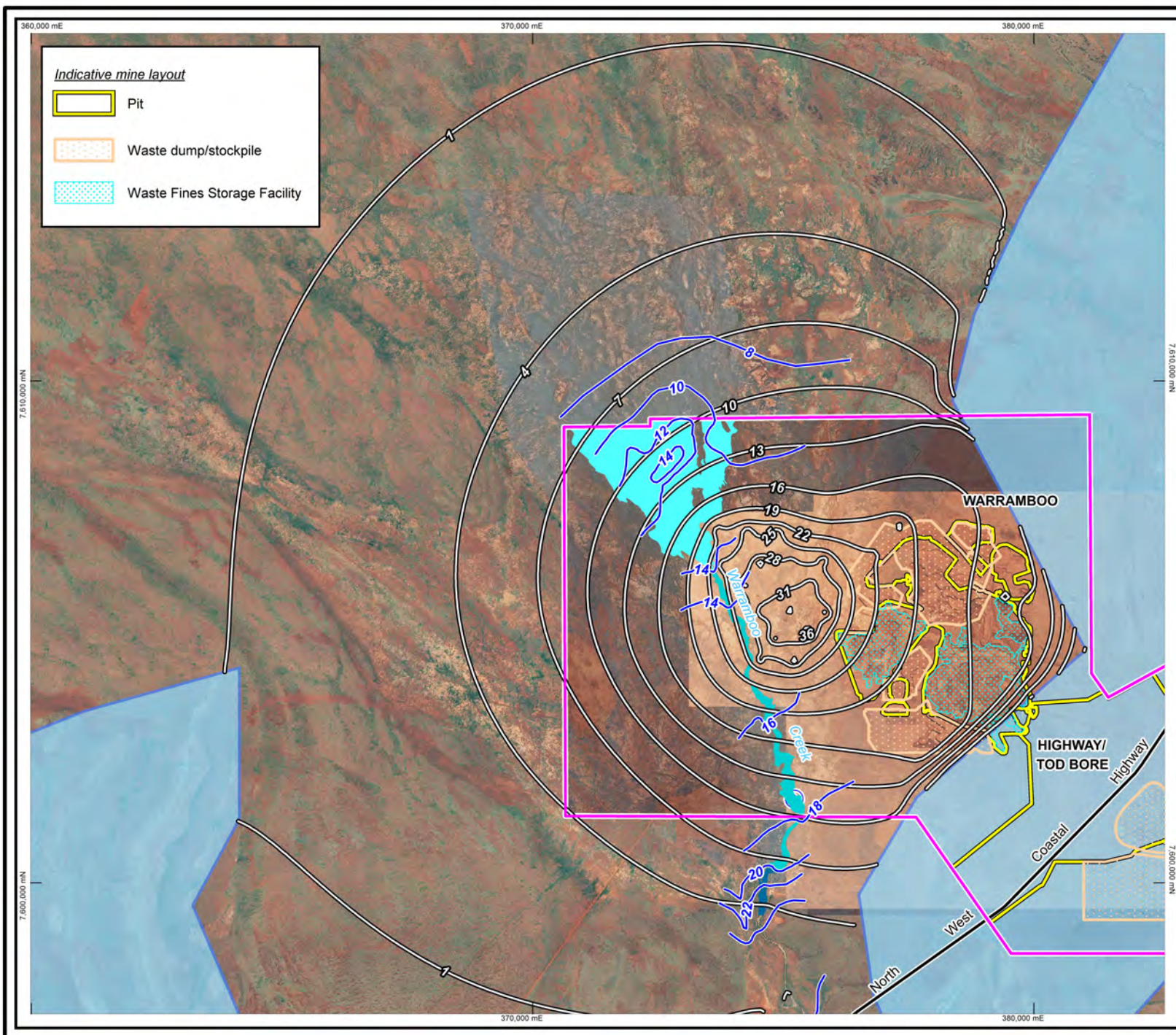
Corymbia candida and Eucalyptus victrix low open woodland (with scattered Eucalyptus camaldulensis subsp. refulgens), over Acacia ancistrocarpa, Acacia trachycarpa, Acacia bivenosa and Acacia tumida var. pilbarensis tall to mid open shrubland, over Triodia epactia open to sparse hummock grassland
- EcrAtAanAtTe**

Eucalyptus camaldulensis subsp. refulgens mid woodland over Acacia trachycarpa, Acacia ancistrocarpa and Acacia tumida var. pilbarensis tall open shrubland over Triodia epactia mid open hummock grassland
- EcrAtAanTe**

Eucalyptus camaldulensis subsp. refulgens mid woodland over Acacia trachycarpa and Acacia ancistrocarpa tall open shrubland over Triodia epactia mid open hummock grassland
- EcrEvCcAtAs**

Eucalyptus camaldulensis subsp. refulgens, Eucalyptus victrix and Corymbia candida mid to low woodland, over Acacia trachycarpa and Acacia sclerosperma subsp. sclerosperma tall to mid sparse shrubland, over Triodia epactia open hummock grassland over *Cenchrus ciliaris, Eulalia aurea and Eriachne benthamii sparse tussock grassland
- EvCcAtpAccaA**

Eucalyptus camaldulensis subsp. refulgens, Eucalyptus victrix and Corymbia candida mid to low woodland, over Acacia trachycarpa and Acacia sclerosperma subsp. sclerosperma tall to mid sparse shrubland, over Triodia epactia open hummock grassland over *Cenchrus ciliaris, Eulalia aurea and Eriachne benthamii sparse tussock grassland
- Highly disturbed**



LEGEND

- Development Envelope
- Rio Tinto Railway
- Highway

Warrambo Creek Zone

- Zone 1 - facultative phreatophytes - low/moderate potential groundwater use
- Zone 2 - facultative phreatophytes - low potential groundwater use
- Zone 3 - facultative phreatophytes - negligible groundwater use
- Estimated existing groundwater depth contour (m below ground level)
- Ashburton Formation intersects water table (modelled no-flow boundary)
- Predicted drawdown contour at end of mining (m)



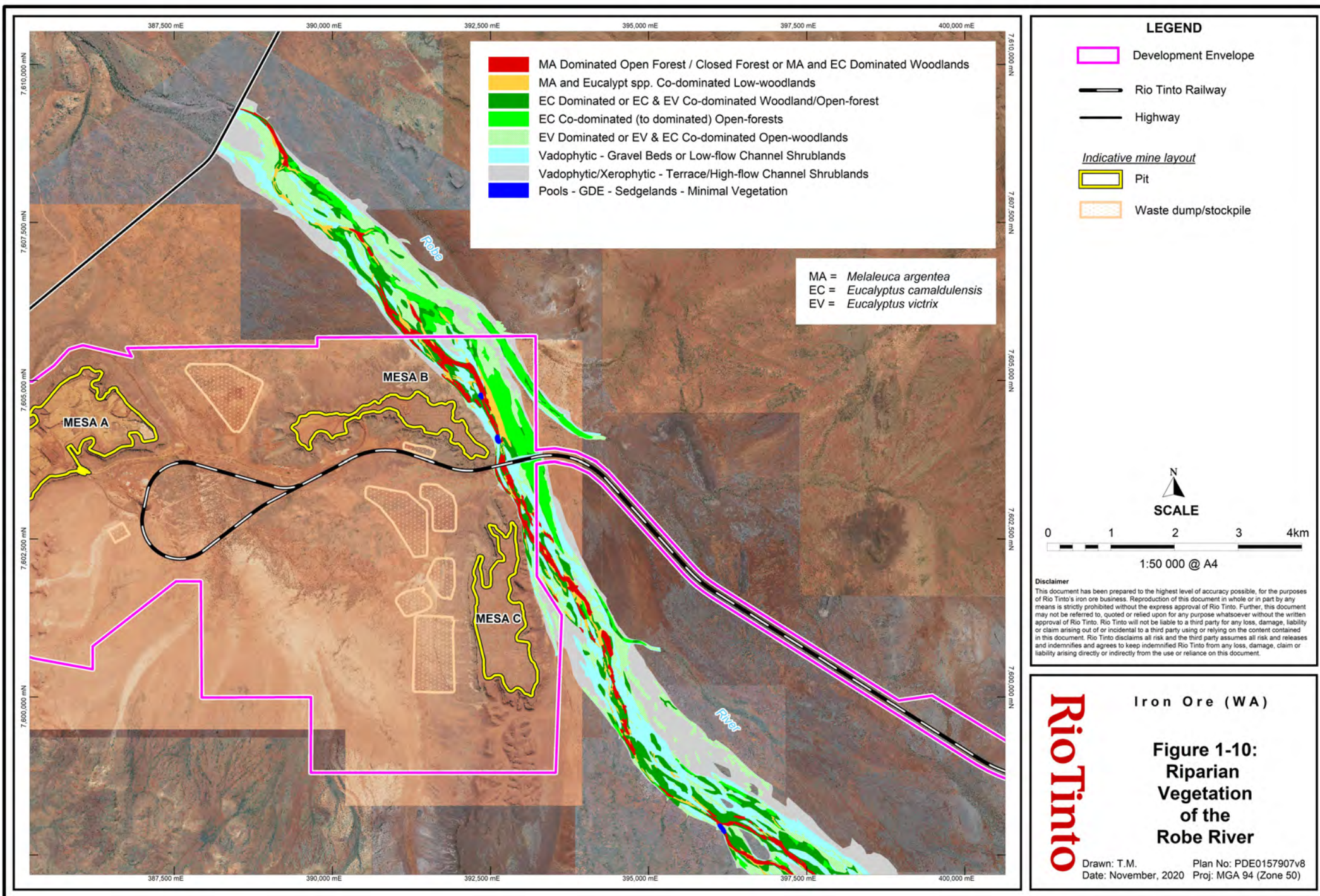
Disclaimer
This document has been prepared to the highest level of accuracy possible, for the purposes of Rio Tinto's iron ore business. Reproduction of this document in whole or in part by any means is strictly prohibited without the express approval of Rio Tinto. Further, this document may not be referred to, quoted or relied upon for any purpose whatsoever without the written approval of Rio Tinto. Rio Tinto will not be liable to a third party for any loss, damage, liability or claim arising out of or incidental to a third party using or relying on the content contained in this document. Rio Tinto disclaims all risk and the third party assumes all risk and releases and indemnifies and agrees to keep indemnified Rio Tinto from any loss, damage, claim or liability arising directly or indirectly from the use or reliance on this document.

Iron Ore (WA)

**Figure 1-9:
Groundwater depen-
-dence zones along
Warrambo Creek**

Rio Tinto

Drawn: T.M.
Date: July, 2019
Plan No: PDE0160394v8
Proj: MGA 94 (Zone 50)



1.4.2 Key assumptions and uncertainties

The key limitations relating to the information used for this EMP include:

- Limited baseline data for the Sand Sheet PEC to assess the long-term natural variation of species presence/absence (including weeds), ecosystem function and vegetation condition.
- Limited understanding of the occurrence of *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) in the region, and its ecology (for example the taxon appears to readily germinate following disturbance).
- Limited regional population studies for Ghost Bat and Northern Quoll to assist in understanding the long-term natural population variability and movements of these species.
- Limited data on the sensitivity of the Ghost Bat and Northern Quoll to noise and vibration.
- Limited understanding of the response of riparian vegetation to cumulative stressors such as groundwater abstraction, surplus water discharge and climate variability.
- Inherent difficulty in interpolating local groundwater table elevation from limited groundwater data to predict the groundwater dependence of riparian vegetation.

The key assumptions relating to this EMP are:

- Baseline surveys of the Sand Sheet PEC, the Ghost Bat, the Northern Quoll and riparian vegetation provide representative species inventories and reflect sampling over variable seasonal conditions, however may not necessarily capture the full range of climatic variables experienced in an arid environment (which may be on a decade-scale).
- All individuals of *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) occurring within the Warramboos Borefield extension area were identifiable and recorded at the time of the baseline surveys and are identifiable and recorded during the proposed pre-clearance surveys.
- Baseline surveys provide a complete representative weed species inventory and reflect sampling over variable seasonal conditions.
- Tolerance of conservation significant fauna species to some level of noise, vibration and light emissions without any significant impact to their normal behaviours or survival.
- The EMP has been developed with a conservative assumption that caves with potential to be a maternal roost or potential to be more than an occasional diurnal roost warrant management. Multiple records of Ghost Bat presence in a cave during the day and/or the dimensions of a cave (sufficient height and depth) and/or the configuration of a cave (multiple levels of cavities) were used as an indication of the potential for a cave to be a diurnal/maternal Ghost Bat roost. Additional data from longer term monitoring of potential diurnal/maternal roost caves may indicate that a different status, and potentially a different level of management, may be appropriate for these caves.
- The effectiveness of blast management measures to prevent disturbance to the retained mesa escarpments. The Proponent has a strong record of managing and maintaining landform stability, as demonstrated at the existing Mesa A/Warramboos Iron Ore Project, with no record of mesa escarpment collapse or failure.
- The hydrogeological modelling of groundwater abstraction from the Yarraloola aquifer and the Mesa C CID aquifer provides an appropriate estimate of the extent and depth of groundwater drawdown, based on the hydrogeological conceptualisation. The hydrogeological models will be updated as additional data become available hence revisions to the management of phreatophytic vegetation may be required.
- Hydrological modelling based on the hydrological conceptualisation has been used to provide an indicative extent of continuous flow under natural no-flow conditions for surplus water discharge to Warramboos Creek. The hydrological model and estimates will be reviewed as additional data become available, hence revisions to the management of phreatophytic vegetation may be required.

- Facultative phreatophytic vegetation along Warramboo Creek and within the broad Warramboo Creek floodplain may be utilising groundwater from the Yarraloola Aquifer to varying degrees despite the current depth to water table being at the limit of accessibility for facultative phreatophytic species, thus there is some potential for impacts from abstraction of groundwater from the Yarraloola aquifer.

1.4.3 Management approach

A risk-based approach has been taken through the Environmental Impact Assessment process to identify the key environmental values that may be impacted by the Proposal and warrant additional management. Regional data, baseline survey data and, where available, ongoing monitoring data have been used to assess the potential impacts of the Proposal on environmental values.

The key environmental values that have been identified as warranting additional management are:

- Sand Sheet PEC;
- Priority 1 flora (*Abutilon* sp. Onslow (F. Smith s.n 10/9/61));
- Conservation significant fauna (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python); and
- Riparian vegetation associated with the Robe River and Warramboo Creek.

This EMP adopts a combination of an outcome-based approach and a management-based approach. For parts of the environment that can be objectively measured and monitored an outcome-based approach is adopted with establishment of trigger and threshold criteria and associated contingency actions if the environmental criteria are not met. Trigger criteria are set at a conservative level to ensure management actions are implemented well in advance of the environmental outcome being compromised. Thus, trigger criteria are set at a level below the threshold criteria to signal the need to focus and investigate and where applicable, mitigate the impact. For parts of the environment that are not amenable to objective measurement or where a level of uncertainty exists that prevents setting measurable criteria, a management-based approach is adopted. This approach includes a management objective that relates to the EPA's environmental objective for the relevant environmental factor; management actions to meet the environmental objective; and management targets to assess the effectiveness of the management actions.

This EMP also describes the monitoring that will be undertaken to measure performance against the environmental outcomes and to assess the effectiveness of management actions in meeting management-based objectives. The monitoring to be undertaken as part of this EMP has been designed to build upon and improve on existing monitoring programs conducted as part of the Mesa A/Warramboo Iron Ore Project and build upon data from baseline surveys.

Key to the overall environmental management approach for the Proposal is avoidance of direct disturbance to key environmental values such as riparian vegetation; high value habitat for Matters of National Environmental Significance (MNES); the Sand Sheet PEC; and Priority 1 flora species. Where avoidance is not practicable, the management approach is to minimise disturbance to key environmental values, particularly habitats, such as the mesa escarpments as detailed in this EMP.

1.4.4 Rationale for choice of provisions

Environmental criteria have been developed based on consideration of:

- Threatening processes and risks associated with each environmental value;
- The current state of knowledge for each environmental value; and
- The availability of suitable monitoring methods.

The specific trigger and threshold criteria, management targets and actions defined in Table 2-1 through Table 2-6, Table 2-13 and Table 2-14 have been chosen as they provide a basis for detecting and avoiding, or otherwise managing, potential impacts, such that the condition

environmental outcomes and objectives stated in conditions 7, 8, 9 and 11 of MS 1112, and the requirements of conditions 3 and 4 of EPBC Act approval 2016/7843 can be met.

Trigger criteria are set at a conservative level to ensure management actions are implemented well in advance of the environmental objective being compromised. Exceedance of a trigger criterion will, therefore, not be treated as a non-compliance. There is potential for the threshold criteria for vegetation to be exceeded due to natural variability; this must be accounted for in the management response. Exceedance of a threshold criterion will be treated as a potential non-compliance against the environmental objective if the exceedance is attributable to the Proposal.

The tables of EMP provisions relating to MS 1112 (Table 2-1 through Table 2-6) contain environmental outcomes that include 'no irreversible impact'. For the purpose of this EMP, an irreversible impact is defined as, 'an impact resulting in a permanent loss of environmental value(s); or where intensive, and/or un-proven management intervention, potentially over a long timeframe, would be required to restore the environmental value(s)'.

The tables of EMP provisions include monitoring to measure performance against the environmental outcomes and to determine whether trigger or threshold levels have been exceeded. Table 2-3 also includes supporting monitoring that will be undertaken. Supporting monitoring is not directly required as a measure of performance but will be used to provide context, to assess the impact on the environmental value and to investigate possible causes should the trigger or threshold criteria be exceeded.

The rationale for selection of provisions for each environmental value is discussed below.

Flora and Vegetation – Sand Sheet (Robe Valley) PEC

Outcome-based and management-based provisions for the Sand Sheet PEC are prescribed by MS 1112. The environmental outcome for the Sand Sheet PEC is:

- No direct impact to the Sand Sheet PEC as a result of implementation of the Proposal, other than existing and authorised disturbance.

Removal of vegetation within the Sand Sheet PEC not only directly impacts vegetation through net loss but also has the potential to decrease diversity, introduce weed species and alter the structure of the community and hydrological flows. Limiting direct disturbance will reduce the risk of irreversible impacts to the Sand Sheet PEC.

Trigger and threshold criteria for ground disturbance and presence and extent (percentage foliar cover) of high priority weed species in the Sand Sheet PEC have been selected as these are indicators of impacts that could result in irreversible damage attributable to the Proposal. Both ground disturbance and monitoring of weeds are readily measurable, can be monitored regularly, have a baseline and measurement of these parameters is consistent with other flora and vegetation monitoring programs.

The management objective for the Sand Sheet PEC is:

- To minimise indirect impacts due to the Proposal as far as practicable to the Sand Sheet Vegetation (Robe Valley) PEC so that the biological diversity and ecological integrity of the PEC are maintained.

The four key species of the Sand Sheet PEC together help to define the Sand Sheet PEC. Loss of one or more of the key species would result in a significant change to the structure of the sand sheet community. A management target relating to persistence of the four key species present in the Sand Sheet PEC has, therefore, been selected.

A management target relating to native species richness has also been selected as an indicator of the biological diversity and integrity of the Sand Sheet PEC. Between 2008 and 2019, the lowest number of native species recorded in a quadrat in the Sand Sheet was 9 (site MSS11 in 2012) and the highest was 45 (site MSS12 in 2017). Native species richness per quadrat declined significantly in both the Sand Sheet PEC quadrats and the reference quadrats between 2017 and 2018 (Astron

2018a), showing similar trends. There was no significant difference in native species richness between 2018 and 2019 (Astron 2019). Analyses have been performed on perennial native species, and annual and perennial native species and results are indistinguishable (Astron 2018a, 2019).

Species richness for the Sand Sheet PEC quadrats will continue to be compared with species richness at reference sites and with historical data (where available), with consideration of proximity of each quadrat to the mining operation to indicate if trends may not be due to natural variation.

Surface water flows may be important to the health of the Sand Sheet PEC. A management target has, therefore, been selected to ensure that infrastructure is located and designed such that there is no loss of the immediate hydrological contributing area that would affect surface water flow to the Sand Sheet PEC, other than existing and authorised disturbance.

Flora and Vegetation – Priority 1 Flora

A management-based provision is prescribed by MS 1112 for the Priority 1 species, *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61). The management objective for *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) is:

- To avoid where possible, and minimise direct and indirect impacts to *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61).

A management target related to the direct impacts on *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) has been selected to assess whether the management actions are effective in meeting the environmental objective. Specifically, the target is to limit direct impacts to no greater than predicted (5% of known records as represented in the Rio Tinto database).

