

BHP

Eastern Pilbara Water Resource Management Plan

DRAFT

**April 2022
Version 6.2**

Draft

Authorisation

Version	Name	Position	Date
6.1	Chris Serginson	Manager Environment WA Iron Ore	15/12/2021
6.2	Chris Serginson	Manager Environment WA Iron Ore	29/04/2022

Document amendment record

Version	Section/page	Version description	Key changes	Date
3.0	All	Submitted to Office of the EPA to meet conditions 7 and 8 of Ministerial Statement 1021	Addition of Schedules 1 and 2	05/08/2016
4.0	All	Revised to meet condition 8 of Ministerial Statement 1037. Revised to align with EPA (2016) <i>Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans</i>	EPWRMP structure, including Schedules, reformatted to reflect EPA's EMP Instructions	24/07/2017
5.0	All	Revised to meet condition 9 of Ministerial Statement 857	Addition of Schedule 3 and Section 1.4.4	13/09/2017
6.0	All	Revised to meet condition 8 of Ministerial Statement 857	Previous Schedule 1 broken down by Ministerial Statement number. Addition of Schedule 1c.	13/04/2018
6.1	All	Administrative update to align with Ministerial Statement 1126 and EPA (2021) <i>Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans</i>	Restructured/updated to align with EPA's revised October 2021 EMP Instructions and requirements of the current Ministerial Statements. Amended content to reflect current Ministerial Statement 1126 issued March 2020 and remove references and content related to superseded Ministerial Statements 857 (as amended by 1029), 809 and 683.	15/12/2021
6.2	All	Update to include the Orebody 32 Below Water Table derived proposal and to include stygofauna monitoring	Administrative update to include Orebody 32 Below Water Table. Minor change to the EMP rationale and components to include reference to the stygofauna monitoring program that BHP currently implements.	28/04/2022

Abbreviations

Term	Meaning
BHP	BHP Iron Ore Pty Ltd
CEO	Chief Executive Officer
DWER	Department of Water and Environmental Regulation
Ethel Gorge TEC	Ethel Gorge aquifer stygobiont Threatened Ecological Community
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP Act	<i>Environmental Protection Act 1986</i>
EPWRMP	Eastern Pilbara Water Resource Management Plan
km	kilometre
MAR	Managed Aquifer Recharge
mbgl	metres below ground level
mg/L	milligram per litre
ML/d	megalitres per day
MS	Ministerial Statement
TDS	Total Dissolved Solids
RiWI Act	<i>Rights in Water and Irrigation Act 1914</i>

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Executive summary

Eastern Pilbara Water Resource Management Plan	
Proposal names	Jimblebar Iron Ore Project - Revised Proposal (MS1126) Eastern Ridge Revised Proposal (MS1037) Orebody 31 Iron Ore Project (MS1021) Orebody 32 Below Water Table (Pilbara Expansion Strategic Proposal MS1105)
Proponent name	BHP Iron Ore Pty Ltd
Ministerial Statements	1126, 1037, 1021, 1105
Purpose of the EMP	To meet the requirements of MS1126 Condition 6, MS1037 Condition 8, MS1021 Conditions 7 and 8, and MS1105 Conditions 6, 9 and 10.
Key environmental factors and EMP outcomes	<p>Inland Waters and Subterranean Fauna Maintain the habitat of, and minimise impacts to, the Ethel Gorge Aquifer Stygobiont Community.</p> <p>Inland Waters and Flora and Vegetation Minimise impacts to the riparian vegetation along Jimblebar Creek.</p>
Condition clauses	<p>MS1126: Condition 6 Subterranean Fauna Environmental Management Plan</p> <p>MS1037: Condition 8 Subterranean Fauna – Ethel Gorge Aquifer Stygobiont Community</p> <p>MS1021: Condition 7 Surplus Water Discharge (Hydrological Processes)</p> <p>MS1021: Condition 8 Surplus Water Discharge (Inland Waters Environmental Quality)</p> <p>MS1105: Condition 6 Condition Environmental Management Plans</p> <p>MS1105: Condition 9 Subterranean Fauna Environmental Management Plan</p> <p>MS1105: Condition 10 Water Environmental Management Plan</p>
Key components in the EMP	<p>Outcomes-based components, including trigger and threshold criteria for:</p> <ul style="list-style-type: none"> groundwater levels and water quality (salinity) in the Ethel Gorge aquifer water quality (salinity and pH) at Jimblebar Creek discharge point vegetation condition along Jimblebar Creek.
Proposed construction date	<p>Jimblebar Iron Ore Project - Revised Proposal, Eastern Ridge Revised Proposal, Orebody 31 Iron Ore Project (MS1021): Not applicable - approved proposals are in operations.</p> <p>Orebody 32 Below Water Table: Q1, 2023</p>
EMP required pre-construction?	Not applicable. Required for multiple approved proposals which are in operations.