The confirmed records of *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) lie in the Warramboore borefield extension area approximately 3 km south-west of the Warramboore mining area and approximately 9 km west of the Mesa A mining area. Winds in the area are predominantly southerly to south-easterly. Activities to be undertaken in the borefield extension area as part of the Mesa A Hub Proposal are considered low impact, primarily involving establishment of tracks and water bores. Given the disturbance opportunistic nature of *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61), the location of confirmed records and the nature of activities in the borefield extension area, most potential indirect impacts are not considered to present a significant risk to the species. Weeds are considered to represent the only potential indirect impact to *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) that warrant a management target. A management target to minimise the potential indirect impacts of high priority weeds on *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) is, therefore included in the management-based provisions.

Terrestrial Fauna habitat – Ghost Bat (*Macroderma gigas*)

Outcome-based and management-based provisions are prescribed under MS 1112 and EPBC Act approval 2016/7843 for the Ghost Bat. The outcome-based provisions (Table 2-3) address condition 9 of MS 1112 while management-based provisions (Table 2-13 and Table 2-14) address conditions 3 and 4 of EPBC Act approval 2016/7834.

The environmental outcome for the Ghost Bat under MS 1112 is:

- No irreversible impact, as a result of the Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance.

The Breakaways and Gullies habitat contained within the escarpments of Mesas A, B and C represents potential roosting and foraging habitat. Habitat loss through disturbance to roost caves, specifically caves that play a role in breeding activities (maternal roosts) and nearby areas is seen as a key risk to this species' conservation status. The Proposal has been designed to retain Breakaways and Gullies habitat through delineation of MEZs. The Proposal has also been designed to avoid direct disturbance to all but one recorded Ghost Bat roost cave. The nocturnal

roost cave MBS-05 (refer Figure 1-7) will be removed if the second escarpment cut onto Mesa B is required. Specifically, the Proposal will avoid:

- Two nocturnal roost caves at Mesa A;
- One potential diurnal/maternal roost cave at Mesa B (MBC-05);
- 11 of the 12 nocturnal roost caves at Mesa B (only nocturnal roost cave MBS-05 may be disturbed);
- All sixteen recorded roost caves at Mesa C, including three potential diurnal/maternal roost caves (MCC-02, MCC-05, CRMC02) and four potential diurnal roost caves (MCC-04, CRMC09, CRMC10, CRMC11); and
- All four inaccessible caves.

The EMP has been developed with a conservative assumption that caves with multiple records of Ghost Bat presence during the day and/or suitable dimensions and/or suitable configurations have potential to be diurnal/maternal roosts and therefore warrant management. Additional data from longer term monitoring of these caves may indicate that a different status, and potentially a different level of management, may be appropriate for these caves.

Direct disturbance near the potential diurnal/maternal roosts has been selected as early warning and threshold criteria as disturbance is readily measurable and targeted to the highest value Ghost Bat habitat. The threshold value for direct disturbance aligns with the commitment made in the ERD that mine pits would be set back a minimum of 40 m from the lateral extent (recorded back) of the potential diurnal or maternal Ghost Bat roost caves. This commitment was based on geotechnical assessment of the roost caves and geotechnical analysis of the mesa formations in the Robe Valley.

Geotechnical assessment of the potential diurnal/maternal roost caves MBC-05, MCC-02, MCC-04 and MCC-05 concluded the caves have a 'Low' geotechnical sensitivity to structural instability, with none of the caves displaying rock fractures or other features that would increase the geotechnical sensitivity (Rio Tinto 2017a).

Geotechnical analysis of mesa formations in the Robe Valley concluded that a minimum of 30 m is adequate to maintain geotechnical stability at an open face.

Given no features were noted that would increase the geotechnical sensitivity, the proposed threshold criterion of 40 m from the recorded back of the diurnal/maternal roosts is considered more than sufficient to meet the geotechnical stability criterion for the roost caves.

Vibration has been selected as a trigger criterion as vibration levels are relevant to protection of the highest value habitat (potential diurnal/maternal roosts), are readily measurable, can be monitored regularly and are consistent with other Ghost Bat monitoring programs. Ensuring the vibration levels at the potential diurnal/maternal roosts remain below a peak particle velocity determined for each cave reduces the risk that vibrations potentially compromise the structural integrity of the roosts.

Designation of the peak particle velocity limit for each potential diurnal/maternal Ghost Bat roost cave is based on AS 2187-2006 'Explosives – Storage and use – Use of Explosives' in combination with a risk assessment of the geotechnical sensitivity, the environmental significance of each cave and the Proponent's vibration control experience.

The environmental significance of each potential diurnal/maternal roost cave was assessed as 'High'. Geotechnical assessment of potential diurnal/maternal Ghost Bat roost caves includes assessment of the rock fractures, bedding planes and degree of cementation. The geotechnical sensitivity for structural instability at all assessed sites, including potential diurnal/maternal roost caves MBC-05, MCC-02, MCC-04 and MCC-05, was assessed as 'Low'.

AS 2187.2 (Appendix J) recommends:

- a ground vibration limit of 100 mm/s peak particle velocity to control damage to structures of reinforced concrete; and
- a transient vibration limit of 50 mm/s peak particle velocity for prevention of cosmetic damage to reinforced or framed structures, industrial and heavy commercial buildings.

The Proponent regularly uses vibration control to protect sensitive sites such as rock shelters with high cultural significance, high pressure gas pipelines, communications towers and the mesa escarpment at Mesa A. From the Proponent's experience in vibration control, it is known that fracturing of intact rock typically occurs at 250 – 1000 mm/s peak particle velocity.

Based on environmental sensitivity, geotechnical assessment and AS 2187.2, the trigger criterion for vibrations at the potential diurnal/maternal Ghost Bat roost caves has been set at 50 mm/s peak particle velocity. This is well below typical vibration levels associated with rock fracture and meets the AS 2187.2 recommendation for prevention of cosmetic damage for heavy commercial buildings. Geotechnical assessments of the potential diurnal/maternal roosts recorded by Biologic (in prep.) (CRMC02, CRMC09, CRMC10 and CRMC11) will be completed prior to blasting occurring within 300 m of each of these caves to confirm the suitability of the 50 mm/s peak particle velocity limit. If geotechnical assessment of any of these caves indicates a higher geotechnical sensitivity (i.e. sensitivity other than 'Low'), then the peak particle velocity limit will be set at a lower level for that cave to ensure the structural integrity of the cave is not compromised.

Blast vibration monitoring will be conducted for blasts within 300 m of the potential diurnal/maternal Ghost Bat roosts. Based on blast vibration monitoring at West Angelas, significant damage is considered unlikely for blasts beyond 300 m as no monitored standard blasts have exceeded peak particle velocity of 50 mm/s outside the 300 m radius. At 300 m, using AS2187.2 scaled distance vibration prediction method and constants, an approximate +80% safety margin for maximum instantaneous charge is allowed for in blast execution and design.

The management objective for the Ghost Bat to address condition 3 of EPBC Act approval 2016/7834 is:

- Improve knowledge of the Ghost Bat population in the Robe Valley, including its use of high value habitat and effects of noise and vibration, in order to assist in maintaining biological diversity and ecological integrity.

This management objective has been selected as it provides an appropriate objective for the management target required under condition 3 of EPBC Act approval 2016/7843. One of the limitations noted during the Environmental Impact Assessment for the Mesa A Hub is the lack of long-term data that would provide an estimate of natural Ghost Bat population variability and an indication of how the Ghost Bat utilises caves within the western part of the Robe Valley. The proposed management action to monitor Ghost Bat utilisation of high value habitat in the Robe Valley has been selected to start to address this limitation as well as to improve knowledge of the effects of noise and vibration on Ghost Bat utilisation of habitat.

Terrestrial Fauna habitat – Northern Quoll (*Dasyurus hallucatus*)

Northern Quoll population numbers fluctuate on both annual and inter-annual cycles. This variability is driven by both the reproductive biology of individuals (males usually die-off after one year) and longer-term cycles in response to regional stochastic processes such as rainfall, fire and related changes of prey populations (How *et al.* 2009). This natural variability makes threshold criteria based on population dynamics inappropriate for compliance at this stage. Protection of high value habitat for the Northern Quoll is, therefore, the most appropriate strategy to protect this conservation significant fauna within the Development Envelope.

The environmental outcome required under MS 1112 for the Northern Quoll is:

- No irreversible impact, as a result of the Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance.

High value denning and foraging habitat is potentially present within the mapped Breakaways and Gullies habitat and Rocky Slopes habitat in the MEZs of Mesas A, B and C. The Proposal has been designed to retain potential high value denning and foraging habitat in the MEZs and the locations of escarpment cuts (i.e. removal of small sections of the mesa escarpments) were selected to avoid the highest value fauna habitat on each mesa escarpment (MWH 2015b).

Limited clearing in the MEZs is authorised by Schedule 1 of MS 1112 as follows:

- Mesa A: No more than 7 ha excluding existing and authorised clearing;
- Mesa B: No more than 41 ha; and
- Mesa C: No more than 43 ha.

The clearing limits in Schedule 1 of MS 1112 apply to the habitat types in the entire MEZ. To meet the environmental outcome required by Condition 9 of MS 1112, trigger and threshold criteria have been developed specifically to further limit disturbance to potential Northern Quoll denning habitat in the MEZ. The trigger and threshold criteria will ensure the maximum clearing in potential Northern Quoll denning habitat will remain well below the clearing authorised by Schedule 1 of MS 1112.

Direct disturbance to potential Northern Quoll denning habitat is readily measurable and can be regularly monitored as disturbance to Breakaways and Gullies habitat and Rocky Slopes habitat in the MEZs of Mesas A, B and C. Ensuring direct disturbance to the Breakaways and Gullies habitat and the Rocky Slopes habitat in the MEZs is minimised reduces the risk that potential Northern Quoll denning habitat is disturbed or degraded.

Disturbance to 5% of the potential Northern Quoll denning habitat in the MEZ of Mesa A, B and C equates to between approximately 1.9 ha and 3.1 ha of new disturbance in the MEZ on each mesa, well under the MEZ disturbance provided for in Schedule 1 of MS 1112 for each mesa. The proposed trigger and threshold will thus provide additional protection to the Breakaways and Gullies Habitat and the Rocky Slopes Habitat in the MEZs and ensure the outcome required by Condition 9 of MS 1112 is met.

The threshold criterion of disturbance to 10% of potential denning habitat in the MEZs of Mesas A, B and C was selected based on consideration of Northern Quoll use of partially intact mesa escarpments in historical mining areas in the Robe Valley. Historical mining in the Robe Valley did not include retention of mesa escarpments; escarpments were either completely or partially removed or waste rock was tipped over the escarpments resulting in loss of the original cliff line and denning/shelter features. Survey work in historically mined areas in the Robe Valley has recorded Northern Quoll use of historical mining areas near partially intact mesa escarpments as shown in Table 1-5.

Table 1-5 Historically mined mesas in the Robe Valley with nearby records of Northern Quoll

Mesa name	Estimated percentage of intact escarpment
Mesa K	45%
Mesa L	22%
Mesa 2400E	42%
Mesa 2401A	44%
Mesa 2403ABC	22%
Mesa 2403D	93%

The above data indicate that Northern Quoll use of habitat at Mesa A, B and C would be expected to continue even if the selected threshold of disturbance to 10% of potential Northern Quoll denning

habitat in the MEZs were reached. The trigger and threshold have been set conservatively (i.e. well below disturbance levels in historical mining areas) to ensure disturbance associated with the Proposal is minimised and does not result in an irreversible impact to high value Northern Quoll habitat in the MEZs.

EPBC Act listed threatened species

In addition to the management outlined above for Ghost Bat and Northern Quoll habitat, the following environmental outcome and objective (Table 2-13) will be implemented to meet the requirements of condition 3 of EPBC Act approval 2016/7843 in relation to threatening processes:

- Outcome: Minimise impacts to EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) associated with implementation of the Action
- Objective: Manage threatening processes associated with implementation of the Action, where relevant to minimising impacts to EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python).

Key to the overall environmental management approach for the Proposal is avoidance of direct disturbance to key environmental values including high value habitat for MNES. Where avoidance is not practical, the management approach is to minimise impacts associated with implementation of the Proposal. The management objective has been selected as it is recognised that mitigation and management of relevant threatening processes will assist in minimising the impacts of the Proposal on EPBC Act listed threatened species.

Inland Waters and riparian vegetation

Three environmental outcomes are prescribed by MS 1112 for riparian vegetation for different aspects of the Proposal:

- Maintain groundwater levels to ensure there is no impact to the health of riparian vegetation of the Robe River, as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal;
- No irreversible impact to the health of riparian vegetation of Warrambo Creek as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal; and
- No irreversible impact to the health of riparian vegetation of Warrambo Creek as a result of surplus water discharge associated with implementation of the Proposal.

The outcome to ensure no impact to the health of riparian vegetation of the Robe River acknowledges the high value of this feature and that impacts from the Proposal are not expected. The outcomes for riparian vegetation of Warrambo Creek acknowledge that the Proposal may have an impact on riparian vegetation; however, potential impacts are not expected to be permanent as they will be limited in spatial extent and/or will occur over a limited time period.

For Warrambo Creek, an early warning criterion for the location of surface water expression from surplus water discharge was selected as limiting the distance of surface water expression under natural no-flow conditions will limit the extent of potential impacts. Use of the distance of surface water expression is a readily measurable indicator of the extent of potential impacts which can be monitored regularly and is consistent with other riparian vegetation monitoring programs. Groundwater depth in the Warrambo area has also been included as an early warning criterion to provide warning of potential stress to groundwater dependent riparian vegetation associated with Warrambo Creek in advance of any observed impact. Groundwater depth has been further included as a trigger criterion to ensure groundwater drawdown, and therefore potential impact to groundwater dependent riparian vegetation associated with Warrambo Creek, is no greater than was predicted in the ERD. Additional trigger criteria and the threshold criteria for Warrambo Creek are based on the environmental value of Warrambo Creek as measured by the response of the riparian vegetation, as described below.

Groundwater levels, in combination with assessment of change to the groundwater dependent riparian vegetation, is included in both the trigger and threshold criteria for the Robe River as described below, given that no decline in the groundwater levels in the Robe River adjacent to Mesa C as a result of dewatering is predicted.

Selected early warning, trigger and threshold criteria for the upper canopy of Robe River and Warrambo Creek are based on an index of vegetation health derived from high spatial resolution satellite imagery. Currently modified soil adjusted vegetation index (MSAVI) is used but an alternative index may be used in the future subject to advances in remote sensing. MSAVI is a readily measurable indicator of the health of riparian vegetation for which reference sites can be established and regular monitoring undertaken. Measurement of MSAVI is also consistent with other Rio Tinto riparian vegetation monitoring programs. A time series of MSAVI values from the baseline period to the latest date is used to monitor the condition of riparian tree canopy over time.

Rio Tinto proposes to use empirically based criteria, derived from the relationship between MSAVI and visual indications of canopy decline, i.e. ecologically significant states of health (e.g. foliage loss) can be translated to index values (e.g. MSAVI of 0.3) (Astron 2019). However, there are currently insufficient data to derive this relationship for the canopy of Robe River and Warrambo Creek (see Appendix 2 for baseline data). Therefore, the trigger and threshold criteria will be informed by baseline statistics (5th percentile) of MSAVI. Statistically based criteria aim to determine the limits of natural variation (Morrison 2008); a decrease below the 5th percentile of baseline represents change below the lower end (one-tailed) of a normally distributed data set and may indicate that canopy health has decreased beyond established patterns of variation. As the baseline period for Robe River and Warrambo Creek is limited (currently 2014 to 2019; Appendix 2) and is insufficient to cover typical levels of seasonal and longer term (decadal) variability experienced in the Pilbara, the 5th percentile of baseline data will be used to inform initial criteria, which will be refined as site-specific knowledge develops in accordance with adaptive management principles. Any changes evident in the annual dry season remote sensing capture will be investigated with more frequent remotely sensed imagery (e.g. Sentinel), a longer term record (e.g. Landsat), and including ground-truthing of any observed declines, to help distinguish potential mining related impacts from seasonal variation and regional trends (although some of these data are captured at coarser spatial resolution and may reflect both understorey and overstorey vegetation cover and health).

A greater than 10% increase in the proportion of phreatophytic canopy area that falls below the baseline 5th percentile than the reference areas has been designated as an early warning criterion for Warrambo Creek and the trigger criterion for Robe River. A 10% margin above reference is considered reasonable in order to detect a decline in canopy condition that may be beyond natural variation and reflect a potential impact from dewatering or discharge. For the Robe River, this will be applied to obligate phreatophytic vegetation in proximity to the Mesa C deposit, i.e. *Melaleuca argentea* dominated and co-dominated communities, as these communities are considered to be at moderate to high risk of impact if groundwater drawdown were to occur. Other facultative phreatophytes in the *M. argentea* co-dominated communities will also be sensitive to groundwater change, as root systems will be shallow on account of groundwater levels being shallow in these areas. The presence of these communities has been mapped in detail for the Robe River (Rio Tinto 2017), and as satellite imagery is captured at fine spatial resolution, it is possible to assess the vegetation health index separately for these communities to provide a sensitive indicator of any potential change. For Warrambo Creek, the trigger criterion has been specified as an increase in the proportion of phreatophytic canopy area that falls below the baseline 5th percentile of 20% or greater than the reference areas, as a certain level of impact to the groundwater dependent riparian vegetation is expected as a result of dewatering.

For Warrambo Creek, a threshold criterion of canopy health decline over a period of two consecutive years has been selected. Given the natural variability of rainfall and streamflow, and variation seen in the vegetation health index during the baseline period (Appendix 2), two years has been selected as a suitable timeframe to assess whether the condition of upper canopy vegetation is under threat of long-term impacts from the Proposal, and to differentiate natural variation of the

canopy from the potential impacts of groundwater abstraction and surplus water discharge. Decline over two consecutive dry season monitoring events is chosen for the threshold criterion as condition of the upper canopy is best measured from remote sensing in the dry season when there is less influence from the understorey. Assessment of seasonal variation in comparison to long term and regional trends, including ground-truthing of any observed decline, is also considered in the threshold criterion.

Following the completion of collection and analysis of baseline data, the trigger and threshold criteria for overstorey canopy will be reviewed and adjusted if deemed appropriate. Note that the Robe River adjacent to Mesa C was impacted by fire in 2018, with a resultant decrease in MSAVI levels (see Appendix 2); some recovery was evident in 2019, however this will continue to be tracked prior to commencement of dewatering of the BWT component of the ore at the Mesa C deposit and the trigger criterion revised if no longer considered sensitive enough to detect potential impacts to riparian vegetation.

On ground monitoring of understorey and overstorey vegetation (including weeds) will also be undertaken to detect any change in composition, structure and condition of riparian vegetation. For Warrambo Creek, the trigger criterion has been designated as significant decline in number and/or a change in composition of native perennial species. Baseline riparian vegetation monitoring of Warrambo Creek (and the Robe River adjacent to Mesa C) has shown significant variation in the occurrence of native perennial species present within transects (increases and decreases in numbers of up to 50% between monitoring events; Astron 2020b). Therefore, decline in native perennial species number would not necessarily signify a lasting impact to vegetation, but provides an indicator that requires further investigation. Assessing change in native perennial species composition takes into account that replacement of some native species by others, resulting in a shift in the assemblage composition, may represent a potential impact to the riparian vegetation community. A certain level of impact from dewatering and discharge on the riparian vegetation of Warrambo Creek is expected, therefore management would only be implemented if this impact (including potential augmentation of vegetation from surplus water discharge) caused a statistically significant decline in the number and/or a change in composition of native species. Univariate response data will be used for transects that have been repeatedly sampled over time, to test for differences in number of native perennial species across time, across treatment and for a time-by-treatment interaction. In order to test for a significant change in the plant species assemblage, composition over time and across treatment, multivariate analysis will be undertaken (for example PERMANOVA).

A trigger criterion for detection of new high priority introduced weed species within the potential impact zone and downstream of the discharge extent in Warrambo Creek was selected as an indicator of potential impacts from discharge of surplus water. Weed species can be monitored regularly, have a baseline and measurement of these parameters is consistent with other flora and vegetation monitoring programs.

For Warrambo Creek, a threshold criterion has been selected based on the composition and structure of both understorey and overstorey species (including weed species), determined from on-ground survey. Dewatering and discharge are expected to result in some temporary compositional and structural changes to the riparian vegetation; however, this is not expected to affect the long-term functioning of the community (Eco Logical Australia 2018). Discharge will result in intermittent to permanent inundation for sections of the low flow channel base, as well as likely saturation of alluvial sediments throughout the low flow channel, within the surface discharge extent. This may result in decline in presence or cover of some native species due to waterlogging and/or increased presence or cover of other native and introduced species as a result of augmentation over confined sections of the creek. Less significant changes may occur in the remaining areas of the creek channel, terrace and banks due to increased water availability. Dewatering is expected to result in some compositional and structural change due to decreased water availability in the creek channel, terrace, banks and floodplain. While a proportion of the creek is expected to be impacted (most likely significant changes in the base of the primary channel (or low flow) and banks), broad scale maintenance of species composition and structure in the remaining proportion

(i.e. secondary channels (high flow), terrace and floodplain zones) would allow recolonization once dewatering or discharge ceases, thus preventing an irreversible impact. The threshold criterion describes structural shift or loss of dominant species across 50% of the predicted dewatering or discharge extent, to occur in any part of the creek habitat (channel, terrace, banks or floodplain), beyond which there is the potential for irreversible impacts to occur. The threshold criterion aims to detect a major change to vegetation outside of natural variation and beyond the expected effects of dewatering and discharge from the Proposal that may indicate potential for an irreversible change.

For the Robe River, a threshold criterion has been selected based on changes to groundwater level together with a significant decline in number and/or a change in composition of native perennial species in transects adjacent to Mesa C in comparison to reference areas. As for the trigger criteria, due to the relatively high conservation value of the Robe River and as the Proposal is not anticipated to have detrimental impacts to the riparian vegetation, a more stringent threshold criterion has been applied in comparison to other riparian systems. Focus will be on areas adjacent to Mesa C that are most sensitive to any change in groundwater level; quadrats were established during baseline in groundwater dependent vegetation classified as medium or high risk of impact if groundwater drawdown were to occur. Risk was determined based on detailed mapping of composition of vegetation in the Robe River and knowledge of the degree of groundwater dependency of species present (Rio Tinto 2017).

2. EMP PROVISIONS

2.1 Requirements under MS 1112

This section of the EMP identifies the provisions the Proponent will implement to ensure that the environmental outcomes and management objectives of MS 1112 conditions 7, 8, 9 and 11 are met during implementation of the Proposal. Outcome-based and management-based provisions are provided in Section 2.1.1 and monitoring and reporting are further detailed in Sections 2.1.2 and 2.1.3.

Section 2.2 identifies the provisions the Proponent will implement to meet relevant requirements of EPBC Act Approval 2016/7843.

2.1.1 Outcome-based and management-based provisions

The environmental outcomes, environmental criteria (trigger and threshold) and response actions (trigger level and threshold level) are provided in Table 2-1 and Table 2-3 to Table 2-6, for each environmental value that is to be managed using outcome-based provisions. Management objectives, management actions and management targets are provided in Table 2-1 and Table 2-2 for environmental values where management-based provisions are adopted.

Table 2-1: EMP Provisions – Flora and Vegetation (Sand Sheet Vegetation (Robe Valley) PEC)

Flora and Vegetation - Sand Sheet Vegetation (Robe Valley) PEC			
<p>EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained</p> <p>Key environmental values: Priority Ecological Community – Sand Sheet PEC</p> <p>Key impacts and risks: Potential degradation of the Sand Sheet PEC due to ground disturbance, increased dust deposition and introduction of weed species as a result of implementation of the Proposal</p>			
Outcome-based provisions			
<p>Outcome: No direct impact to the Sand Sheet Vegetation (Robe Valley) PEC as a result of implementation of the Proposal, other than existing and authorised disturbance.</p>			
Environmental criteria	Response actions	Monitoring actions	Reporting
<p>Trigger criteria:</p> <p>1. Clearing within 20 m of the boundary of the Sand Sheet Vegetation (Robe Valley) PEC, other than existing and authorised disturbance</p> <p>OR</p> <p>2. Transect monitoring detects new high priority weed species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC</p> <p>OR</p> <p>3. Quadrat monitoring detects new high priority weed species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC or an increase in number and/or extent of a previously detected high priority weed species</p>	<p>Trigger criterion 1:</p> <ul style="list-style-type: none"> Investigate cause of clearing Check delineation of the 20 m buffer around the Sand Sheet PEC meets Rio Tinto Iron Ore standard work practices for delineation of critical boundaries where required Inform all personnel of clearing restrictions within PEC boundaries, restrict access to authorised personnel only, erect signage (if not already present) and consider fencing or physical barriers (e.g. bunding) Re-assess work practices and training needs to prevent further disturbance <p>Trigger criteria 2 and 3:</p> <ul style="list-style-type: none"> Review monitoring results for emerging spatial and temporal trends and correlations between rainfall and fire patterns Implement targeted monitoring of vegetation condition, weed species' preferred habitat or key species where required Review presence and abundance of weed species. Internally record, report, map and monitor. Investigate the risk of high priority weed species becoming dominant Implement weed management controls where required taking into account local environmental conditions, life stages of species and individual treatment methods. Control is to include annual targeted spraying and/or physical removal Review weed hygiene practices 	<ul style="list-style-type: none"> Annual land clearing reconciliation against Sand Sheet PEC boundaries and the area within 20 m of the Sand Sheet PEC boundaries utilising Geographical Information System (GIS) layers Annual transect monitoring to identify new occurrences of high priority weed species in Sand Sheet PEC and reference transects Annual quadrat monitoring to identify new occurrences and increased number/extent (foliage cover) of previously detected high priority weed species in Sand Sheet PEC and reference quadrats 	<ul style="list-style-type: none"> The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the Annual Compliance Assessment Report (ACAR) for MS 1112 If a trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions
<p>Threshold criteria:</p> <p>1. Clearing within the Sand Sheet Vegetation (Robe Valley) PEC, other than existing and authorised disturbance</p> <p>OR</p> <p>2. High priority weed species becomes established and dominant within the Sand Sheet Vegetation (Robe Valley) PEC</p>	<p>If exceedance of threshold criterion is considered likely to be attributable to the Proposal, implement threshold contingency actions as agreed with the Department of Water and Environmental Regulation (DWER), for example:</p> <p>Threshold criterion 1:</p> <ul style="list-style-type: none"> Undertake rehabilitation of the area cleared in the Sand Sheet PEC Undertake targeted monitoring of rehabilitation progress in the cleared Sand Sheet PEC area Commence seed collection if appropriate based on rehabilitation progress and feasibility of alternative rehabilitation options <p>Threshold criterion 2:</p> <ul style="list-style-type: none"> Increase intensity and frequency of weed control activities at specified area of exceedance, taking into account local environmental conditions, life stages of species and individual treatment methods. Consider implementing fencing or other physical barriers 	<ul style="list-style-type: none"> As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions 	<ul style="list-style-type: none"> Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being reported to the DWER The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR If a threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact

Management-based provisions			
Management objective: To minimise indirect impacts due to the Proposal as far as practicable to the Sand Sheet Vegetation (Robe Valley) PEC so that the biological diversity and ecological integrity of the PEC are maintained			
Management actions	Management targets	Monitoring	Reporting
<p>Design infrastructure as far as practicable such that there is no loss of immediate hydrological contributing area, excluding existing and authorised disturbance, affecting surface water flow to the Sand Sheet Vegetation (Robe Valley) PEC.</p> <p>Continue to implement dust control measures at the Mesa A Hub.</p>	<ol style="list-style-type: none"> 1. Persistence of the four key species (<i>Corymbia zygophylla</i>, <i>Acacia tumida</i> var. <i>pilbarensis</i>, <i>Grevillea eriostachya</i> and <i>Triodia schinzii</i>) of the Sand Sheet Vegetation (Robe Valley) PEC 2. No decline in native species richness in the Sand Sheet PEC attributable to the Proposal, taking into account historical variation and reference site trends 3. No loss of immediate hydrological contributing area due to the Proposal, excluding existing and authorised disturbance, that affects surface water flow to the Sand Sheet Vegetation (Robe Valley) PEC 	<ul style="list-style-type: none"> • Annual land clearing reconciliation against Sand Sheet PEC boundaries utilising GIS layers • Annual land clearing reconciliation against the immediate hydrological contributing area boundaries for the Sand Sheet PEC (Figure 2-3) and hydrological assessment of any new disturbance to establish if the disturbance may affect surface water flows to the Sand Sheet PEC • Annual quadrat monitoring to examine the persistence (presence and percentage foliar cover) of the key species; assess vegetation cover; assess native species richness between reference and Sand Sheet quadrats and between historic and current surveys; and transect monitoring to assess weed species' presence • Annual quadrat monitoring to also include visual assessment of vegetation condition, plant health and visual dust cover rankings • Annual assessment of vegetation using remote sensing of the Sand Sheet PEC 	<ul style="list-style-type: none"> • Notify the DWER within 7 days of non-achievement of a management target being known and provide a report within 21 days of the non-achievement being reported to the DWER • The environmental outcome will be reported against the management target for each calendar year by 30 April in the ACAR for MS 1112 • If the management target was not met during the reporting period, the ACAR will include discussion of the effectiveness of the management actions and whether revision of the management actions is required

Table 2-2: EMP Provisions – Flora and Vegetation (Priority 1 Flora)

Flora and Vegetation – Priority Flora			
<p>EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained</p> <p>Key environmental values: Priority 1 species, <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61)</p> <p>Key impacts and risks: Inadvertent clearing of individuals as a result of implementation of the Proposal</p>			
Management -based provisions			
<p>Management Objective: To avoid where possible, and minimise direct and indirect impacts to <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61).</p>			
Management actions	Management targets	Monitoring	Reporting
<p>Within Warrambo Borefield extension area:</p> <ul style="list-style-type: none">Undertake pre-clearance survey for <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61)²As far as practical, design clearing footprint to avoid <i>Abutilon</i> sp. Onslow individualsInform appropriate personnel of presence of clearing restrictionsConduct annual weed monitoring in the areas where the main populations of <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) have been recorded as depicted in Figure 2-1If a high priority weed species becomes established within the monitored areas depicted in Figure 2-1, implement weed management controls in the monitoring areas where those areas are within the Development Envelope.	<ol style="list-style-type: none">Limit direct impacts on <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) due to implementation of the Proposal to no greater than predicted (5% of known records as represented in the Rio Tinto database)Minimise potential indirect impacts of high priority weeds on <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61)	<ul style="list-style-type: none">Annual land clearing reconciliation of known records against individuals impacted as a result of implementation of the Proposal, utilising GIS layersAnnual weed monitoring (transects) selected within the monitoring areas depicted in Figure 2-1	<ul style="list-style-type: none">Notify the DWER within 7 days of non-achievement of a management target being known and provide a report within 21 days of the non-achievement being reported to the DWERThe environmental outcome will be reported against the management target for each calendar year by 30 April in the ACAR for MS 1112If the management target was not met during the reporting period, the ACAR will include discussion of the effectiveness of the management actions and whether revision of the management actions is required

² Any new records of *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) recorded during a pre-clearance survey will be added to the Rio Tinto database.

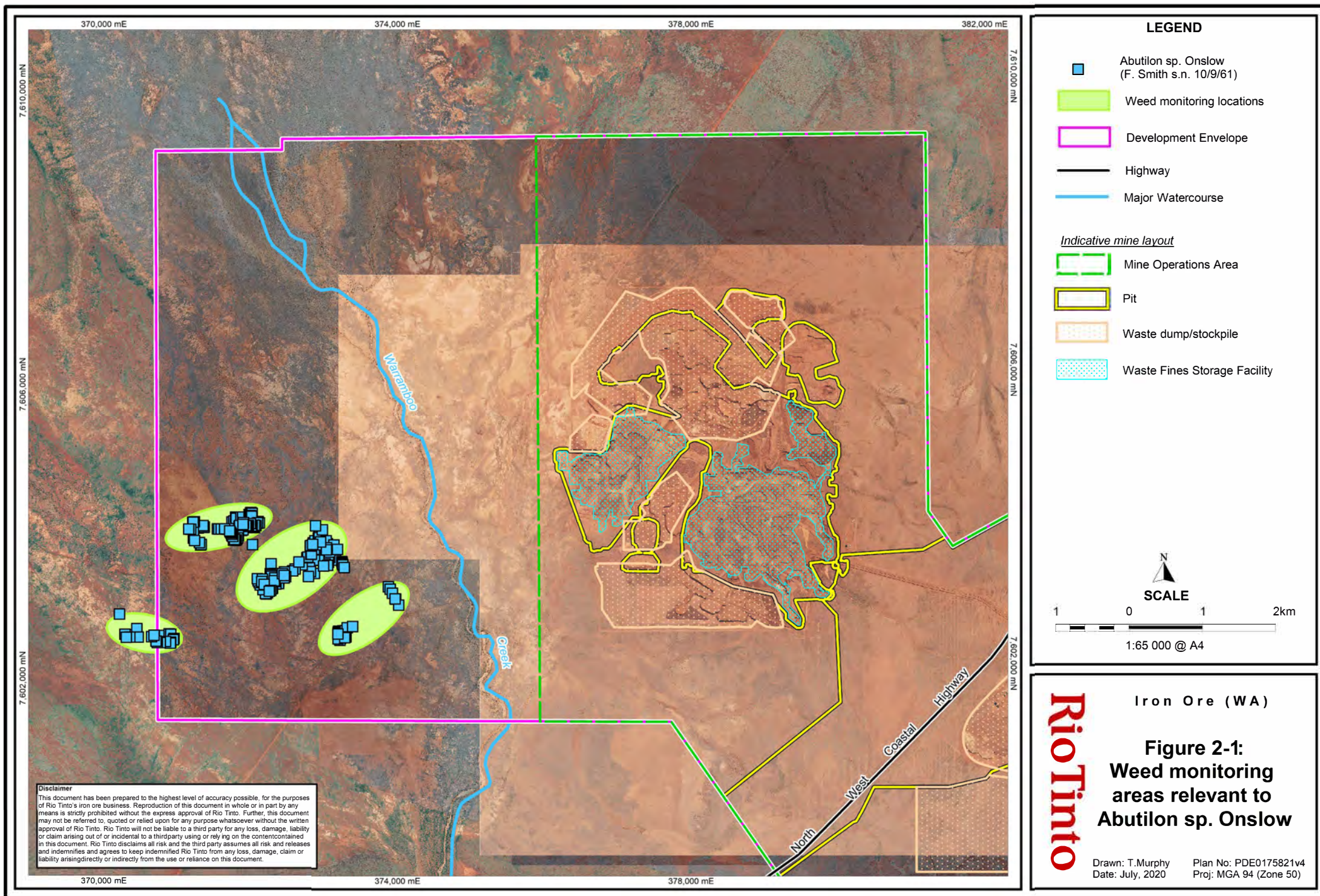


Table 2-3: EMP Provisions – Terrestrial Fauna habitat (Ghost Bat and Northern Quoll)

Terrestrial Fauna – Ghost Bat			
EPA Objective: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained Key environmental values: Conservation significant fauna species – Ghost Bat and Northern Quoll Key impacts and risks: Potential loss or degradation of high value (roosting and denning) habitat as a result of implementation of the Proposal			
Outcome-based provisions			
Outcome: No irreversible impact, as a result of the Proposal, to Breakaways and Gullies habitat retained in the escarpments of Mesa A, B and C MEZs, other than existing and authorised disturbance			
Environmental criteria	Response Actions	Monitoring	Reporting
Early warning criterion: 1. Disturbance, other than existing and authorised clearing ³ , within 50 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 2-2	<ul style="list-style-type: none">Review clearing extent, blast vibration predictions, blast vibration monitoring levels and other natural factors (e.g. seasonal rainfall data) to determine if disturbance is as expectedModify land clearing procedure, vibration model and/or blast management controls as appropriate	<ul style="list-style-type: none">Blast vibration monitoring for all blasts within 300 m of the potential diurnal/maternal Ghost Bat roosts as shown in Figure 1-7Annual land clearing reconciliation against potential diurnal/maternal Ghost Bat roost cave buffers as shown in Figure 2-2	If the trigger or threshold criterion was exceeded during the reporting period, the ACAR will include review of early warning criteria, if relevant to the exceedance
Trigger criteria: 1. Vibration levels exceed 50 mm/s peak particle velocity at the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7 OR 2. Disturbance of ≥ 5% of potential Northern Quoll denning habitat (comprising Breakaways and Gullies habitat and Rocky Slopes habitat) in the MEZ of Mesa A, B or C, excluding existing disturbance and disturbance authorised prior to grant of MS 1112	Trigger criterion 1: <ul style="list-style-type: none">Review blast vibration predictions and blast vibration monitoring dataUpdate vibration model and/or modify blast management controls as appropriateConduct geotechnical assessment of the site to assess structural stability of the roostReview supporting Ghost Bat monitoring data Trigger criterion 2: <ul style="list-style-type: none">Review clearing extent, blast vibration predictions, blast vibration monitoring levels and other natural factors (e.g. seasonal rainfall data) to determine if disturbance is as expectedConduct on-ground assessments as appropriateInvestigate potential MEZ remediation strategies	<ul style="list-style-type: none">Blast vibration monitoring for all blasts within 300 m of the potential diurnal/maternal Ghost Bat roosts as shown in Figure 1-7Annual land clearing reconciliation against potential Northern Quoll denning habitat in the MEZs of Mesas A, B and CTemperature and humidity monitoring in diurnal/maternal Ghost Bat roosts as shown in Figure 1-7	<ul style="list-style-type: none">The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS 1112If a trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions
Threshold criteria: 1. Permanent structural damage to potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7 OR 2. Disturbance, other than existing and authorised clearing ³ , within 40 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 2-2 OR 3. Disturbance of >10% of potential Northern Quoll denning habitat (comprising Breakaways and Gullies habitat and Rocky Slopes habitat) in the MEZ of Mesa A, B or C, excluding existing disturbance and disturbance authorised prior to grant of MS 1112	Threshold criterion 1: <ul style="list-style-type: none">Review temperature and humidity monitoring data to determine if the roost cave microclimate has been compromisedIf the roost cave microclimate has been compromised from structural damage, remediate any noticeable new cave openings exposed pit-side Threshold criterion 2: <ul style="list-style-type: none">If exceedance of threshold criterion is considered likely to be attributable to the Proposal, remediate disturbance within 40 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves Threshold criterion 3: <ul style="list-style-type: none">If exceedance of threshold criterion is considered likely to be attributable to the Proposal, remediate disturbance to the MEZ	<ul style="list-style-type: none">As for trigger level monitoring with the addition of monitoring of the effectiveness of contingency actions	<ul style="list-style-type: none">Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being reported to the DWERThe environmental outcome will be reported against the threshold criterion for each calendar year in the ACARIf a threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact
Supporting ⁴ Northern Quoll monitoring parameters for the trigger and threshold criteria			
Northern Quoll monitoring	N/A	<ul style="list-style-type: none">Camera monitoring and annual field survey of Northern Quoll	N/A

³ Authorised clearing is as authorised in Table 2 of Schedule 1 of MS 1112

⁴ Parameters collected during annual surveys will assist in the interpretation of trigger and threshold criteria should an exceedance or trend be noted.