1 Context, scope and rationale

BHP Iron Ore Pty Ltd (BHP) has prepared the Eastern Pilbara Water Resource Management Plan (EPWRMP) to meet the requirements under Part IV of the *Environmental Protection Act 1986* (EP Act). BHP has prepared the EPWRMP to be consistent with the *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (the Instructions) (EPA 2021a).

1.1 Proposals

The scope of the EPWRMP is the management of water-related activities that have the potential to impact the Ethel Gorge aquifer stygobiont Threatened Ecological Community (Ethel Gorge TEC) associated with the following BHP proposals in the Eastern Pilbara water management area (Figure 1), that are approved under Part IV of the EP Act:

- Ministerial Statement (MS) 1126: Jimblebar Iron Ore Project - Revised Proposal
- MS1037: Eastern Ridge Revised Proposal
- MS1021: Orebody 31 Iron Ore Project.

The scope includes the management of surplus water discharge from Orebody 31 to Jimblebar Creek.

The scope of the EPWRMP also includes the following new mining operations and future expansions identified as a future proposal in the Pilbara Expansion Strategic Proposal MS1105 Schedule 1 - Table 1 and Figure 2:

- Orebody 32 Below Water Table (proposed).

The purpose of the EPWRMP is to meet the requirements of MS1126 Condition 6, MS1037 Condition 8, MS1021 Conditions 7 and 8, and MS1105 Conditions 6, 9 and 10.

All of the proposals are in operations except for the Orebody 32 Below Water Table proposal. Below is a summary of the proposals.

Jimblebar Iron Ore Project - Revised Proposal

The Jimblebar mine is located approximately 40 km east of Newman. Mining of iron ore deposits is undertaken above and below the water table. Mining operations include open pits, overburden storage areas and the construction and operation of associated mine, processing and rail infrastructure. Groundwater is abstracted for water supply and to dewater the orebodies. Surplus water management includes transfer to Ophthalmia Dam, controlled creek discharge and managed aquifer recharge (MAR).

The management of surplus water to creeks and aquifers is addressed in the *Jimblebar Water Management Plan* (BHP 2020a) which is required by MS1126 Condition 7 Water Environmental Management Plan (see Section 1.4.1).

Eastern Ridge Revised Proposal

The Eastern Ridge proposal is to undertake mining and associated activities at Eastern Ridge, located approximately 3 km north-east of Newman. The proposal involves open-pit mining above the water table at Orebody 32 and below the water table at Orebody 24, Orebody 25, and Orebody 25 West. The proposal includes pit dewatering, discharge of surplus dewater into Ophthalmia Dam and the construction and operation of associated mine infrastructure.