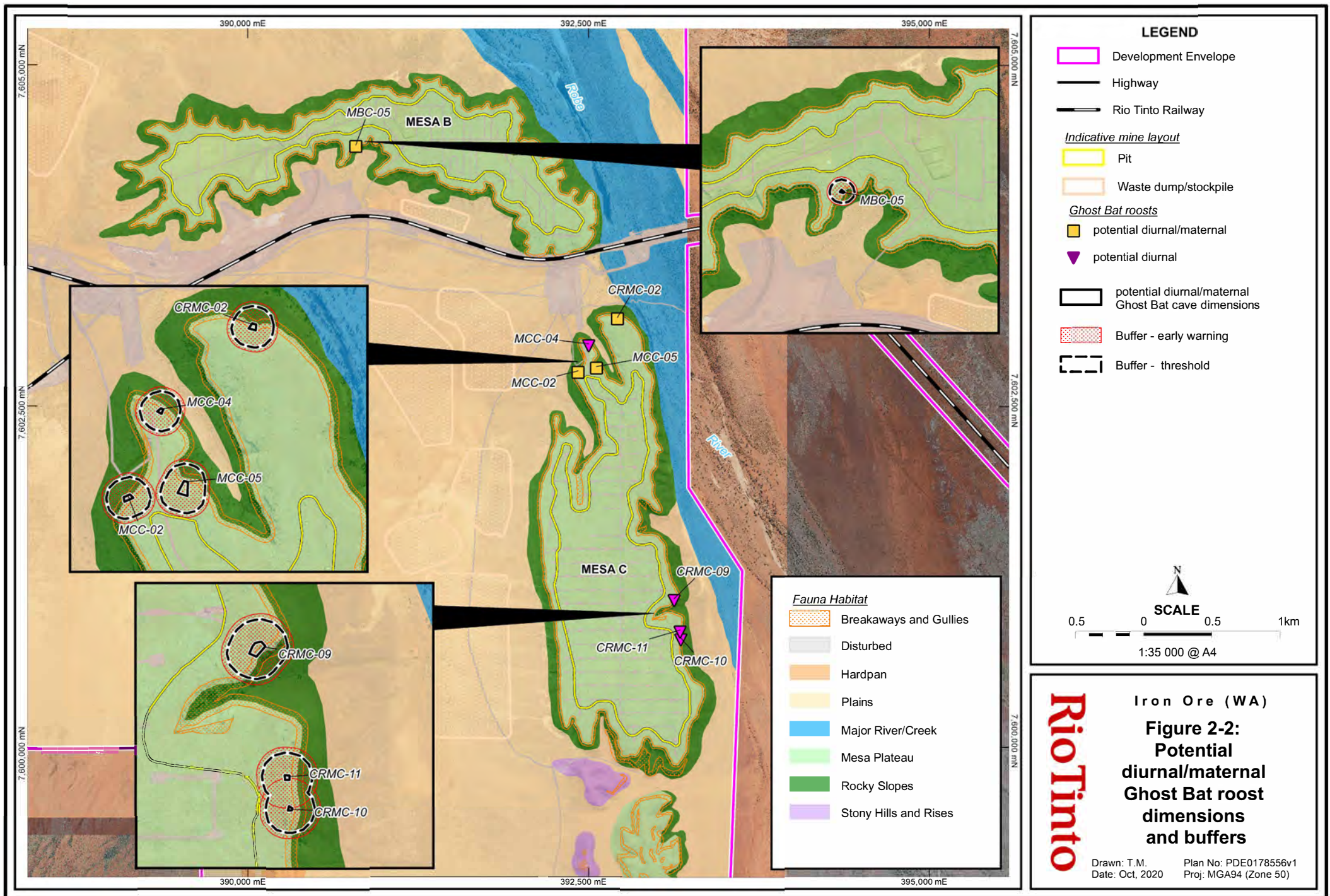


Table 2-4: EMP Provisions – Inland Waters (groundwater abstraction and riparian vegetation of the Robe River)

Inland Waters – Groundwater abstraction and/or dewatering and riparian vegetation of the Robe River			
EPA Objective: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected			
Key environmental values: Robe River including groundwater dependent riparian ⁵ vegetation			
Key impacts and risks: Potential adverse impacts on groundwater dependent vegetation as a result of dewatering of the Mesa C deposit.			
Outcome-based provisions			
Outcome: Ensure that groundwater levels are maintained to ensure there is no impact to the health of riparian vegetation of the Robe River, as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal			
Environmental criteria	Response actions	Monitoring	Reporting
<p>Trigger criteria:</p> <p>1. Robe River groundwater level trends adjacent to the Mesa C deposit are significantly different to trends in the broader locality or reference sites</p> <p>OR</p> <p>2. The area of decline below the MSAVI baseline 5th percentile⁶ for overstorey obligate phreatophytic canopy is 10% greater in the Robe River adjacent to the Mesa C deposit than in reference areas</p>	<p>All trigger criteria:</p> <ul style="list-style-type: none">Review local/regional reference data with regard to groundwater levels, trend in baseline groundwater levels and climatic information to assess if groundwater changes are due to natural variationReview groundwater abstraction rate, bore location and pumping biases in relation to extent of the cone of depression and the draw down at potential impact sites compared to predicted impacts on riparian vegetationReview local and regional reference data, including rainfall, temperature, flooding and fire regime, to assess if changes to vegetation are due to natural variation <p>If investigations indicate that trigger exceedance is due to the Proposal:</p> <ul style="list-style-type: none">Revise the hydrogeological conceptualisation in relation to the hydraulic barrier between the Mesa C CID aquifer and the Robe River alluvial aquiferRe-calibrate the analytical model based on the observed groundwater levels and generate revised groundwater draw down predictionsRe-consider potential environmental impacts in relation to any change in the hydrogeological conceptualisation and/or predicted groundwater abstraction <p>If warranted for trigger criterion 2:</p> <ul style="list-style-type: none">Undertake visual census of remote sensing imagery and review on-ground monitoring to confirm areas of exceedanceIf above step confirms exceedance, assess seasonal trends (e.g. with Sentinel imagery) and/or longer term and regional trends (e.g. with Landsat imagery)Review current trigger levels according to result of above investigation if necessaryIncrease frequency of monitoring to bi-annual if appropriate <p>If investigations indicate that trigger exceedance is due to the Proposal and may continue to be exceeded with no indication of recovery:</p> <ul style="list-style-type: none">Review contingency actions/strategyConsider mitigation options, for example:<ul style="list-style-type: none">Change rate of dewateringChange timing of dewateringUse variable speed dewatering bores if relevantRe-optimize dewatering bore/sumping and trenching configuration/locationsOther options as agreed with relevant stakeholders <p>Consult with the DWER if investigation indicates threshold criteria are likely to be exceeded</p>	<ul style="list-style-type: none">Monthly groundwater level monitoring in the Robe River while dewatering of the Mesa C deposit is occurring⁷Annual (dry season) or biannual as triggered (wet and dry season) assessment of overstorey canopy condition and cover using satellite imagery of the Robe River adjacent to Mesa C and upstream and downstream reference areas until dewatering of the Mesa C deposit ceasesAnnual (wet season) or biannual as triggered (wet and dry season) monitoring of composition, condition and cover of riparian vegetation (overstorey and understorey, including weed species) within selected⁸, established monitoring areas adjacent to Mesa C and upstream and downstream reference areas until dewatering of the Mesa C deposit ceases	<ul style="list-style-type: none">The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS 1112If a trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions

⁵ See Section 1.4.1 for more information regarding composition of riparian vegetation within the Robe River system

⁶ Refer to Appendix 2 for baseline values. The Proponent will update the criteria after baseline monitoring is complete, and as knowledge develops based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground-truthing.

⁷ Installation of low impact piezometers and groundwater bores to enable monitoring is subject to heritage and tenure constraints

⁸ The Proponent will determine 'selected' areas from established monitoring sites based on factors such as trigger outcome from annual survey and/or dewatering extent and volume. Locations may not always be available due to accessibility, weather or safety considerations.

Environmental criteria	Response actions	Monitoring	Reporting
<p>Threshold criterion:</p> <p>There is a significant decline since baseline in the number and/or a change in composition of native perennial species⁹ relative to reference sites and groundwater level trends are significantly different to regional trends or reference sites, within the Robe River adjacent to the Mesa C deposit as a result of groundwater abstraction and/or dewatering associated with the Proposal</p>	<p>If exceedance of threshold criterion is considered likely to be attributable to the Proposal implement contingency action/s as agreed during prior consultation with the DWER, for example:</p> <ul style="list-style-type: none">• Change rate of dewatering• Change timing of dewatering• Use variable speed dewatering bores if relevant• Re-optimize dewatering bore/sumping and trenching configuration/locations• Increase frequency and/or extent and/or duration of monitoring as appropriate• Monitor to ensure contingency actions are successful and review procedures, if appropriate	<ul style="list-style-type: none">• Monthly groundwater level monitoring while dewatering of the Mesa C deposit is occurring (or for a longer period as triggered)¹⁰• Annual (dry season) or biannual as triggered (wet and dry season) assessment of overstorey canopy condition and cover using satellite imagery in the Robe River adjacent to Mesa C and upstream and downstream reference areas until dewatering of the Mesa C deposit ceases (or for a longer period as triggered)• Annual (wet season) or biannual as triggered (wet and dry season) monitoring of composition, condition and cover of riparian vegetation (overstorey and understorey, including weed species) within selected, established monitoring areas adjacent to Mesa C and upstream and downstream reference areas until dewatering of the Mesa C deposit ceases (or for a longer period as triggered)	<ul style="list-style-type: none">• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being reported to the DWER• The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR• If the threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact

⁹ Significant decline in number of species ($\alpha=0.05$) and/or compositional change to species assemblage as measured during wet season monitoring

¹⁰ Installation of low impact piezometers and groundwater bores to enable monitoring is subject to heritage and tenure constraints

Table 2-5: EMP Provisions – Inland Waters (groundwater abstraction and riparian vegetation of Warramboo Creek)

Inland Waters – Groundwater abstraction and riparian vegetation of Warramboo Creek			
EPA objective: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected			
Key environmental values: Warramboo Creek including groundwater dependent riparian ¹¹ vegetation			
Key impacts and risks: Potential adverse impacts on groundwater dependent riparian vegetation as a result of groundwater abstraction from the Yarraloola aquifer			
Outcome-based provisions			
Outcome: No irreversible impact to the health of riparian vegetation of Warramboo Creek as a result of groundwater abstraction and/or dewatering associated with implementation of the Proposal.			
Environmental criteria	Response actions	Monitoring	Reporting
Early warning criteria: 1. Groundwater draw down equivalent to 1.5 m from baseline at the modelled 2 m draw down contour OR 2. The area of decline below the baseline MSAVI 5 th percentile ¹² for overstorey phreatophytic canopy is 10% greater within the potential impact area than in reference areas	<ul style="list-style-type: none">Review local/regional reference data with regard to surface water quality, groundwater quality, groundwater levels, trend in baseline groundwater levels and climatic information to assess if groundwater changes are due to natural variationReview groundwater abstraction rate, bore location and pumping biases in relation to extent of the cone of depression and the draw down at potential impact sites compared to predicted impacts on riparian vegetationReview local and regional reference data, including rainfall, temperature, flooding and fire regime, to assess if changes to vegetation are due to natural variation	<ul style="list-style-type: none">Monthly groundwater level monitoringAnnual (dry season) assessment of overstorey canopy condition and cover using satellite imagery within selected¹³, established monitoring areas	If the trigger or threshold criterion was exceeded during the reporting period, the ACAR will include review of early warning criteria, if relevant to the exceedance
Trigger criteria: 1. Groundwater draw down equivalent to 2 m from baseline at the modelled 2 m draw down contour OR 2. The area of decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy is 20% greater within the potential impact area than in reference areas OR 3. Significant decline in number and/or change in composition of native perennial species ¹⁴ within the potential impact area since baseline, in comparison to reference sites	<p>All trigger criteria:</p> <ul style="list-style-type: none">Review local/regional reference data with regard to surface water quality, groundwater quality, groundwater levels, trend in baseline groundwater levels and climatic information, to assess if groundwater changes are due to natural variationReview groundwater abstraction rate, bore location and pumping biases in relation to extent of the cone of depression and the draw down at potential impact sites compared to predicted impacts on riparian vegetationReview local and regional reference data, including rainfall, temperature, flooding and fire regime, to assess if changes to vegetation are due to natural variation <p>If warranted for trigger criterion 2:</p> <ul style="list-style-type: none">Undertake visual census of remote sensing imagery and review on-ground monitoring to confirm areas of exceedanceIf above step confirms exceedance, assess seasonal trends (e.g. with Sentinel imagery) and/or longer term and regional trends (e.g. with Landsat imagery)Review current trigger levels according to result of above investigation if necessary <p>If investigations indicate that trigger exceedance is due to the Proposal and may continue to be exceeded with no indication of recovery:</p> <ul style="list-style-type: none">Review contingency actions/strategyConsider mitigation options, for example:<ul style="list-style-type: none">Change rate of abstractionRe-optimize the pumping operating strategy away from the impacted areasProvide temporary supplementary irrigation to high value stands of vegetationOptimise surplus water discharge outlet location to support recovery/reduce impact to high value stands of vegetationPassive rechargeOther options as agreed with relevant stakeholdersConsult with the DWER if investigation indicates threshold criteria are likely to be exceeded	<ul style="list-style-type: none">Monthly groundwater level monitoringAnnual (dry season) assessment of overstorey canopy condition and cover using satellite imagery within selected, established monitoring areasAnnual (wet season) monitoring of condition, cover and health of riparian vegetation (overstorey and understorey, including weed species) within selected, established monitoring areas	<ul style="list-style-type: none">The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS 1112If a trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions

¹¹ See Section 1.4.1 for more information regarding composition of riparian vegetation within the Warramboo Creek system.

¹² Refer to Appendix 2 for baseline values. The Proponent will update the criteria after baseline monitoring is complete, and as knowledge develops based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground-truthing.

¹³ The Proponent will determine 'selected' areas from established monitoring areas based on factors such as trigger and threshold outcome from annual survey and or dewatering extent and volume. Locations may not always be available due to accessibility, weather conditions, safety considerations etc.

¹⁴ Significant decline in number of species ($\alpha=0.05$) and/or compositional change to species assemblage

Environmental criteria	Response actions	Monitoring	Reporting
<p>Threshold criteria:</p> <p>1. Decline below the baseline MSAVI 5th percentile for overstorey phreatophytic canopy over 50% of potential impact area¹⁵; trend continues over two or more consecutive dry season monitoring events; with no evidence of seasonal recovery; and outside of historical baseline variation, in comparison to reference sites</p> <p>OR</p> <p>2. Over 50% of the potential impact area displays significant structural or compositional change¹⁶ to riparian vegetation since baseline, in comparison to reference sites</p>	<p>If exceedance of threshold criterion is considered likely to be attributable to the Proposal implement contingency action/s as agreed during prior consultation with the DWER, for example:</p> <ul style="list-style-type: none">• Change rate of abstraction• Re-optimize the pumping operating strategy away from the impacted areas• Provide temporary supplementary irrigation to high value stands of vegetation• Optimize surplus water discharge outlet location to support recovery/reduce impact to high value stands of vegetation• Passive recharge• Increase frequency and/or extent of monitoring as appropriate• Monitor to ensure contingency actions are successful and review procedures, if appropriate	<ul style="list-style-type: none">• Annual (dry season) assessment of overstorey canopy condition and cover using satellite imagery within selected¹⁷, established monitoring areas• Annual (wet season) condition, cover and health of riparian vegetation (overstorey and understorey, including weed species) within selected, established monitoring areas	<ul style="list-style-type: none">• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being reported to the DWER• The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR• If a threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact

¹⁵ Refer to Appendix 2 for baseline values. The Proponent will update the criteria after baseline monitoring is complete, and acknowledge developments based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground-truthing.

¹⁶ Change from baseline of i) two or more structural formation classes applied to National Vegetation Information System (NVIS) Level IV sub-formation, classes (ESCAVI 2003 and see Appendix 3), due to decreased or increased cover of native or weed species or ii) loss of species listed as dominant at baseline within any of the upper, mid or ground vegetation strata (dominant species listed in Table 1-4)

¹⁷ The Proponent will determine 'selected' areas from established monitoring areas based on factors such as trigger and threshold outcome from annual survey and dewatering extent and volume. Locations may not always be available due to accessibility, weather conditions, safety considerations etc.

Table 2-6: EMP Provisions – Inland Waters (surplus water discharge and riparian vegetation of Warramboo Creek)

Inland Waters – Surplus water discharge and riparian vegetation of Warramboo Creek			
EPA Objective: To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected. Key environmental values: Warramboo Creek including riparian ¹⁸ vegetation Key impacts and risks: Potential adverse impacts on riparian vegetation as a result of surplus water discharge to Warramboo Creek			
Outcome-based provisions			
Outcome: No irreversible impact to the health of riparian vegetation of Warramboo Creek as a result of surplus water discharge associated with implementation of the Proposal			
Environmental criteria	Response actions	Monitoring	Reporting
Early warning criteria: 1. Surface water expression present ≥ 6km downstream of the discharge point in Warramboo Creek under natural no-flow conditions OR 2. The area of decline below the baseline MSAVI 5 th percentile ¹⁹ for overstorey phreatophytic canopy is 10% greater within the potential impact area than in reference areas	Review discharge regime, frequency, extent and timing in relation to predicted surface water extent	<ul style="list-style-type: none">Monthly monitoring of surface water expression during periods of dischargeAnnual assessment of overstorey canopy condition and cover (dry season) using satellite imagery within selected²⁰, established monitoring areas	If the trigger or threshold criterion was exceeded during the reporting period, the ACAR will include review of early warning criteria, if relevant to the exceedance
Trigger criteria: 1. The area of decline below the baseline MSAVI 5 th percentile ¹⁹ for overstorey phreatophytic canopy is 20% greater within the potential impact area than in reference areas OR 2. Significant decline ²¹ in number and/ or change in composition of native perennial species within the potential impact area since baseline, in comparison to reference sites OR 3. Establishment of new high priority weed species at a potential impact site and/or downstream of the discharge extent, previously not detected within the Development Envelope ²²	<p>All trigger criteria:</p> <ul style="list-style-type: none">Review discharge regime, frequency, extent and timing in relation to predicted impacts on riparian vegetationReview supporting water quality data for surplus discharge and monitoring and production bores (conducted under the Groundwater Operating Strategy)Review local and regional reference data including rainfall, temperature, flooding and fire regime <p>If warranted for trigger criterion 1:</p> <ul style="list-style-type: none">Undertake visual census of remote sensing imagery and review on-ground monitoring to confirm areas of exceedanceIf above step confirms exceedance assess seasonal trends (e.g. with Sentinel imagery) and/or longer term and regional trends (e.g. with Landsat imagery)Review current trigger levels according to result of above investigation if necessary <p>If warranted for trigger criterion 2:</p> <ul style="list-style-type: none">Review data to determine if there has been a significantly increased extent of weed species within the discharge extentIf data indicate increased establishment of weed or other mesophytic species, analyse remote sensing to determine extent of increased vegetation cover <p>If warranted for trigger criterion 2 and 3:</p> <ul style="list-style-type: none">Review weed species' presence and abundance. Internally record, report, map and monitor. Investigate the risk of the weed species becoming dominantReview weed hygiene practicesImplement weed management controls where required, considering priority rating of species, size and location of target population and feasibility of control <p>If investigations indicate that trigger exceedance is due to the Proposal and may continue to be exceeded with no indication of recovery:</p> <ul style="list-style-type: none">Review contingency actions/strategy, including potential modification to surplus water management and discharge regimeIf trigger 2 exceedance is due to competitive impacts from augmentation of some species, implement management controls (e.g. mechanical removal) as appropriateConsult with the DWER if investigation indicates threshold criterion is likely to be exceeded	<ul style="list-style-type: none">Annual assessment of overstorey canopy condition and cover (dry season) using satellite imagery within selected, established monitoring areasAnnual (wet season) condition, cover and health of riparian vegetation (overstorey and understorey, including weed species) within selected, established monitoring areas	<ul style="list-style-type: none">The environmental outcome will be reported against the trigger criteria for each calendar year by 30 April in the ACAR for MS 1112If a trigger criterion was exceeded during the reporting period, the ACAR will discuss potential reasons for exceedance of the trigger criterion and include a description of the effectiveness of trigger level actions

¹⁸ See Section 1.4.1 for more information regarding composition of riparian vegetation within the Warramboo Creek system.

¹⁹ Refer to Appendix 2 for baseline values. The Proponent will update the criteria after baseline monitoring is complete, and acknowledge developments based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground-truthing.

²⁰ The Proponent will determine 'selected' areas from established monitoring areas based on factors such as trigger and threshold outcome from annual survey and discharge extent. Locations may not always be available due to accessibility, weather conditions, safety consideration etc.

²¹ Significant decline in number of species ($\alpha=0.05$), or compositional change to species assemblage.

²² Refer to Appendix 1 for a list of weed species previously recorded in the Development Envelope

Environmental criteria	Response actions	Monitoring	Reporting
<p>Threshold criteria:</p> <p>1. Decline below the baseline MSAVI 5th percentile²³ for overstorey phreatophytic canopy over 50% of potential impact area; trend continues over two or more consecutive dry season monitoring events; with no evidence of seasonal recovery; and outside of historical baseline variation, in comparison to reference sites</p> <p>OR</p> <p>2. Over 50% of the potential impact area displays significant structural or compositional change²⁴ to riparian vegetation since baseline, in comparison to reference sites</p>	<p>If exceedance of threshold criterion is considered likely to be attributable to the Proposal implement contingency action/s as agreed during prior consultation with the DWER, for example:</p> <ul style="list-style-type: none">• Change of surplus water discharge regime• Temporary use of alternative discharge location (subject to additional approval by the DWER if required)• Temporary use of in-pit surplus water disposal/passive recharge• If threshold exceedance is due to increased cover of weeds or other species augmented due to discharge, undertake additional control measures as warranted• Increase frequency and/or extent of monitoring as appropriate• Monitor to ensure contingency actions are successful and review procedures, if appropriate	<ul style="list-style-type: none">• Annual (dry season) assessment of overstorey canopy condition and cover using satellite imagery within selected²⁵, established monitoring areas• Annual (wet season) condition, cover and health of riparian vegetation (overstorey and understorey, including weed species) within selected, established monitoring areas	<ul style="list-style-type: none">• Notify the DWER within 7 days of the non-compliance being known and provide a report within 21 days of the non-compliance being reported to the DWER• The environmental outcome will be reported against the threshold criterion for each calendar year in the ACAR• If a threshold criterion was exceeded during the reporting period, the ACAR will include a description of the effectiveness of threshold contingency action/s that have been implemented to manage the potential impact

²³ Refer to Appendix 2 for baseline values. The Proponent will update the criteria after baseline monitoring is complete, and acknowledge developments based on empirical observations of tree health and/or improvements in monitoring methodology. MSAVI is the current index used, an alternative index may be used in the future subject to advances in remote sensing. Canopy decline evident from satellite imagery will be confirmed and further investigated with ground-truthing.

²⁴ Change from baseline of i) two or more structural formation classes applied to National Vegetation Information System (NVIS) Level IV sub-formation, classes (ESCAVI 2003 and see Appendix 3), due to decreased or increased cover of native or weed species or ii) loss of species listed as dominant at baseline within any of the upper, mid or ground vegetation strata

²⁵ The Proponent will determine 'selected' areas from established monitoring based on factors such as trigger and threshold outcome from annual survey and discharge extent. Locations may not always be available due to accessibility, weather conditions, safety consideration etc.