Orebody 31 Iron Ore Project

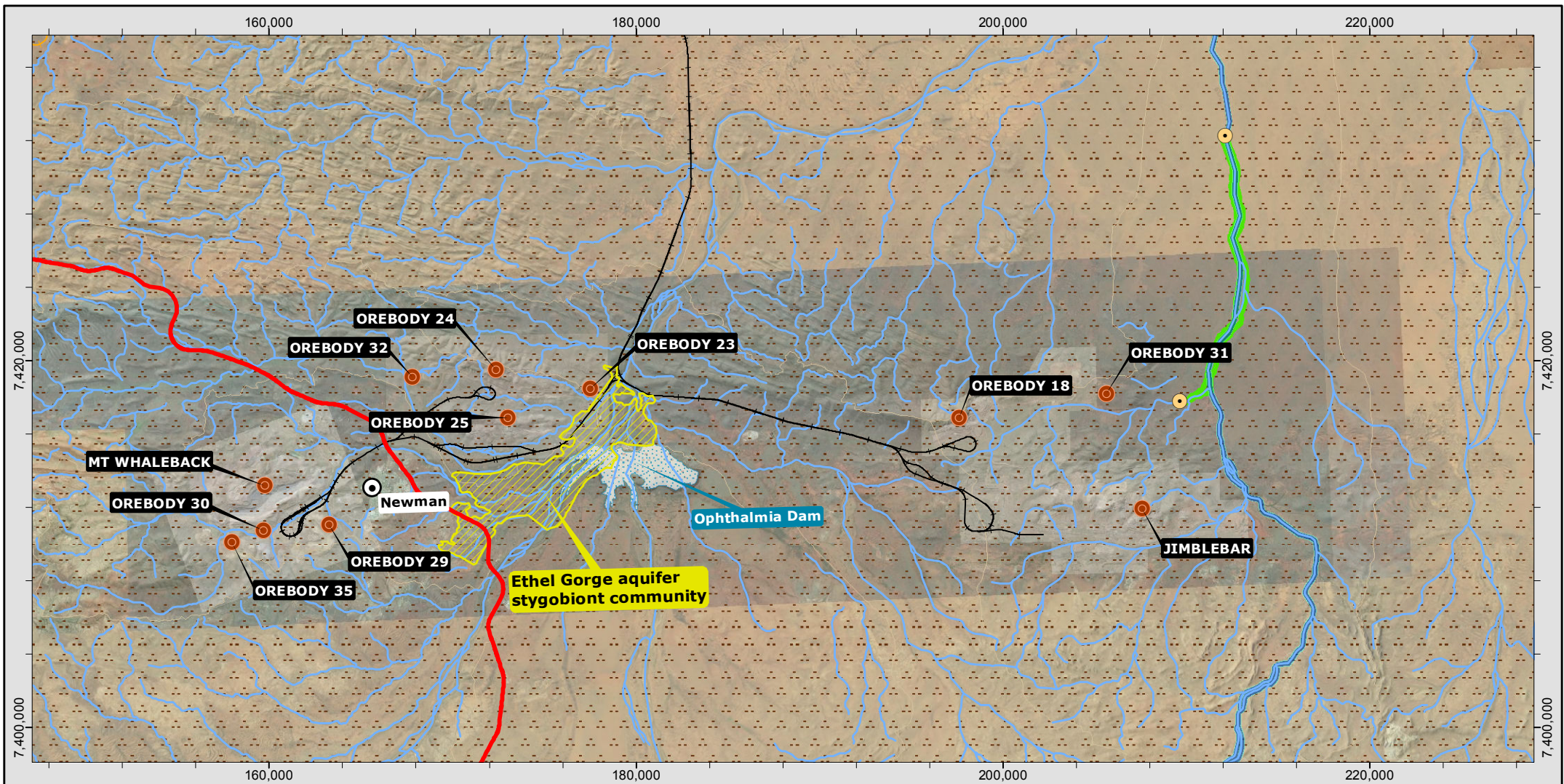
The Orebody 31 proposal is to develop and operate a below water table iron ore mine approximately 40 km east of Newman, Western Australia. The proposal includes the construction of an overland heavy vehicle haul road and an overland conveyor, as well as associated mine infrastructure including an overburden storage area, offices, workshops, roads, dewatering infrastructure, ore and topsoil stockpiles and associated facilities.

Surplus water management includes discharge to Ophthalmia Dam and discharge to Jimblebar Creek.

Orebody 32 Below Water Table

The proposal is a derived proposal for the expansion of existing mining operations at Newman, authorised by the Pilbara Expansion Strategic Proposal, MS1105.