2.1.2 Monitoring

Monitoring will be undertaken to measure performance against the environmental outcomes and to assess the effectiveness of management actions in meeting management-based objectives. Monitoring will inform, through the environmental criteria, when trigger or threshold contingency actions will be implemented. A missed monitoring event will not be treated as a non-compliance provided the Proponent can validate that the required environmental outcome or management objective has still been achieved, for example through the use of alternative data.

a) Flora and Vegetation (Sand Sheet PEC)

Annual quadrat monitoring of the Sand Sheet PEC has been conducted since 2008. Historically, visual assessment at quadrats, dust monitoring data, visual dust cover rankings, leaf chlorophyll fluorescence and remote sensing have been utilised to assess changes to vegetation condition (Biota 2016, Astron 2018a). The Proponent will continue to undertake field-based quadrat monitoring as this is currently the most suitable approach for monitoring community structure and species diversity (native and weed) and, therefore, the overall condition of the Sand Sheet PEC. Remote sensing analysis has formed part of previous monitoring and will continue to be undertaken to enable comparison of any broad scale vegetation changes in the Sand Sheet PEC compared with reference vegetation types. This EMP, therefore, includes a predominantly field-based monitoring program that builds upon previously collected monitoring data by incorporating parameters from the historical quadrat monitoring and field observations.

It is recognised that the condition of the Sand Sheet PEC is influenced by local environmental conditions, including rainfall and fire, that may result in natural variation in the monitoring results. There are limited baseline data available for the Sand Sheet PEC and identified reference sites are limited in that whilst they share some characteristics, they are not completely representative of the species and structure of the Sand Sheet PEC. These two factors constrain the consideration of local environmental conditions when analysing the Sand Sheet monitoring data.

Monitoring potential direct disturbance to the Sand Sheet PEC (criterion 1) will involve reconciliation of the Geographical Information System (GIS) disturbance layers against the Sand Sheet PEC boundaries and the area within 20 m of the Sand Sheet PEC boundaries on an annual basis.

The Proponent has well established strategies for monitoring and management of the risk of weed ingress at its Pilbara operations. The Proponent will continue to implement hygiene procedures to prevent introduction of new or additional populations of weed species at entry and exit points of the Development Envelope and to undertake a weed control program to minimise weed infestations in the Development Envelope. Monitoring the potential introduction of weed species into the Sand Sheet PEC (trigger criteria 2 and 3) will involve:

- Annual transect monitoring to determine the presence of any new high priority weed species within the Sand Sheet PEC
- Annual quadrat monitoring to determine the presence and percentage foliage cover of weed species (further details are provided below).

This monitoring will also supply information relevant to the management-based provisions listed in Table 2-1.

Annual assessment of vegetation condition and cover in the Sand Sheet PEC will be conducted using remote sensing. The Normalised Difference Vegetation Index (NDVI) has been used for analysis of remote sensing data for the Sand Sheet PEC to date as suitable data are available for this index for all data capture dates. An alternative index may be used in the future if considered suitable. Recent and historical changes in NDVI will be quantified for example by using per-pixel raster subtraction between various capture dates. Changes in NDVI at the Sand Sheet quadrats and within the broader Sand Sheet community will then be analysed and verified where applicable during the annual quadrat monitoring.

Annual quadrat monitoring of the Sand Sheet PEC will include:

- Vegetation description
- Habitat description
- Soil description
- Disturbance notes
- Species present (natives and weeds)
- Percentage foliage cover for each species (recorded as a number, not a category/class)
- Height (cm) for each species
- Dust cover (visual rating)
- Photograph (from the NW corner)

Data analysis will include calculation of species richness, with a focus on changes to key species in the Sand Sheet PEC as well as weed species. Analysis will aim to assess changes between monitoring surveys and if changes are detected, further analysis will be completed to determine if different/similar patterns of change are occurring in the reference sites.

Annual transect monitoring of the Sand Sheet PEC will be conducted to align with the annual quadrat monitoring. Transects will be established in key areas (e.g. drainage lines and areas surrounding previously recorded weed populations) within the Sand Sheet PEC and reference areas to the south of the Sand Sheet PEC. Weed species only, along the transects, will be recorded and numbers estimated within a fixed area.

Targeted monitoring may also be required where a trigger criterion is met. This may include, foot traverses and observations to determine the extent of the change, mapping of weed infestations and assessment of vegetation condition.

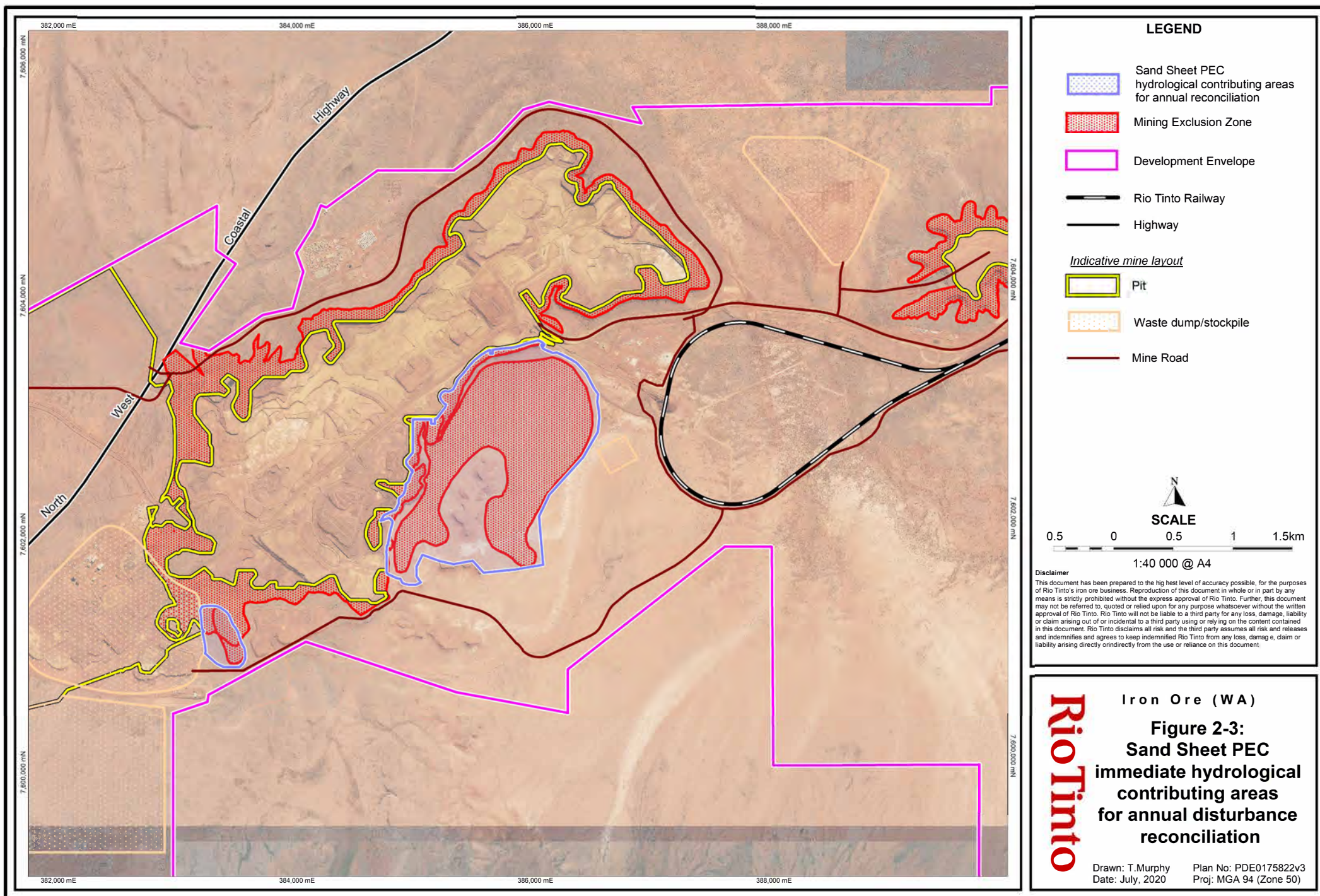
Monitoring placement of infrastructure to avoid affecting surface water flow to the Sand Sheet PEC will involve reconciliation of the GIS disturbance layers against the Sand Sheet PEC immediate hydrological contributing area boundary (Figure 2-3). Hydrological assessment of any new disturbance in the immediate hydrological contributing area will be undertaken to establish if surface water flows to the Sand Sheet PEC may be affected as a result of the disturbance.

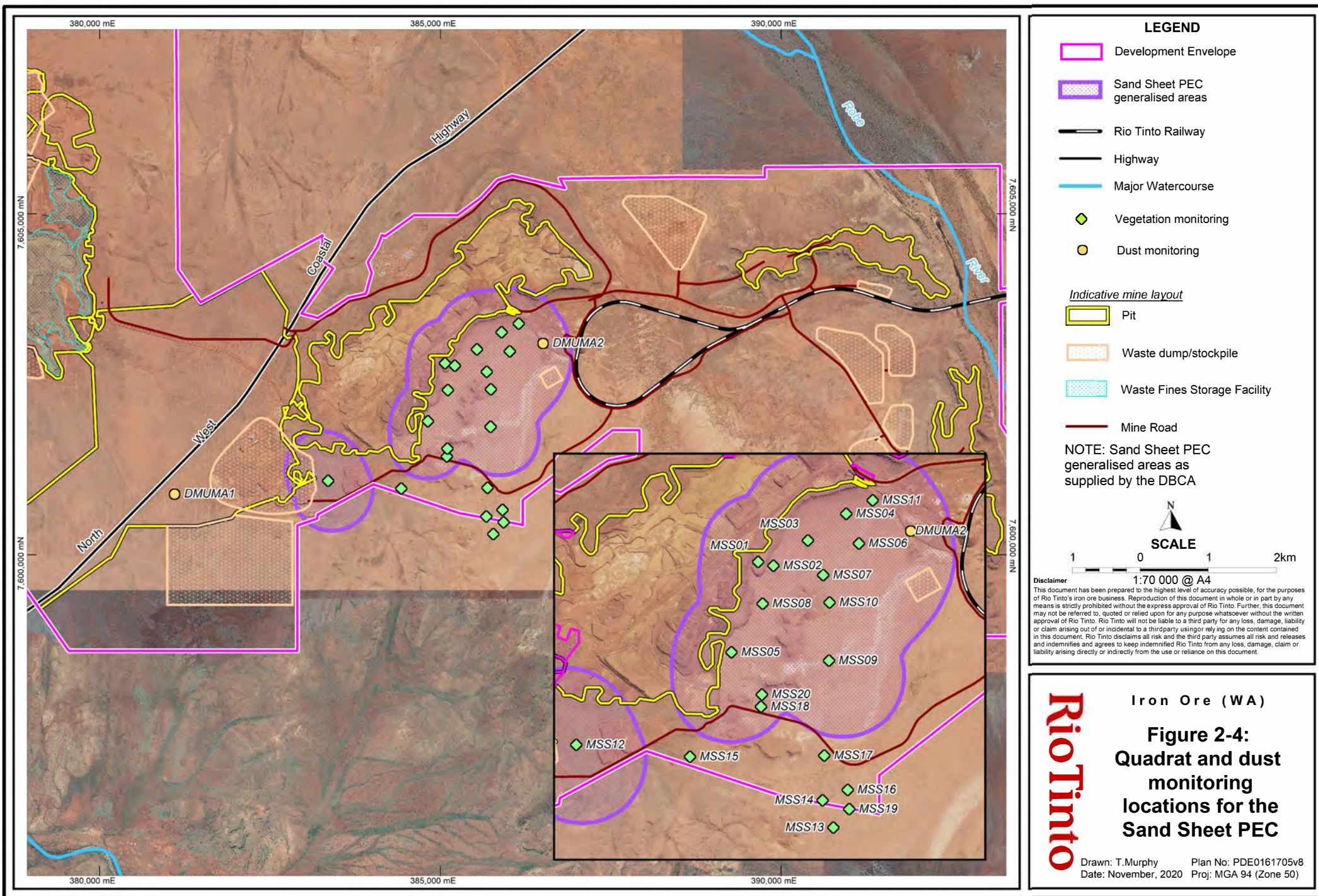
Table 2-7 summarises the monitoring required to measure performance against the environmental outcome and to assess the effectiveness of management actions in meeting the management-based objective.

Table 2-7: Monitoring required to evaluate performance against the environmental outcome and to assess the effectiveness of management actions for the Sand Sheet PEC

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Land clearing reconciliation (trigger criterion 1, threshold criterion 1 and management target 3 in Table 2-1)	Sand Sheet PEC	Annual during operational mine life	GIS avoidance and disturbance layers. Sand Sheet PEC immediate hydrological contributing area boundaries (Figure 2-3). Internal approvals request process.	Operations Environment team
Weed transect monitoring (trigger criterion 2 and threshold criterion 2 in Table 2-1)	Sand Sheet PEC and reference areas	Annual transect monitoring for weed species during operational mine life (completed with quadrat monitoring) ¹	Transect monitoring (number and locations of weed species) in Sand Sheet PEC and reference transects to detect new high priority weed species.	Operations Environment team
Quadrat monitoring of the Sand Sheet PEC (trigger criterion 3, threshold criterion 2 and management targets 1 and 2 in Table 2-1)	Monitoring sites MSS01-MSS12 Reference sites MSS13-MSS20 (Figure 2-4) Sand Sheet PEC for remote sensing	Annual quadrat monitoring during operational mine life Annual remote sensing of the Sand Sheet PEC	Quadrat monitoring (percentage foliage cover, presence and height of all species within quadrat, assessment of native species richness between reference and Sand Sheet quadrats). Weed species presence and abundance. Vegetation disturbance, visual assessment of vegetation condition and visual dust cover. Annual assessment of vegetation using remote sensing of the Sand Sheet PEC.	Operations Environment team

¹ Weed monitoring transects to be established in 2021





b) Priority 1 flora (*Abutilon* sp. Onslow (F. Smith s.n. 10/9/61))

The Proponent will utilise GIS records to monitor clearing of individuals of *Abutilon* sp. Onslow (F. Smith s.n. 10/9/61) within the Warrambo Borefield extension area. The number of impacted individuals will be compared to the total known records from the Rio Tinto database (inside and outside the Development Envelope) to estimate the proportion of individuals impacted. It is recognised that the presence of individuals and the total known records may be influenced by disturbance (potentially promoting germination), rainfall (i.e. lower rainfall inhibiting germination and higher rainfall promoting germination) and additional survey effort (increasing the known number of records).

Table 2-8 summarises the monitoring required to measure performance against the environmental objective, and to assess the effectiveness of management actions in meeting the management-based objective.

Table 2-8: Monitoring required to assess the effectiveness of management actions for the Priority 1 flora

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Land clearing reconciliation (management target 1 in Table 2-2)	Warrambo Borefield extension area	Annual during operational mine life while taxon is listed as Priority 1	Annual land clearing reconciliation of impacted individuals against known records, utilising GIS layers	Operations Environment team
Weed monitoring (management target 2 in Table 2-2)	<i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) weed monitoring areas as depicted in Figure 2-1	Annual (wet season) during operational mine life while taxon is listed as Priority 1	Weed monitoring transect in each of the weed monitoring areas depicted in Figure 2-1 (i.e. four transects in total) ¹	Operations Environment team

¹ Weed monitoring transects to be established in 2021

c) Terrestrial Fauna (Ghost Bat)

Protection of high value habitat for the Ghost Bat is the most appropriate strategy to protect this conservation significant fauna within the Development Envelope. High value habitat for the Ghost Bat includes the escarpment and cave structures associated with mesa formations in the Robe Valley. Early warning, trigger and threshold criteria have been applied to potential diurnal/maternal roosts, as diurnal/maternal roosts are recognised as geographically restricted and ecologically important. Baseline monitoring of the potential diurnal/maternal roost caves (MBC-05, MCC-02, MCC-04, MCC-05, CRMC02, CRMC09, CRMC10, CRMC11) will continue to be undertaken prior to commencement of mining. Additional data from longer term monitoring of these caves may indicate that a different status, and potentially a different level of management, may be appropriate for these caves; this may require revision of the EMP.

Vibration levels will be measured at the potential diurnal/maternal Ghost Bat roost caves at Mesas B and C for all blasts within 300 m of the recorded potential diurnal/maternal roosts. Ensuring the vibration levels at the potential diurnal/maternal roosts remain below a peak particle velocity determined for each cave reduces the risk that vibrations compromise the structural integrity of the roosts. Annual land clearing reconciliation using GIS disturbance layers will also be undertaken to monitor disturbance close to the potential diurnal/maternal roost caves.

Temperature and humidity in the potential diurnal/maternal roost caves at Mesas B and C will be monitored on a continuous basis, and calibrated with ambient temperature and humidity. This approach is to support the above described monitoring actions to verify that blasting and mine pit

development within adjacent pits do not inadvertently generate new openings at the back of the potential diurnal/maternal roost caves which may change the cave microclimate.

Table 2-9 summarises the monitoring required to measure performance against the environmental outcome under MS 1112. Monitoring requirements for the Ghost Bat to meet conditions of EPBC Act approval 2016/7843 are provided in Table 2-13 and Table 2-15.

Table 2-9: Monitoring required to evaluate performance against the environmental outcome under MS 1112 for the Ghost Bat

Monitoring action	Location ¹	Frequency and timing	Data collection method and analysis	Responsible
Vibration levels (trigger criterion 1 in Table 2-3)	Caves MBC-05, MCC-02, MCC-04, MCC-05, CRMC02, CRMC09, CRMC10, CRMC11 (Figure 1-7)	For all blasts within 300m of caves MBC-05, MCC-02, MCC-04, MCC-05, CRMC02, CRMC09, CRMC10, CRMC11	Modelling of peak particle velocity prior to blast. Vibration monitoring of actual peak particle velocity. Analysis of modelled versus actual peak particle velocity.	Drill and Blast team
Land clearing reconciliation (early warning criterion and threshold criterion 2 in Table 2-3)	Caves MBC-05, MCC-02, MCC-04, MCC-05, CRMC02, CRMC09, CRMC10, CRMC11 (Figure 1-7)	Annual during operational mine life	GIS avoidance and disturbance layers. Internal approvals request process.	Operations Environment team
Temperature and humidity monitoring (threshold criterion 1 in Table 2-3)	Caves MBC-05, MCC-02, MCC-04, MCC-05, CRMC02, CRMC09, CRMC10, CRMC11 (Figure 1-7)	Ongoing (continuous ²) during operational mine life	Temperature and humidity logging and data analysis correlated against reference sites and ambient temperature and humidity; and timing of mine pit development / blasting data in adjacent pits as appropriate.	Operations Environment team

¹ Access subject to safety and heritage assessments of caves

² Continuous monitoring except where downtime is experienced e.g. due to periodic maintenance or equipment failure

d) Terrestrial Fauna (Northern Quoll)

Protection of high value habitat for the Northern Quoll is the most appropriate strategy to protect this conservation significant fauna within the Development Envelope. High value denning habitat for the Northern Quoll in the Robe Valley includes the Breakaways and Gullies habitat and the Rocky Slopes habitat on the mesa escarpments. Trigger and threshold criteria for disturbance to potential Northern Quoll denning habitat in the MEZs of Mesas A, B and C will be applied.

An annual field survey of Northern Quoll and camera monitoring will be undertaken as supporting monitoring. Offset actions, including Northern Quoll monitoring, were implemented between 2016 and 2019 (inclusive) on parts of Yarraloola Station as part of the approved Yandicoogina Threatened Species Offset Plan (TSOP). Yarraloola Pastoral Station underlies and surrounds part of the Development Envelope. Trapping protocols for the annual field survey will be based on the protocols established as part of the TSOP so that data from the two programs are comparable. However, separate trapping sites will be established since sites shared with any continuation of the TSOP program would likely result in trapping being conducted twice per year at the same sites in

close succession, potentially resulting in negative behavioural effects on Northern Quoll and biased data. Frequent trapping at the same site may also attract predators, particularly cats, to that site, which would also impact data.

Four trapping sites will be established at the indicative locations shown in Figure 2-5. Each site will be established, where possible, in preferred Northern Quoll habitat (Breakaways and Gullies habitat, particularly where the habitat abuts a major drainage system). Trapping will be completed annually between May and September during the operational mine life.

Camera monitoring will provide supplementary data to the trapping program; in particular presence data for Northern Quoll and its main predator, cats. Seven long-term camera monitoring sites will be established in the western part of the Robe Valley (nominally in the vicinity of Mesa B, Mesa C, Mesa F and Mesa G). The program will utilise two cameras at each site as this will provide stronger presence/absence data than would be achieved through deployment of a single camera at each site. The EPBC Act referral guideline for the Northern Quoll (DotE 2016) states that baiting cameras for more than five consecutive nights may impact animal behaviour. Due to the ethics requirements, use of baited camera traps is not included in the Northern Quoll monitoring program. However, non-consumable baits or alternate attracting methods may be used if considered appropriate and animal ethics approval has been granted as required.