The proposal is to expand the existing Orebody 32 above water table iron ore mine (authorised by the Eastern Ridge Revised Proposal, Ministerial Statement 1037) in BHP's Newman Hub to below the water table. The proposal is located approximately 3 kilometres (km) north-east of Newman (Figure 1) and includes pit dewatering and the discharge of surplus dewater into Ophthalmia Dam.



BHP BILLITON IRON ORE

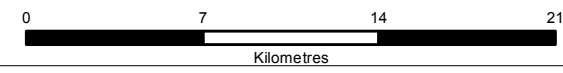
EASTERN PILBARA WATER RESOURCE MANAGEMENT PLAN
Eastern Pilbara Water Management Area

Scale @ A4: 1:300,000	Prepared: P. GANT	Project No: A838/01 REV A
Date: 26/06/2017	Checked: S. BRUNT	Figure: 1
Revision: REV A	Reviewed: L. KINGSHOTT	

- BHP Mine Site
- Town
- BHP Billiton Rail
- Rio Tinto Rail
- Great Northern Highway
- Watercourse
- Discharge Markers
- Jimblebar Creek
- Jimblebar Creek Riparian Vegetation Boundary
- Ophthalmia Dam
- TEC Environmental Receptor
- Hydrographic Catchments - Upper Fortescue

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Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994



1.2 Key environmental factors

The key environmental factors relevant to this EPWRMP are Inland Waters, Subterranean Fauna and Flora and Vegetation. Table 1 summarises the environmental values, proposal activities and actual or potential impacts on the key environmental factors addressed by this EPWRMP.

Table 1: Key environmental factors, values and activities

Key environmental factor	Environmental values	Proposal activities	Actual/Potential impacts
Inland Waters and Subterranean Fauna	Ethel Gorge TEC	Dewatering of mine pits (Eastern Ridge Revised Proposal) Discharge of surplus mine dewater to Ophthalmia Dam (Eastern Ridge Revised Proposal, Orebody 31 Iron Ore Project, Jimblebar Iron Ore Project - Revised Proposal and Orebody 32 Below Water Table)	Direct impacts Changes to groundwater levels and groundwater quality (salinity) in the Ethel Gorge aquifer Indirect impacts Potential changes to stygofauna habitat and reduction in stygofauna species abundance and diversity
Inland Waters and Flora and vegetation	Jimblebar Creek riparian vegetation	Discharge of surplus mine dewater along Jimblebar Creek (Orebody 31 Iron Ore Project)	Direct impacts Changes to water quality Indirect impacts Decline in health of Jimblebar Creek riparian vegetation

BHP manages other water-related environmental values through other Part IV EMPs and other legislation. The relationship between this EPWRMP and other water management and regulation for the proposals addressed in the EPWRMP is outlined in Section 1.4.1.

1.3 Condition requirements

BHP has provided the condition requirements of Jimblebar MS1126 Condition 6, Eastern Ridge MS1037 Condition 8, Orebody 31 MS1021 Conditions 7 and 8, and MS1105 Conditions 6, 9 and 10 in Schedules (see Section 2), which the Instructions allow for, where there are multiple conditions and/or condition clauses.

1.4 Rationale and approach

As required by the Instructions, this section provides a concise description of the rationale and approach for the components in this EPWRMP.

1.4.1 Management approach

BHP uses a regional and site specific approach to manage the impacts of its operations on water-related environmental values in the Eastern Pilbara water management area. The water management framework for the proposals addressed in the EPWRMP is shown in Figure 2.

BHP applied a risk-based approach to identify and prioritise components in this EPWRMP. The purpose of the components is to protect the environmental values in Table 1. BHP applies a regional approach to water management, as outlined in the *Pilbara Water Resource Management Strategy* (BHP 2020b). In developing

the components, BHP has used available scientific information from recent ecohydrological investigations, studies and monitoring.

This EPWRMP does not duplicate monitoring and/or controls in other statutory decision-making processes for water-related activities (Table 2). This includes regulation administered by the Department of Water and Environmental Regulation (DWER), i.e. EP Act Part V and *Rights in Water and Irrigation Act 1914* (RiWI Act).

Table 2: Other approvals relating to the EPWRMP

Activity	Site/location	Legislation and Approval	Control
Groundwater abstraction (Dewatering)	Dewatering at Eastern Ridge operations authorised under MS1037 and proposed under MS1105 (Orebody 32 Below Water Table)	RiWI 5C licence to take water (and associated Operating Strategy): <ul style="list-style-type: none"> Eastern Ridge: GWL182237(4)¹ Orebody 23: GWL74556(11) 	<ul style="list-style-type: none"> Limit on rate of groundwater abstraction Groundwater monitoring (Operating Strategy) – abstraction rate, volume, groundwater levels and quality
Surplus water management	Discharge to Ophthalmia Dam from Eastern Ridge operations authorised under MS1037 and proposed under MS1105 (Orebody 32 Below Water Table), Jimblebar and Orebody 31	EP Act Part V licence: <ul style="list-style-type: none"> Jimblebar Hub (includes Jimblebar and Orebody 31): L5415/1988/9 Eastern Ridge operations: L6942/1997/13² RiWI 5C licence to take water (and associated Operating Strategy): <ul style="list-style-type: none"> Ophthalmia Borefield: GWL65219(12) 	EP Act Part V licences: <ul style="list-style-type: none"> Limit on the rate of emissions (discharge to Ophthalmia Dam) Specifies the location of point source emissions Specifies monitoring (flow rate and volume) at the discharge point RiWI licence GWL65219(12): <ul style="list-style-type: none"> Monitoring of aquifer water quality adjacent to Ophthalmia Dam
	Discharge to Jimblebar Creek tributary from Orebody 31	EP Act Part V licence: <ul style="list-style-type: none"> Jimblebar Hub (includes Jimblebar and Orebody 31): L5415/1988/9 	<ul style="list-style-type: none"> Limit on the rate of emissions (discharge to creeks) Specifies the location of point source emissions Specifies monitoring (flow rate, volume and water quality) at the discharge point

1. Abstraction at OB32 will be regulated through an amendment to the existing RiWI licence for Eastern Ridge or new licence.

2. Surplus water discharge from OB32 to Ophthalmia Dam will be regulated through an amendment to the existing Part V Eastern Ridge Iron Ore Mine licence.

Region	Pilbara Water Resource Management Strategy		
Sub-region	Part IV EP Act: Eastern Pilbara Water Resource Management Plan		
	<ul style="list-style-type: none"> Ethel Gorge TEC: Jimblebar MS1126 Condition 6, Orebody 31 MS1021 Condition 8, Eastern Ridge MS1037 Condition 8, and Pilbara Expansion Strategic Proposal MS1105 Conditions 9 and 10 (<i>proposed</i>) Jimblebar Creek riparian vegetation (Orebody 31 MS1021 Condition 7) 		
Sub-region	Surplus Water Management Plan: Ophthalmia Dam Surplus Water Scheme		
	<ul style="list-style-type: none"> Describes the Ophthalmia Dam surplus scheme and its planned operation 		
Site	Jimblebar	Orebody 31	Eastern Ridge including Orebody 32 BWT (<i>proposed</i>)
	EP Act Part IV MS1126 <ul style="list-style-type: none"> Authorised extents (Ophthalmia Dam discharge rate, Caramulla Creek wetting front, Caramulla aquifer groundwater level) Condition 7 Water Environmental Management Plan (Innawally Pool, Caramulla Creek, Caramulla aquifer) 	EP Act Part IV MS1021 <ul style="list-style-type: none"> Authorised extent (Jimblebar Creek wetting front) 	EP Act Part IV Eastern Ridge MS1037 <ul style="list-style-type: none"> Authorised extents (dewatering abstraction rate, Ophthalmia Dam discharge rate)
	EP Act Part V L5415/1988/9 <ul style="list-style-type: none"> Limit on the rate of emissions (discharge to Ophthalmia Dam and creeks, injection to aquifers) Specifies the location of emissions Specifies monitoring (flow rate, volume, groundwater level and water quality) 		EP Act Part V L6942/1997/13 (<i>amend if approved</i>) <ul style="list-style-type: none"> Limit on the rate of emissions (discharge to Ophthalmia Dam) Specifies the location of emissions Specifies monitoring (flow rate, volume and water quality)
	RiWI 5C GWL158795(11) and Operating Strategy	RiWI 5C GWL181025(4) and Operating Strategy	RiWI 5C GWL182237(4) and Operating Strategy (<i>amend or new if OB32 BWT approved</i>)
	<ul style="list-style-type: none"> Limit on rate of groundwater abstraction Monitoring at the source (dewatering bores) – abstraction rate, volume, groundwater levels and quality Monitoring along pathway – groundwater levels 		