Camera sites will be primarily located in the Breakaways and Gullies habitat type (as this is considered to be the preferred habitat type for the Northern Quoll). However, sites will also be located in the Mesa Plateau, Hills and Plains habitat types to contribute to a broader understanding of Northern Quoll habitat utilisation. Indicative monitoring site locations are shown in Figure 2-5 and described below:

- Four sites (Mesa B, Mesa C, Mesa F and Mesa G) in Breakaways and Gullies habitat abutting a major drainage line;
- One site (likely at Mesa G) in Mesa Plateau habitat;
- One site (likely north-east of Mesa B) in Hills habitat type; and
- One site (likely east of Mesa B/Mesa C) in Plains habitat type

Camera monitoring will be undertaken annually for four months in the period April to September. This timing has been selected to match the ecology of the species and to minimise equipment failure due to high temperatures and cyclonic events.

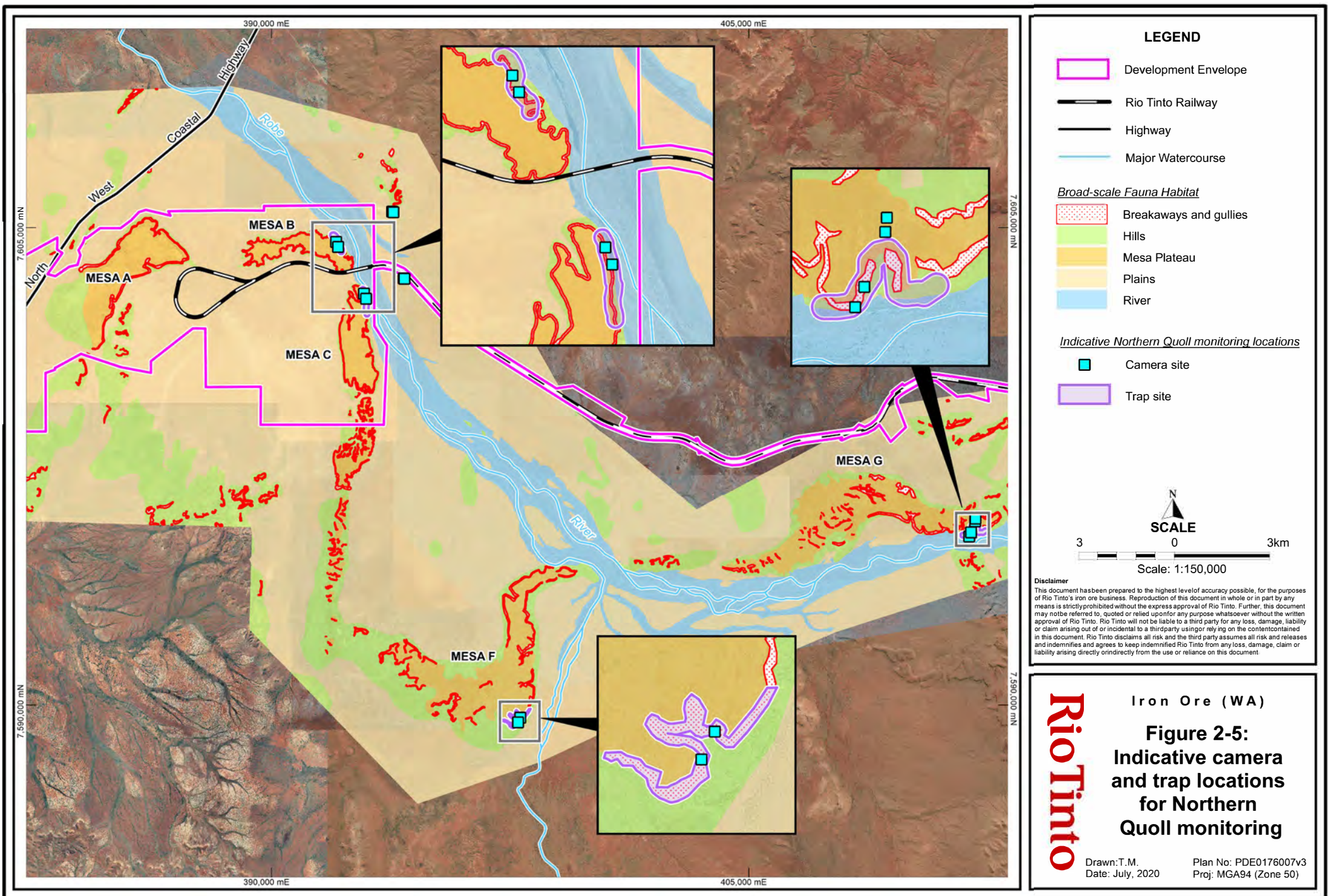
Table 2-10 summarises the monitoring required to measure performance against the environmental outcome and the supporting field monitoring that will be undertaken. The Northern Quoll monitoring program will be reviewed after 3 years of monitoring to enable changes or additions to be made to the program based on the data collected.

Table 2-10: Monitoring required to evaluate performance against the environmental outcome for the Northern Quoll

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Land clearing reconciliation (trigger criterion 2 and threshold criterion 3 in Table 2-3)	Potential Northern Quoll denning habitat in the MEZs of Mesas A, B and C	Annual during the operational mine life	MEZ GIS layer. Internal approvals request process.	Operations Environment team
Annual field survey and camera monitoring (supporting monitoring in Table 2-3) ¹	<p>4 trap monitoring sites in the indicative locations shown in Figure 2-5.</p> <p>7 long-term camera monitoring sites (2 cameras at each site) in the indicative locations shown in Figure 2-5.</p>	<p>Annual field trapping (May– September) during operational mine life</p> <p>Camera monitoring conducted annually for 4 months between April and September² during operational mine life</p>	<p>Trapping</p> <p>Camera monitoring</p>	Operations Environment team

¹ Monitoring frequency, type of monitoring and monitoring sites will be reviewed after 3 years of monitoring.

² Continuous monitoring for 4 months except where downtime is experienced e.g. due to periodic maintenance or equipment failure



d) Inland Waters and riparian vegetation

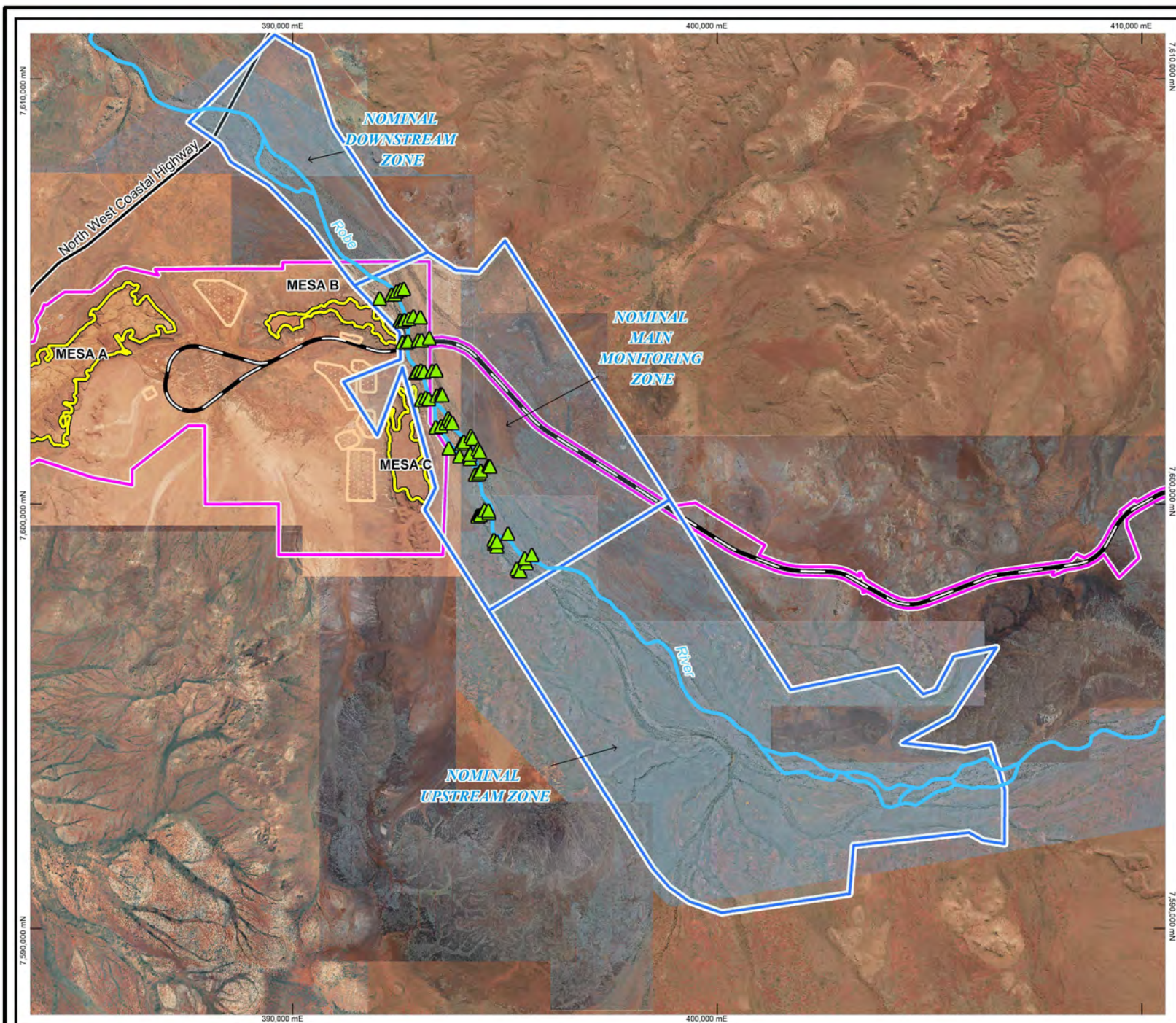
The Proponent will monitor the health of riparian vegetation of the Robe River and Warrambo Creek both within the area of potential impact from groundwater drawdown and surplus water discharge and at reference sites (Figure 2-6 and Figure 2-7).

The effects of groundwater drawdown on facultative and obligate phreatophytes are dependent upon both the historical groundwater level and the rate of groundwater drawdown. For example, trees accessing shallow, stable groundwater may be more sensitive to groundwater drawdown than trees growing above a fluctuating groundwater table at greater depth. While it is inherently difficult to interpolate local groundwater table elevation from limited data and hence predict groundwater dependence of local phreatophytes, monitoring the cover of the upper canopy provides an indicator of stress either due to groundwater drawdown or due to surplus water discharge. The health of phreatophytic species along the Robe River and Warrambo Creek will, therefore, be monitored utilising remote sensing with supporting field-based surveys. Due to the difficulty of distinguishing phreatophytic riparian tree species using remote sensing, the phreatophytic assemblages of Warrambo Creek will be treated as a functional group 'riparian overstorey' for trigger and threshold criteria. Detailed vegetation mapping of the Robe River (2017) will be used to monitor the response of obligate phreatophytic communities separately to other riparian vegetation.

The Proponent will monitor the health of obligate and facultative phreatophytic vegetation of the Robe River and Warrambo Creek using remote sensing to ensure there are no significant changes to health beyond natural variation. The technique for monitoring riparian trees using remote sensing imagery has been established and refined in recent years (Astron 2018c) involving capture of high spatial resolution satellite imagery and automated delineation (segmentation) of canopies of the riparian tree species. Imagery is routinely captured across time series towards the end of the dry season, which coincides with the period in which trees are under greatest stress and when the contrast between the greenness of the tree canopy and lower storey canopy is more discernible. Values of a spectral index that are positively related to canopy health, the MSAVI (or similar indices) are extracted from the delineated canopy polygons (segments). The MSAVI (or similar indices) provide a representation of the cover and photosynthetic vigour of vegetation, by assessing the ratio of red and near-infra red radiation wavelengths. Changes can, therefore, be used to provide a meaningful indication of vegetation condition and stress. A time series of MSAVI values from the baseline period to the latest date is then used to monitor the condition of riparian tree canopy for the management zones and comparisons made to reference zones, alongside correlative parameters including rainfall, water levels and fire. The large coverage of canopy captured in remote sensing will accommodate assessment of potential relationships between dewatering and vegetation condition across the entire riparian zone, overcoming some of the limitations of field-based assessment. If changes are detected from the annual capture of high resolution imagery, these will be investigated further, by looking at longer term data-sets (e.g. Sentinel and Landsat imagery) and including ground-truthing of any areas of decline evident in imagery, to assess seasonal changes and determine if changes are outside long-term natural variation. However, some of these data are captured at coarse spatial scales so cannot be used to look at individual canopy scale changes. The methodology for measuring phreatophytic canopy health will be reviewed and may be revised if appropriate (in consultation with the DWER), as advances in remote sensing technology and improvements in analysis techniques occur.

The condition, composition, cover and health of riparian vegetation (understorey and overstorey, including weed species) will be monitored annually via qualitative field assessment. The monitoring program includes an annual (post-wet season) survey of defined monitoring sites, established during baseline surveys. Health of riparian overstorey captured during remote sensing will be supported by parameters (e.g. overstorey taxa, number of individual species, health) captured during the field monitoring survey for understorey health. The riparian monitoring transects and remote sensing capture areas established during baseline monitoring are shown in Figure 2-6 and Figure 2-7 for the Robe River and Warrambo Creek respectively.

The monitoring to be undertaken is summarised in Table 2-11.



LEGEND

Riparian vegetation monitoring transects from which a subset will be selected for EMP monitoring

Remote sensing capture areas

Development Envelope

Major Watercourse

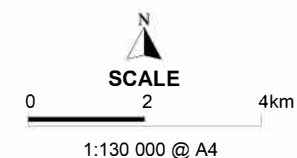
Highway

Rio Tinto Railway

Indicative mine layout

Pit

Waste dump/stockpile



Disclaimer

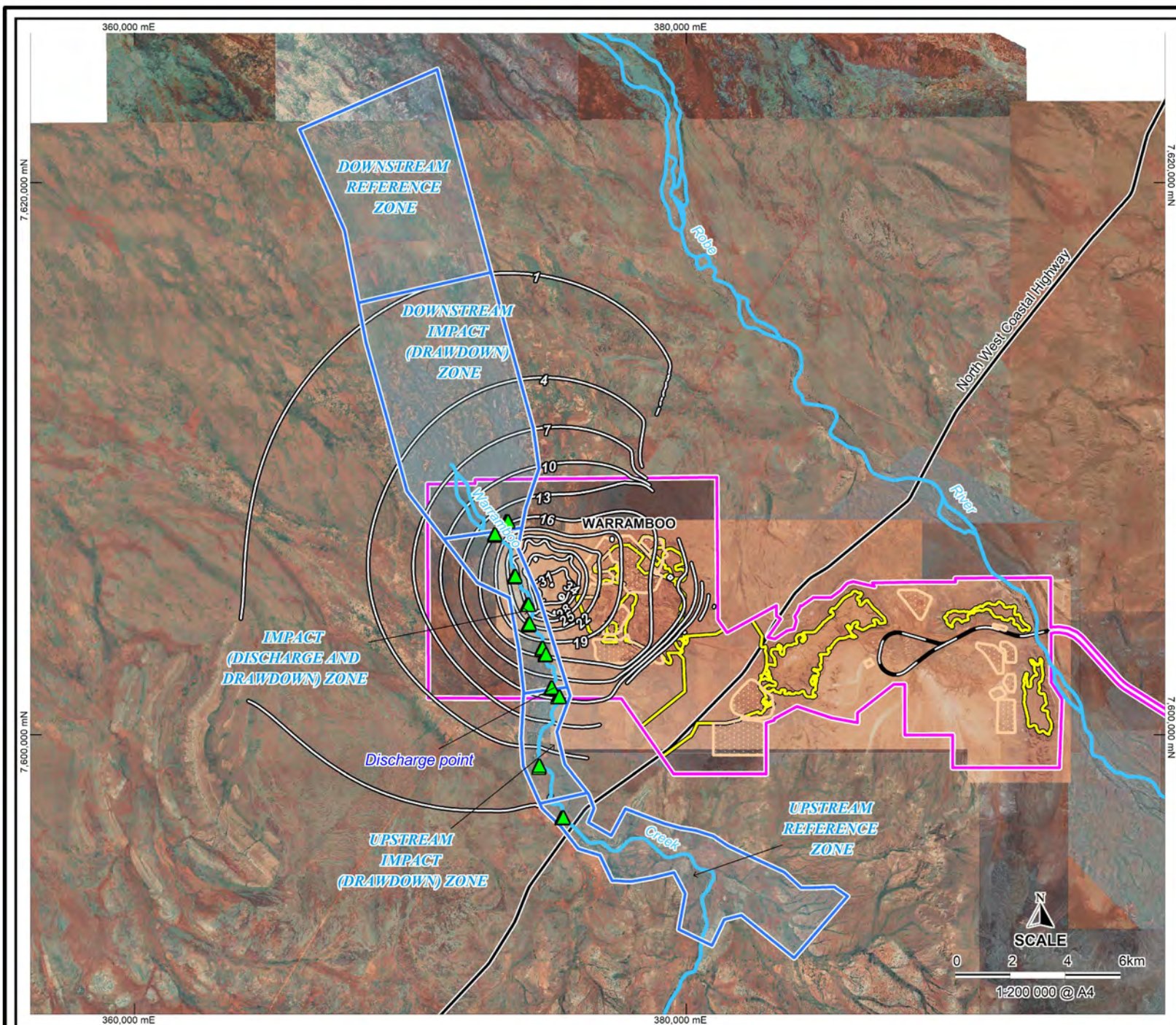
This document has been prepared to the highest level of accuracy possible, for the purposes of Rio Tinto's iron ore business. Reproduction of this document in whole or in part by any means is strictly prohibited without the express approval of Rio Tinto. Further, this document may not be referred to, quoted or relied upon for any purpose whatsoever without the written approval of Rio Tinto. Rio Tinto will not be liable to a third party for any loss, damage, liability or claim arising out of or incidental to a third party using or relying on the content contained in this document. Rio Tinto disclaims all risk and the third party assumes all risk and releases and indemnifies and agrees to keep indemnified Rio Tinto from any loss, damage, claim or liability arising directly or indirectly from the use or reliance on this document.

Rio Tinto

Iron Ore (WA)

**Figure 2-6:
Established riparian
vegetation monitoring
areas for the Robe River
adjacent to Mesa C**

Drawn: T.M. Plan No: PDE0173062v4
Date: November, 2020 Proj: MGA94 (Zone 50)



LEGEND

Riparian vegetation monitoring transects from which a subset will be selected for EMP monitoring

Remote sensing capture areas

Development Envelope

Predicted drawdown contour at end of mining (m)

Major Watercourse

Highway

Rio Tinto Railway

Indicative mine layout

Pit

Waste dump/stockpile

Disclaimer

This document has been prepared to the highest level of accuracy possible, for the purposes of Rio Tinto's iron ore business. Reproduction of this document in whole or in part by any means is strictly prohibited without the express approval of Rio Tinto. Further, this document may not be referred to, quoted or relied upon for any purpose whatsoever without the written approval of Rio Tinto. Rio Tinto will not be liable to a third party for any loss, damage, liability or claim arising out of or incidental to a third party using or relying on the content contained in this document. Rio Tinto disclaims all risk and the third party assumes all risk and releases and indemnifies and agrees to keep indemnified Rio Tinto from any loss, damage, claim or liability arising directly or indirectly from the use or reliance on this document.

Rio Tinto

Iron Ore (WA)

**Figure 2-7:
Established riparian
vegetation
monitoring areas for
Warrambo Creek**

Drawn: T.M. Plan No: PDE0173062v4
Date: November, 2020 Proj: MGA94 (Zone 50)

Table 2-11 Monitoring required to evaluate performance against the environmental outcomes for Inland Waters and riparian vegetation

Monitoring action	Location ¹	Frequency and timing	Data collection method and analysis	Responsible
Groundwater level monitoring (trigger criterion 1 and threshold criterion 1 in Table 2-4; early warning criterion and trigger criterion 1 in Table 2-5)	Robe River: upstream and downstream of Mesa C and adjacent to Mesa C. Warrambo Creek borefield extension area.	Monthly while groundwater abstraction and/or dewatering is occurring	Groundwater levels measured via boreholes and/or low impact piezometers	Hydrology team/ Mine Technical Services
Capture and analysis of remote sensing images (trigger criterion 2 in Table 2-4; early warning criterion 2, trigger criterion 2 and threshold criterion 1 in Table 2-5; early warning criterion 2, trigger criterion 1 and threshold criterion 1 in Table 2-6)	Selected potential impact sites and reference sites established during baseline monitoring along the Robe River adjacent to Mesa C and along Warrambo Creek	Annual (dry season) or biannual (wet and dry season) as triggered for Robe River ¹ Robe River adjacent to Mesa C: until groundwater abstraction ceases (or as triggered) Warrambo Creek: during operational mine life	Remote sensing images and analysis of changes	Operations Environment team
Annual field survey (threshold criterion 1 in Table 2-4; trigger criterion 3 and threshold criterion 2 in Table 2-5; and trigger criteria 2 and 3 and threshold criterion 2 in Table 2-6)	Selected potential impact sites and reference sites established during baseline monitoring along the Robe River adjacent to Mesa C and along Warrambo Creek	Annual (wet season) or biannual as triggered (wet and dry season) for Robe River ¹ Robe River adjacent to Mesa C: until groundwater abstraction ceases (or as triggered) Warrambo Creek: during operational mine life	Understorey and overstorey riparian taxa: condition, cover and health Weed species: number and locations	Operations Environment team
Monitoring of surface water expression (early warning criterion 1 in Table 2-6)	Monitoring point on Warrambo Creek established prior to commencement of surplus water discharge for the Proposal	Monthly during periods of discharge when natural no-flow conditions are present and access is possible ¹	Visual inspection or camera	Hydrology team/ Operations Environment team

¹ Locations may not always be available due to accessibility, weather conditions, safety considerations etc.

Baseline data from potential impact and reference sites will be collected prior to operations commencing to quantify natural variation in foliage cover (and health). The mean of all measurements made during the baseline period will be calculated for each reach (or system). Changes over time at these reaches (or potential impact areas) will be compared back to the baseline and to reference sites to assess any potential impacts from the Proposal.

The species richness and cover of both native and introduced species will be recorded during field-based, post-wet season, annual monitoring surveys in selected transects established during baseline surveys (Table 2-6). Monitoring of the understorey and overstorey vegetation will provide data about the structure, cover and health of both native and introduced species to assist in investigation of any trends that may occur as a result of changed hydrological regime and measured against management criteria (Table 2-4 through Table 2-6). Trends in the presence of native species will be analysed in parallel with the presence of introduced species, to detect any threats which introduced species may pose to native vegetation. In the area of Warrambo Creek potentially impacted by surplus water discharge, the presence of introduced species will be monitored in isolation and assessed for the trigger criterion. The threshold criterion takes into account the balance of all species, to ensure that the potential increased productivity as a result of discharge is not misinterpreted as a positive impact to the health of riparian vegetation.

2.1.3 Reporting

In the event of a potential non-compliance with MS 1112, the DWER will be advised of the potential non-compliance within seven days of the non-compliance being known.

In the event that monitoring indicates exceedance of a threshold criteria or non-achievement of a management target, the DWER will be notified in writing of the exceedance or non-achievement within seven days of the exceedance or non-achievement being identified. A report containing details as required by Condition 5-5 (5) or Condition 5-6 (3) of MS 1112 for an exceedance or non-achievement respectively will be provided to the DWER within twenty-one days of the exceedance or non-achievement being reported to the DWER.

The ACAR will report against the trigger and threshold criteria and the management targets for the for each calendar year. The annual report will also include a summary of the analysis of monitoring data to facilitate adaptive management.

In the event that trigger and threshold criteria were exceeded during the reporting period, the ACAR will include a description of the effectiveness of any management contingency actions that have been implemented to manage the impact.

Table 2-12: Mesa A Hub Environmental Management Plan reporting table for MS 1112

Key environmental factors: Flora and Vegetation (Sand Sheet PEC and Priority 1 Flora), Terrestrial Fauna (Ghost Bat and Northern Quoll), Inland Waters (groundwater abstraction, surplus discharge and riparian vegetation)	
Environmental outcomes, trigger and threshold criteria and management targets as per MS 1112	Reporting period 1 January-31 December
Early warning criteria:	Status report: Associated trigger/threshold criteria not exceeded Associated trigger/threshold criteria exceeded
1. Disturbance, other than existing and authorised clearing, within 50 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 2-2	
2. Warrambo Creek (abstraction): Groundwater draw down equivalent to 1.5 m from baseline at the modelled 2 m draw down contour	
3. Warrambo Creek (abstraction): The area of decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy is 10% greater within the potential impact area than in reference areas	
4. Warrambo Creek (surplus discharge): Surface water expression present \geq 6km downstream of the discharge point in Warrambo Creek under natural no-flow conditions	
5. Warrambo Creek (surplus discharge): The area of decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy is 10% greater within the potential impact area than in reference areas	
Trigger criteria:	Status report: Trigger criterion not exceeded Trigger criterion exceeded
1. Clearing within 20 m of the boundary of the Sand Sheet Vegetation (Robe Valley) PEC, other than existing and authorised disturbance	
2. Transect monitoring detects new high priority weed species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC	
3. Quadrat monitoring detects new high priority weed species not previously detected within the Sand Sheet Vegetation (Robe Valley) PEC or an increase in number and/or extent of a previously detected high priority weed species	
4. Vibration levels exceed 50 mm/s peak particle velocity at the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7	
5. Disturbance of \geq 5% of potential Northern Quoll denning habitat (comprising Breakaways and Gullies habitat and Rocky Slopes habitat) in the MEZ of Mesa A, B or C, excluding existing disturbance and disturbance authorised prior to grant of MS 1112	
6. Robe River: Groundwater level trends adjacent to the Mesa C deposit are significantly different to trends in the broader locality or reference sites	

Key environmental factors: Flora and Vegetation (Sand Sheet PEC and Priority 1 Flora), Terrestrial Fauna (Ghost Bat and Northern Quoll), Inland Waters (groundwater abstraction, surplus discharge and riparian vegetation)	
7. Robe River: The area of decline below the MSAVI baseline 5 th percentile for overstorey obligate phreatophytic canopy is 10% greater in the Robe River adjacent to the Mesa C deposit than in reference areas	
8. Warramboo Creek (abstraction): Groundwater draw down equivalent to 2 m from baseline at the modelled 2 m draw down contour	
9. Warramboo Creek (abstraction): The area of decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy is 20% greater within the potential impact area than in reference areas	
10. Warramboo Creek (abstraction): Significant decline in number and/or change in composition of native perennial species within the potential impact area since baseline, in comparison to reference sites	
11. Warramboo Creek (surplus discharge): The area of decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy is 20% greater within the potential impact area than in reference areas	
12. Warramboo Creek (surplus discharge): Significant decline in number and/or change in composition of native perennial species within the potential impact area since baseline, in comparison to reference sites	
13. Warramboo Creek (surplus discharge): Establishment of new high priority weed species at a potential impact site and/or downstream of the discharge extent, previously not detected within the Development Envelope	
Threshold criteria:	Status report: Threshold criterion not exceeded Threshold criterion exceeded
1. Clearing within the Sand Sheet Vegetation (Robe Valley) PEC, other than existing and authorised disturbance	
2. High priority weed species becomes established and dominant within the Sand Sheet Vegetation (Robe Valley) PEC	
3. Permanent structural damage to potential diurnal/maternal Ghost Bat roost caves as shown in Figure 1-7	
4. Disturbance, other than existing and authorised clearing, within 40 m of the recorded back of the potential diurnal/maternal Ghost Bat roost caves as shown in Figure 2-2	
5. Disturbance of >10% of potential Northern Quoll denning habitat (comprising Breakaways and Gullies habitat and Rocky Slopes habitat) in the MEZ of Mesa A, B or C, excluding existing disturbance and disturbance authorised prior to grant of MS 1112	
6. Robe River: There is a significant decline since baseline in the number and/or a change in composition of native perennial species relative to reference sites and groundwater level trends are significantly different to regional trends or reference sites, within the Robe River adjacent to the Mesa C deposit as a result of groundwater abstraction and/or dewatering associated with the Proposal	
7. Warramboo Creek (abstraction): Decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy over 50% of potential impact area; trend continues over two or more consecutive dry season monitoring events; with no evidence of seasonal recovery; and outside of historical baseline variation, in comparison to reference sites	

Key environmental factors: Flora and Vegetation (Sand Sheet PEC and Priority 1 Flora), Terrestrial Fauna (Ghost Bat and Northern Quoll), Inland Waters (groundwater abstraction, surplus discharge and riparian vegetation)	
8. Warramboo Creek (abstraction): Over 50% of the potential impact area displays significant structural or compositional change to riparian vegetation since baseline, in comparison to reference sites	
9. Warramboo Creek (surplus discharge): Decline below the baseline MSAVI 5 th percentile for overstorey phreatophytic canopy over 50% of potential impact area; trend continues over two or more consecutive dry season monitoring events; with no evidence of seasonal recovery; and outside of historical baseline variation, in comparison to reference sites	
10. Warramboo Creek (surplus discharge): Over 50% of the potential impact area displays significant structural or compositional change to riparian vegetation since baseline, in comparison to reference sites	
<u>Management targets:</u>	Status report: Management target achieved Management target not achieved
1. Persistence of the four key species (<i>Corymbia zygophylla</i> , <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Grevillea eriostachya</i> and <i>Triodia schinzii</i>) of the Sand Sheet Vegetation (Robe Valley) PEC	
2. No decline in native species richness in the Sand Sheet PEC attributable to the Proposal, taking into account historical variation and reference site trends	
3. No loss of immediate hydrological contributing area due to the Proposal, excluding existing and authorised disturbance, that affects surface water flow to the Sand Sheet Vegetation (Robe Valley) PEC	
4. Limit direct impacts on <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) due to implementation of the Proposal to no greater than predicted (5% of known records as represented in the Rio Tinto database)	
5. Minimise potential indirect impacts of high priority weeds on <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61)	

2.2 Requirements under EPBC Act approval 2016/7843

This section of the EMP identifies the provisions the Proponent will implement to meet the requirements of EPBC Act approval 2016/7843. General provisions and monitoring in relation to threatening processes are provided in Section 2.2.1. Provisions and monitoring specific to the Ghost Bat are provided in Sections 2.2.2 and 2.2.3 respectively. Reporting for all provisions is detailed in Section 2.2.4.

2.2.1 General provisions and monitoring in relation to threatening processes

Management and mitigation of threatening processes resulting from the Action for the EPBC Act listed threatened species, Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python and their habitats, will assist in reducing impacts to these species. Threatening processes relevant to the Action include fire, vehicle and machinery movements, fauna encounters/sightings, weeds, feral animals, noise and vibration and dust and light. Table 2-13 provides an outcome and objective and specifies the management actions and targets to be implemented where relevant to EPBC Act listed threatened species in order to reduce risks from threatening processes associated with implementation of the Action (i.e. implementation of the Proposal).

Table 2-13: EMP Provisions – General provisions for EPBC Act listed threatened species

EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python)					
Key environmental values: EPBC Act listed threatened species - Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python					
Key impacts and risks: Potential loss or degradation of high value habitat, or injury to MNES fauna, as a result of implementation of the Action					
Outcome: Minimise impacts to EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) associated with implementation of the Action					
Management-based provisions					
Objective: Manage threatening processes associated with implementation of the Action, where relevant to minimising impacts to EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python)					
Management Actions	Management Targets	Monitoring			
		Method	Location	Frequency and timing	Responsibility
Threatening process: fire					
1. Appropriate fire fighting equipment is to be available to control localised outbreaks of fire. Regular inspection and maintenance of fire fighting equipment will be implemented to comply with relevant fire safety standards 2. Emergency response (fire fighting) procedures are to be implemented to control fires arising as a result of implementation of the Proposal	1. Provision and maintenance of fire fighting equipment in accordance with the relevant fire safety standards 2. Fire fighting emergency response procedures are in place	<ul style="list-style-type: none">Inspection of fire fighting equipment to ensure availability and compliance with fire safety standardsInspection of hazard/incident records	Development Envelope	Annual, or as appropriate, during the operational mine life	Safety Representatives (item 1) Emergency Services team (item 2)
Threatening process: vehicle and machinery movements					
1. Vehicles and machinery to remain on designated roads unless in the case of emergency or for undertaking necessary activities	1. No incidents of vehicles being used off designated roads outside operational areas, unless in the case of emergency or for necessary activities, that result in significant impacts to high value MNES habitat	Inspection of incident records	Development Envelope	Annual, or as appropriate, during the operational mine life	Operations Environment team

Management Actions	Management Targets	Monitoring			
		Method	Location	Frequency and timing	Responsibility
Threatening process: fauna encounters/sightings					
<ol style="list-style-type: none">1. All site personnel to be informed during their site induction of EPBC Act listed threatened species (Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) that may occur on site2. Any EPBC Act listed threatened species encountered on site are to be recorded and records maintained for the Proposal. This will include locations, and animal status (alive/dead).3. If EPBC Act listed threatened fauna species are required to be moved, fauna are to be handled and transported in accordance with Rio Tinto's Wildlife Interaction Guidelines. Handling and capture will be undertaken by trained personnel only.4. Feeding of native fauna, hunting, keeping of firearms²⁶ or pets on site is prohibited5. The MEZs are to be demarcated and access restricted to authorised personnel6. Barbed wire use is to be avoided in the Development Envelope, except where there is a legislative requirement to do so. Where barbed wire is required by legislation, reflectors are to be installed on the barbed wire.	<ol style="list-style-type: none">1. Induction material contains information relating to Ghost Bat, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python2. Records of all EPBC Act listed threatened species observed are appropriately maintained3. Fauna handling is only undertaken by trained personnel, in accordance with Rio Tinto's Wildlife Interaction Guidelines4. No incidents of native fauna feeding, hunting or keeping of firearms or pets on site5. Access to the MEZs (which potentially contain significant roost/den sites) is restricted to authorised personnel and there are no incidents of unauthorised access6. No use of barbed wire on site, except in the case of statutory requirements7. Where barbed wire is used in accordance with legislation, reflectors are installed	<ul style="list-style-type: none">• Inspection of records, related to sightings, records, encounters and fauna removal• Inspection of MEZ demarcation and procedures restricting access to the MEZs• Inspections to assess whether any unauthorised barbed wire is being utilised on site• Inspection of barbed wire installation to ensure reflectors are in place	Development Envelope	Annual, or as appropriate, during the operational mine life	<div>Training Department (item 1)</div> <div>Operations Environment team</div>

²⁶ Excluding firearms for use in pastoral station activities

Management Actions	Management Targets	Monitoring			
		Method	Location	Frequency and timing	Responsibility
Threatening process: weed management					
1. Weed management measures, including equipment hygiene procedures, are to be implemented to ensure weeds are recorded and controlled and equipment is cleaned to minimise the spread of weeds 2. Weeds within the Development Envelope are to be managed through a weed control program.	1. Compliance with equipment hygiene procedures 2. Weed control is undertaken in the Development Envelope each year	Weed monitoring is undertaken during quadrat and targeted vegetation monitoring	Development Envelope	Annual, or as appropriate, during the operational mine life	Operations Environment team
Threatening process: feral animal control					
Feral animal presence is to be managed on site by: <ul style="list-style-type: none">prohibiting feeding animalsprohibiting keeping petsappropriate waste disposal for food scraps and other wastes as per the Rio Tinto waste management guidelines	Feral animal management actions are implemented	Inspection of waste disposal areas	Mesa A Village and administration block	Bi-annual inspection during the operational mine life	Operations Environment team
Threatening process: noise and vibration					
1. Delineate MEZs to ensure retention of potential high value MNES habitat in the MEZs of Mesas A, B and C 2. Implement the Blast Management Plan where relevant to minimising potential impacts to roosting Ghost Bats	1. No disturbance, other than existing and authorised clearing ²⁷ , in the MEZs of Mesas A, B and C 2. Compliance with the sections of the Blast Management Plan where relevant to minimising potential impacts to roosting Ghost Bats	<ul style="list-style-type: none">Annual land clearing reconciliation against MEZs of Mesas A, B and CNoise and blast vibration monitoring for all blasts within 300 m of the potential diurnal/maternal Ghost Bat roosts shown in Figure 1-7	Development Envelope	Annual land clearing reconciliation Noise and blast vibration monitoring – as required by distance from potential diurnal/maternal Ghost Bat roost	Mine Operations team (item 1) Drill and Blast team (item 2)

²⁷ Authorised clearing is as authorised in Table 2 of Schedule 1 of MS 1112

Management Actions	Management Targets	Monitoring			
		Method	Location	Frequency and timing	Responsibility
Threatening process: dust and light					
1. Delineate MEZs to ensure retention of potential high value MNES habitat in the MEZs of Mesa A, B and C 2. Install lighting only where required, that is, mainly in-pit and operational areas 3. Direct lighting into the active pits to avoid the mesa escarpments 4. Manage dust emissions through application of dust suppression methods including water sprays, where applicable	1. No disturbance, other than existing and authorised clearing ²⁸ , in the MEZs of Mesas A, B and C 2. Lighting and dust management actions are implemented	<ul style="list-style-type: none">• Annual land clearing reconciliation against MEZs of Mesas A, B and C• Dust monitoring	Development Envelope	Land clearing reconciliation – annual Dust monitoring – continuous ²⁹	Mine Operations team

²⁸ Authorised clearing is as authorised in Table 2 of Schedule 1 of MS 1112

²⁹ Continuous monitoring except where downtime is experienced e.g. due to periodic maintenance or equipment failure

2.2.2 Provisions specific to the Ghost Bat

Conditions 3 and 4 of EPBC Act approval 2016/7843 include requirements to minimise impacts to the Ghost Bat and to ensure no significant long-term decline in the Ghost Bat population attributable to implementation of the Action. Table 2-14 provides management-based provisions to meet these requirements.

Table 2-14: EMP Provisions – EPBC Act listed threatened species (Ghost Bat)

EPBC Act listed threatened species – Ghost Bat (<i>Macroderma gigas</i>)			
Key environmental values: Conservation significant fauna species (Ghost Bat) Key impacts and risks: Potential loss or degradation of high value (roosting) habitat as a result of implementation of the Proposal			
Management-based provisions			
Objective: Improve knowledge of the Ghost Bat population in the Robe Valley, including its use of high value habitat and effects of noise and vibration, in order to assist in maintaining biological diversity and ecological integrity			
Management Actions	Management Targets	Monitoring	Reporting
Undertake monitoring of Ghost Bats and indicate how Ghost Bats use caves within the western part of the Robe Valley (e.g. diurnal versus maternal)	Ensure no significant long-term decline in the Ghost Bat population attributable to the Action (i.e. implementation of the Proposal)	<ul style="list-style-type: none"> Annual visual inspection³⁰ of the structural integrity of Ghost Bat roosts (nocturnal³¹ and potential diurnal/maternal) and inaccessible caves as shown in Figure 1-7 that were within 300 m of the active pits during the previous 12 month period (i.e. inspection of those roosts/caves with potential to have been impacted by noise/vibration in the 12 month reporting period) Noise and blast vibration monitoring for all blasts within 300 m of the potential diurnal/maternal Ghost Bat roosts as shown in Figure 1-7 Temperature and humidity monitoring in potential diurnal/maternal Ghost Bat roosts as shown in Figure 1-7 to assess potential changes to the structural integrity of potential diurnal/maternal Ghost Bat roosts Bat audio monitoring at Mesas A, B, C, F and G 	If the Action results in permanent structural damage ³² to a Ghost Bat roost (other than MBS-05) or data indicate a significant long-term decline in the Ghost Bat population attributable to the Action, notify the Commonwealth Department within 2 days of the non-compliance against Condition 4(a) of EPBC Act approval 2016/7843 being known and provide a report within 10 days of the non-compliance being known. The notification and report will include information as required by EPBC Act approval Conditions 17 and 18.

³⁰ Visual inspection will be conducted either in-person from the base of the mesa or through the use of drones or other suitable method. The visual inspection is designed to verify that there has not been a loss of structural integrity which would be evident as significant collapse of the cave opening.

³¹ Visual inspection of nocturnal roosts excludes MBS-05 as this roost is approved for disturbance

³² Where 'permanent structural damage' is defined as, 'damage that negatively impacts the integrity of the cave and microclimate such that future Ghost Bat use of the site is prevented'.

2.2.3 Monitoring specific to the Ghost Bat

Monitoring will be undertaken to assess the effectiveness of management actions in meeting the objective for the Ghost Bat. A missed monitoring event will not be treated as a non-compliance provided the Proponent can validate that the required management objective has still been achieved, for example through the use of alternative data.

Protection of high value habitat for the Ghost Bat is the most appropriate strategy to protect this conservation significant fauna within the Development Envelope. High value habitat for the Ghost Bat includes the escarpment and cave structures associated with mesa formations in the Robe Valley. In addition to blast management controls addressed in Section 1.4.4, visual assessment of the structural integrity of Ghost Bat roosts within 300 m of an active pit will be undertaken to confirm blasting in the vicinity of the roosts has not resulted in permanent structural damage³³ to the roosts. Temperature and humidity monitoring will also be undertaken in potential diurnal/maternal Ghost Bat roosts. Significant changes in temperature and humidity in a cave, taking into account local weather conditions, would indicate potential loss of the structural integrity of the cave.