Figure 2: Water management framework

1.4.2 Rationale for Ethel Gorge TEC components

Table 3 provides a concise description (in tabular format) of the rationale for the EMP components relating to the Ethel Gorge TEC in Section 2 (Schedules 1a to 1c), including:

- environmental outcome
- survey and study findings
- key assumptions and uncertainties
- rationale for choice of indicators.

Detail on the Ethel Gorge monitoring program and management controls is provided in Sections 1.4.2.1 and 1.4.2.2.

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Table 3: Rationale for EMP components - Ethel Gorge TEC

Surveys and studies	Survey and study findings	Key assumptions and uncertainties	Rationale for choice of components
<p>Environmental value: Ethel Gorge TEC</p> <p>EMP environmental outcome: Maintain the habitat of the Ethel Gorge Aquifer Stygobiont Community</p>			
<ul style="list-style-type: none"> Bennelongia (2013). <i>Characterisation and Mapping of Ethel Gorge Aquifer Stygobiont Threatened Ecological Community</i>. BHP Billiton (2015). <i>SEA Hydrology – Ecohydrological Change Assessment</i> Halse et. al. (2014). <i>Pilbara stygofauna: deep groundwater of an arid landscape contains globally significant radiation of biodiversity. Records of the Western Australian Museum, Supplement 78: 443-483.</i> Stantec (2017). <i>Ethel Gorge Stygofauna Monitoring Program: 2017.</i> Stantec (2022). <i>Eastern Ridge and Jimblebar Stygofauna Monitoring 2020/2021.</i> 	<ul style="list-style-type: none"> Ethel Gorge is an important feature of the Eastern Pilbara hydrological system, as the surface and groundwater flows from the upstream catchment area, converge here. The area can be characterised as a receiving environment, comprising channels, flood plains and calcretes of the river and calcrete land systems dissected by ridges of bedrock. It has groundwater levels of less than 10 metres below ground level (mbgl) which gives rise to potential interactions between the groundwater and terrestrial environments (through surface water connection and vegetation). The ecohydrological representation of the system is shown in Figure 3 (BHP Billiton 2015). The Ethel Gorge Aquifer Stygobiont community has been identified by Department of Environment and Conservation (DEC) (now Department of Biodiversity, Conservation and Attractions (DBCA)) as a TEC (Endangered) due to high biodiversity values and conservation significance. It is located approximately 10 km north-east of Newman (Figure 1), however the buffer extends out further. The Ethel Gorge TEC is characterised by the co-occurrence of a diverse assemblage of stygofauna species inhabiting the shallow alluvial and calcrete aquifers within Ethel Gorge and downstream of the gorge for approximately five kilometres (Bennelongia 2013). Thirty-seven 'core endemic' species have been recognised from the Ethel Gorge area from monitoring programs conducted annually since 2009. Species accumulation modelling estimates that between 68.5 to 95.9 percent of the assemblage predicted to exist within the Ethel Gorge area has been recorded. (Stantec 2022). The findings of the 2020/2021 monitoring along with previous monitoring rounds indicate that current groundwater management practices have been successful in mitigating potential impacts to the Ethel Gorge stygofauna TEC from BHP WAIO operations. It is also considered that adequate saturation of the core habitat has been maintained, enabling persistence of stygofauna. The hydrogeological units that host the highest species richness are the shallow alluvial and calcrete aquifers within the gorge, and approximately 5 km downstream (Stantec 2022) (Figure 1). The Ethel Gorge TEC has a strong groundwater hydrological dependency provided by shallow saturated pore spaces in which stygofauna live. The community is hosted in shallow alluvial aquifers (notably calcrete) and their habitat is maintained by saturation of these aquifers. Changes to groundwater levels or quality, therefore, may have an impact on the TEC. Ophthalmia Dam, some 5 km upstream of Ethel Gorge (Figure 4 and Figure 5), was designed as a managed aquifer recharge (MAR) facility and has an important influence on the hydrological condition downstream in Ethel Gorge. Recharge to the shallow groundwater system occurs as seepage from Ophthalmia Dam and associated infiltration structures as