The EMP includes a management objective to improve knowledge of the Ghost Bat population in the Robe Valley, including its use of high value habitat and the effect of noise and vibration, and a management target to ensure no significant long-term decline in the Ghost Bat population attributable to the Action. Noise and blast vibration monitoring are to be conducted for all blasts within 300 m of potential diurnal/maternal Ghost Bat roosts and bat audio monitoring is to be conducted at Mesas A, B, C, F and G to meet the management objective. Audio monitoring has been selected in preference to the previously proposed scat collection and analysis as audio monitoring is considered less invasive (ongoing repetitive cave entry is not required) and changes in the numbers of calls recorded over time provide information about bat utilisation of a roost over time. Successful audio monitoring programs are also currently being utilised for Ghost Bats at other Rio Tinto sites. Data from audio monitoring will provide information about the Ghost Bat population and its utilisation of caves in the western part of the Robe Valley. Audio monitoring will also indicate which caves are in use as maternity roosts; a significant increase in calls near civil twilight during the maternity period (November to December) will indicate that the cave is likely in use as a maternity roost.

³³ Where 'permanent structural damage' is defined as, 'damage that negatively impacts the integrity of the cave and microclimate such that future Ghost Bat use of the site is prevented'.

Table 2-15: Monitoring required to assess the effectiveness of the management actions under EPBC Act approval 2016/7843 for the Ghost Bat

Monitoring action	Location	Frequency and timing	Data collection method and analysis	Responsible
Inspection of the structural integrity of Ghost Bat roost caves (management target Table 2-14)	Roost caves (nocturnal ³⁴ and potential diurnal/maternal) and inaccessible caves as shown in Figure 1-7 that were within 300 m of the active pit during the previous 12 month period	Annual during operational mine life	Visual inspection ³⁵	Operations Environment team
Noise and blast vibration monitoring (management target Table 2-14)	Potential diurnal/maternal roost caves as shown in Figure 1-7	For all blasts within 300 m of potential diurnal/maternal roost caves as shown in Figure 1-7	Noise and vibration monitoring	Drill and Blast team
Temperature and humidity monitoring (management target Table 2-14)	Caves MBC-05, MCC-02, MCC-04, MCC-05, CRMC02, CRMC09, CRMC10, CRMC11 (Figure 1-7)	Continuous ³⁶ monitoring during operational mine life	Temperature and humidity logging and data analysis correlated against reference sites and ambient temperature and humidity; and timing of mine pit development / blasting data in adjacent pits as appropriate.	Operations Environment team
Bat audio monitoring (management target Table 2-14)	Mesas A, B, C, F and G	Continuous ³⁶ monitoring during operational mine life.	Bat audio detectors	Operations Environment team

2.2.4 Reporting

In the event of a non-compliance against the conditions of EPBC Act approval 2016/7843, the Commonwealth Department will be notified in writing as soon as practicable, and no later than two business days of the non-compliance being known. The Commonwealth Department will also be provided with details of the non-compliance as required by Condition 18 as soon as practicable, and no later than ten business days of the non-compliance being known.

³⁴ Visual inspection of nocturnal roosts excludes MBS-05 as this roost is approved for disturbance

³⁵ Visual inspection will be conducted either in-person from the base of the mesa or through the use of drones or other suitable method. The visual inspection is designed to verify that there has not been a loss of structural integrity which would be evident as significant collapse of the cave opening.

³⁶ Continuous monitoring except where downtime is experienced e.g. due to periodic maintenance or equipment failure

Compliance against the conditions of EPBC Act approval 2016/7843 will be reported annually as required by Condition 16. For conditions related to this EMP, the information to be reported as part of annual compliance reporting is shown in Table 2-16.

Table 2-16: Mesa A Hub Environmental Management Plan reporting table for EPBC 2016/7843

Condition		Reporting period 1 January-31 December
2	<p>To minimise impacts to EPBC Act listed threatened species, the approval holder must comply with Condition 5 (Condition Environmental Management Plan(s)), Condition 9 (Terrestrial Fauna Habitat – Conservation Significant Fauna Species; Ghost Bat (<i>Macroderma gigas</i>) and Northern Quoll (<i>Dasyurus hallucatus</i>)) and Condition 11 (Inland Waters) of the Western Australian approval where relevant to EPBC Act listed threatened species.</p>	<p>Report status:</p> <p>Compliant</p> <p>Proposal implemented in accordance with conditions 5-1 to 5-8, 9-1 and 11-1 of MS 1112 where relevant to EPBC Act listed threatened species.</p> <p>OR</p> <p>Potentially non-compliant if the approval holder has not complied with Condition 5, Condition 9 and Condition 11 of the Western Australian approval where these conditions relate to EPBC Act listed threatened species.</p>
3	<p>The Condition Environmental Management Plan(s), specified in Condition 2 above, must include environmental outcomes and objectives related to the mitigation and management of the following threatening processes:</p> <ul style="list-style-type: none"> (a) fire (b) vehicle and machinery movements (c) fauna encounters/sightings (d) weed management (e) feral animal control (f) noise and vibration (g) dust and light <p>where relevant to EPBC Act listed threatened species. For 3.(f) noise and vibration, the Condition Environmental Plan(s) must include monitoring of the EPBC Act listed Ghost Bat (<i>Macroderma gigas</i>) and include a management target to ensure no significant long-term decline in the Ghost Bat population attributable to the Action for the purposes of Condition 4.</p>	<p>Report status:</p> <p>Compliant</p> <p>Condition Environmental Management Plan includes:</p> <ul style="list-style-type: none"> • environmental outcomes and objectives for the listed threatening processes where relevant to EPBC Act listed threatened species; and • monitoring of Ghost Bat; and • a management target to ensure no significant long-term decline in the Ghost Bat population attributable to the Action <p>OR</p> <p>Potentially non-compliant</p>
4(a)	<p>To minimise impacts to EPBC Act listed Ghost Bat (<i>Macroderma gigas</i>), the approval holder must:</p> <p>(a) if the Action results in permanent structural damage to a Ghost Bat roost (other than nocturnal roost MBS-05 at Mesa B), or a failure to meet the management target established in Condition 3, Conditions 17 and 18 will apply in respect of that result. If the structural damage cannot be remedied the Proponent must provide an offset proposal to the Department for approval within two months.</p>	<p>Report status:</p> <p>Compliant</p> <p>The Action has not resulted in:</p> <ul style="list-style-type: none"> • permanent structural damage to a Ghost Bat roost; or • failure to meet the management target established in Condition 3. <p>OR</p> <p>Compliant</p>

Condition		Reporting period 1 January-31 December
		<p>The Action has resulted in either permanent structural damage to a Ghost Bat roost or a failure to meet the management target established in Condition 3, Conditions 17 and 18 have been complied with and, either the damage can be remedied or an offset proposal has been/will be submitted within two months.</p> <p>OR</p> <p>Potentially non-compliant</p>
4(b)	<p>To minimise impacts to EPBC Act listed Ghost Bat (<i>Macroderma gigas</i>), the approval holder must:</p> <p>(b) Implement a Mining Exclusion Zone and Blast Management Plan to minimise potential impacts to roosting Ghost Bats from noise and vibration associated with mining activities (with the exception of nocturnal roost MBS-05 at Mesa B)</p>	<p>Report status:</p> <p>Compliant</p> <p>Where relevant to minimising potential impacts to roosting Ghost Bats, a Mining Exclusion Zone and Blast Management Plan have been implemented</p> <p>OR</p> <p>Potentially non-compliant</p>

3. ADAPTIVE MANAGEMENT AND REVIEW OF THIS EMP

The Proponent will implement adaptive management to learn from monitoring and evaluation against trigger and threshold criteria, monitoring and evaluation of progress against management targets and monitoring of the effectiveness of response actions, to more effectively meet the environmental outcomes and management objectives.

The following approach will apply:

- Monitoring data will be systematically evaluated and compared to baseline and reference site data on a regular basis in a process of adaptive management to verify whether responses to the impact are the same or similar to predictions.
- Based on the analysis of these monitoring data, the Proponent will review and adjust the management measures in consultation with the DWER.

4. STAKEHOLDER CONSULTATION

Stakeholder consultation for the Proposal, including environmental management of key environmental factors, was undertaken as part of the Environmental Impact Assessment for the Proposal as summarised in the *Mesa A Hub Revised Proposal Environmental Review Document* (Eco Logical Australia 2018). Additional consultation specific to the EMP has been undertaken as summarised in Table 2-14.

Table 4-1: Stakeholder consultation

Stakeholder	Date	Issues/topics raised	Proponent response/outcome
DWER	29 April 2019	<p>The DWER requested changes to the draft EMP:</p> <ul style="list-style-type: none"> • Inclusion of pre-clearance survey for <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) • Inclusion of a management target to ensure impacts to <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61) • Inclusion of groundwater level triggers and monitoring for the Robe River and Warrambo Creek • Inclusion of multiple lines of evidence for potential impacts to riparian vegetation • Further details of methodology used for remote sensing monitoring of riparian vegetation 	<p>The Proponent completed additional analysis and consultation with the DWER as documented below.</p> <p>The Proponent has incorporated the requested changes into a revised version of the draft EMP for discussion with the DWER.</p>
Commonwealth Department	15 May 2019	Draft EMP provided	No specific response or additional action required from the Proponent

Stakeholder	Date	Issues/topics raised	Proponent response/outcome
DWER	9 July 2019	<p>The methodology for remote sensing of riparian vegetation, as well as triggers and thresholds were discussed with the DWER.</p> <p>The DWER requested analysis of Rio Tinto data to demonstrate the suitability of proposed triggers and thresholds.</p>	The Proponent completed the requested data analysis and provided the analysis to the DWER on 17 September 2019. The results of the analysis were discussed with the DWER on 26 September 2019.
DWER	17 September 2019	The analysis of Rio Tinto data to demonstrate the suitability of proposed triggers and thresholds was provided to the DWER for review.	The results of the analysis were discussed with the DWER on 26 September 2019.
DWER	26 September 2019	The analysis of Rio Tinto data to demonstrate the most suitable analysis method for detection of impacts to riparian vegetation was presented. The DWER requested, and were provided with, details of updated triggers and thresholds for review.	The Proponent revised the riparian vegetation provisions to incorporate the feedback provided by the DWER.
DWER	25 October 2019	Proposed management targets, triggers and thresholds for <i>Abutilon</i> sp. Onslow (F. Smith s.n. 10/9/61), groundwater levels and riparian vegetation monitoring were presented for discussion with the DWER prior to submission of the EMP.	No specific response or additional action required from the Proponent.

5. REFERENCES

Astron 2018a. *Mesa A Annual Sand Sheet Vegetation Monitoring*, September 2018. Unpublished report prepared for Rio Tinto.

Astron 2018b. *Mesa A Riparian Vegetation Baseline Monitoring*, May 2017. Unpublished report prepared for Rio Tinto.

Astron 2018c. *Remote Sensing of Riparian Vegetation Background and Methods*, September 2018. Unpublished report prepared for Rio Tinto.

Astron 2019. *Remote Sensing Trigger Formulation – Illustration Guide*, August 2019. Unpublished report prepared for Rio Tinto.

Astron 2020a. *Warramboe Riparian Analysis – Condition Assessment Memo*, April 2020.

Astron 2020b. *Mesa A Riparian Vegetation Monitoring Program*, October-November 2019. Unpublished report prepared for Rio Tinto.

Bat Call Pty Ltd (Bat Call WA) 2016. *Mesa B and C Ghost Bat roost cave Assessment*, July 2016. Unpublished report prepared for Rio Tinto.

Bat Call Pty Ltd (Bat Call WA) 2017. *Robe Valley Mesas A and C Ghost Bat roost cave assessment*, April 2017. Unpublished report prepared for Rio Tinto.

Biologic Environmental Survey (Biologic) (in prep.). *Robe Valley Project Ghost Bat Monitoring 2018-2019*.

Biota Environmental Sciences (Biota) 2005a. *Fauna Habitats and Fauna Assemblage of Mesa A and G, near Pannawonica*. Unpublished report prepared for Robe River Iron Associates.

Biota Environmental Sciences (Biota) 2005b. *Vegetation and Flora Survey of Mesa A and Mesa G, near Pannawonica*. Unpublished report prepared for Robe River Iron Associates,

Biota Environmental Sciences (Biota) 2006a. *Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboe*. Unpublished report prepared for Robe River Iron Associates.

Biota Environmental Sciences (Biota) 2006b. *A Vegetation and Flora Survey of the Proposed Mesa A Transport Corridor, Warramboe Deposit and Yarraloola Borefield*. Unpublished report prepared for Robe River Iron Associates.

Biota Environmental Sciences (Biota) 2011. *Robe Valley Mesas Fauna Report*. Unpublished report prepared for Rio Tinto.

Biota Environmental Sciences (Biota) 2016. *Mesa A Sand Sheet Environmental Monitoring Report: Baseline Survey to 2016*. Unpublished report prepared for Rio Tinto Iron Ore.

Department of Parks and Wildlife 2014. *Priority Ecological Communities for Western Australia Version 21*. Government of Western Australia.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011. *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the endangered northern quoll, Dasyurus hallucatus*. EPBC Act policy statement 3.25, Department of Sustainability, Environment, Water, Population and Communities.

Department of the Environment (DotE) 2016. *EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus*. EPBC Act Policy Statement. January 2016.

Eco Logical Australia 2018. *Mesa A Hub Revised Proposal Environmental Review Document*. December 2018.

Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003. *Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0*. Department of the Environment and Heritage, Canberra.

How, R. A., Spencer, P. B. and Schmitt, L. H. 2009. Island populations have high conservation value for northern Australia's top marsupial predator ahead of a threatening process. *Journal of Zoology* 278:206–217.

Morrison 2008. The use of control charts to interpret environmental monitoring data. *Natural Areas Journal*, 28, pp. 66-74.

MWH 2015a. *Level 2 Terrestrial Fauna Surveys: Mesa B-C, Warrambo BWT and Highway to Tod Bore*. Unpublished report prepared for Rio Tinto Iron Ore.

MWH 2015b. *Mesa Façade Assessment – Mesas B and C*. Unpublished report prepared for Rio Tinto.

MWH 2016. *Level 2 Flora and vegetation survey: Mesa B-C, Warrambo BWT, Highway to Tod Bore and Mesa A extension*. Unpublished report prepared for Rio Tinto Iron Ore.

Rio Tinto 2017. *Assessment of Groundwater Dependent Vegetation distribution on the Robe River – Targeted Riparian Vegetation Survey – Stage 1*.

Rio Tinto 2017a. *Geotechnical assessments – Potential diurnal Ghost Bat roost complexes at Robe Valley*.

Stantec 2018. *Proposed Warrambo Borefield Area: Detailed Flora and Vegetation Assessment*. Unpublished report prepared for Rio Tinto Iron Ore.

Van Dyck, S. and Strahan, R. (Eds.) 2008. *The Mammals of Australia*, 3rd edition. Reed New Holland, Sydney.

Western Australian Herbarium (WAH) 2019. *Florabase – the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions.

APPENDIX 1: Weed species lists

Table A1-1: Weed species recorded in the Sand Sheet PEC (2008-2019)

Family	Species	DBCA Ecological Rating	DBCA Invasiveness Rating
Poaceae	<i>Cenchrus ciliaris</i>	High	Rapid
Poaceae	<i>Cenchrus setiger</i>	High	Rapid
Poaceae	<i>Digitaria ciliaris</i>	Low	Slow
Asteraceae	<i>Flaveria trinervia</i>	-	-
Malvaceae	<i>Malvastrum americanum</i>	High	Rapid
Poaceae	<i>Setaria verticillata</i>	High	Rapid

Table A1-2: Weed species recorded in the Development Envelope to 2019

Family	Species	DBCA Ecological Rating	DBCA Invasiveness Rating
Amaranthaceae	<i>Aerva javanica</i>	High	Rapid
Papaveraceae	<i>Argemone ochroleuca</i> (and subsp. <i>ochroleuca</i>)	Unknown	Rapid
Asteraceae	<i>Bidens bipinnata</i>	Unknown	Rapid
Poaceae	<i>Cenchrus ciliaris</i>	High	Rapid
Poaceae	<i>Cenchrus setiger</i>	High	Rapid
Poaceae	<i>Chloris barbata</i>	High	Rapid
Cucurbitaceae	<i>Citrullus colocynthis</i>	Unknown	Moderate
Cucurbitaceae	<i>Citrullus lanatus</i>	Unknown	Moderate
Poaceae	<i>Cynodon dactylon</i>	High	Rapid
Solanaceae	<i>Datura leichhardtii</i>	Unknown	Unknown
Poaceae	<i>Digitaria ciliaris</i>	Low	Slow
Poaceae	<i>Echinochloa colona</i>	High	Rapid
Euphorbiaceae	<i>Euphorbia hirta</i>	Low	Slow
Asteraceae	<i>Flaveria trinervia</i>	-	-

Family	Species	DBCA Ecological Rating	DBCA Invasiveness Rating
Malvaceae	<i>Malvastrum americanum</i>	High	Rapid
Malvaceae	<i>Melochia pyramidata</i>	-	-
Lamiaceae	<i>Ocimum basilicum</i>	-	-
Passifloraceae	<i>Passiflora foetida</i> (and var. <i>hispida</i>)	High	Rapid
Portulacaceae	<i>Portulaca pilosa</i>	-	-
Polygonaceae	<i>Rumex vesicarius</i>	High	Rapid
Poaceae	<i>Setaria verticillata</i>	High	Rapid
Zygophyllaceae	<i>Tribulus terrestris</i>	Unknown	Moderate
Fabaceae	<i>Vachellia farnesiana</i>	High	Rapid

APPENDIX 2: MSAVI baseline for Robe River and Warrambo Creek

Table A2-1: MSAVI baseline³⁷ for Robe River and Warrambo Creek.

River/creek	Potential impact/reference area	2014		2016		2017		2018		2019	
		median	5 th percentile	median	5 th percentile	median	5 th percentile	median	5 th percentile	median	5 th percentile
Robe River	Mesa C nominal downstream reference	0.444	0.227	0.417	0.313	0.480	0.385	0.354	0.234	0.382	0.279
	Mesa C nominal main monitoring zone ³⁸	0.500	0.243	0.502	0.415	0.525	0.420	0.294	0.224	0.338	0.268
	Mesa C nominal upstream reference	0.398	0.224	0.437	0.319	0.482	0.377	0.432	0.295	0.458	0.321
Warrambo	Downstream potential impact (drawdown)	NS	NS	NS	NS	0.510	0.329	0.581	0.490	0.471	0.305
	Downstream reference	NS	NS	NS	NS	NS	NS	0.524	0.451	0.493	0.317
	Potential impact (drawdown & discharge)	NS	NS	NS	NS	0.529	0.311	0.609	0.491	0.500	0.276
	Upstream potential impact (drawdown)	NS	NS	NS	NS	0.519	0.312	0.583	0.440	0.519	0.287
	Upstream reference	NS	NS	NS	NS	0.561	0.349	0.590	0.444	0.416	0.233

³⁷ Baseline statistics will continue to be updated until implementation of the Proposal. The Robe River adjacent to Mesa C was impacted by fire in 2018, with a subsequent reduction in MSAVI; recovery will be tracked prior to commencement of dewatering at Mesa C and the trigger criterion for the Robe River revised if no longer considered sensitive enough to detect potential impact.

³⁸ The main monitoring zone represents a nominal potential impact zone which has been designated for Mesa C for the calculation of baseline statistics, as no impact from the Proposal is anticipated. After implementation of the Proposal, the zones for Mesa C will be reassessed depending on the extent, if any, of groundwater drawdown on the Robe River.

APPENDIX 3: NVIS level IV structural classes and integration with Aplin structural classes, for assessment of Warrambo Creek riparian vegetation

Table A3-1: NVIS level IV³⁹ structural classes and integration with Aplin⁴⁰ structural classes, for assessment of Warrambo Creek riparian vegetation

Stratum		Canopy cover (%)				
NVIS level IV (Sub-association)	Growth form	70-100%	30-70%	10-30%	2-10%	<2%
Upper Stratum	Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
	Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
	Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Mid Stratum	Shrubs over 2 m	Tall closed shrub	Tall open shrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
	Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
	Shrubs under 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Ground Stratum	Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
	Grasses, Sedges, Herbs	Closed tussock grassland/ bunch grassland/ sedgeland/ herbland	Tussock grassland/ bunch grassland/ sedgeland/ herbland	Open tussock grassland/ bunch grassland/ sedgeland/ herbland	Very open tussock grassland/ bunch grassland/ sedgeland/ herbland	Scattered tussock grasses/ bunch grasses/ sedges/ herbs

³⁹ Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003, Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0. Department of the Environment and Heritage, Canberra

⁴⁰ Aplin T.E.H 1979, The Flora. Chapter 3 In O'Brien, B.J (ed). Environment and Science. University of Western Australia Press