well as direct infiltration from channel flow events. The hydraulic behaviour of the gorge groundwater system has been dominated by Ophthalmia Dam since its commissioning in 1981. The dam was designed to increase groundwater recharge and hydraulic loading on the alluvial aquifer to offset drawdown from the Ophthalmia Borefield (Figure 5). The dam impounds and retards flood waters in the Fortescue River to allow larger volumes of infiltration over a prolonged period. As such, groundwater levels in the aquifer have been sustained at much higher levels since the dam was constructed than would otherwise have been the case. Groundwater levels are reflective of the significant recharge events following relatively wet periods during the summer months. The range in water levels maintains a substantial saturated thickness in the upper alluvial aquifer (including the calcretes) and provides a consistent habitat for stygofauna. The area of the Ethel Gorge TEC coincides with both areas of shallow groundwater and the deposit of subsurface calcretes. The BHP mining activities which have the potential to change the hydrological condition of the Ethel Gorge TEC environment have been identified as: mine dewatering, groundwater abstraction, mine pit salinisation and surplus water discharge. Within 10 km of Ethel Gorge are BHP mining operations at Eastern Ridge, where the mineralised Banded Iron Formation aquifer is dewatered to provide access to the ore. Operational dewatering results in localised water table drawdown and reduced through-flow in sections of the aquifer south east of pits, although groundwater levels recover in some areas following flow events in the catchment. 	<ul style="list-style-type: none"> There are a range of water-affecting activities in the Upper Fortescue River catchment which may result in changes to hydrological processes. These include: <ol style="list-style-type: none"> local drawdown of the groundwater levels, resulting from abstraction of water to facilitate below water table mining; regional drawdown of the groundwater levels, that is drawdown that extends beyond the immediate vicinity of the deposit or site, resulting in abstraction of water to facilitate below water table mining changes in groundwater water quality resulting from mining, abstraction or re-injection; and changes in surface water flows or water quality resulting from surface water management, including discharge of surplus water, or diversion. Cumulative effects <ul style="list-style-type: none"> Hydrological conditions can be impacted by more than one mining operation, depending on the surface water and groundwater hydrological interconnectivity at the catchment scale. The Eastern Pilbara water management area is a unique environment as BHP is the only mining operation in this catchment. As such, BHP has been collecting data at the catchment level and can undertake cumulative impact assessments for its operations as new developments are progressed. Regional Monitoring Network and catchment-scale eco-hydrological studies are undertaken to provide baseline assessments and predictive models, which will be updated iteratively to inform cumulative impact assessments and inform adaptive management. Scientific uncertainty <ul style="list-style-type: none"> Key areas of uncertainty include the hydrologic function of the catchment, resilience and susceptibility of receptors to water changes and long term changes to mining activities. Limitations to developing robust ecological indicators include but are not limited to: <ul style="list-style-type: none"> the inherent limitations of methods used to sample stygofauna (e.g. false absences); limited understanding (and ability to understand) of the trophic structure of the community and how natural processes contribute to variability in species abundance and richness spatially and temporally. Improving Understanding – Ethel Gorge TEC <p>The following have been identified as aspects for which BHP is going to improve understanding:</p> <ul style="list-style-type: none"> Understanding of the tolerances of the stygofauna community, specifically the 'core endemic' species, to changes in salinity and other hydrochemistry changes. <p>Stygofauna monitoring at the Ethel Gorge TEC has been ongoing since 2003 (Stantec 2022). The current stygofauna monitoring program includes annual seasonal monitoring of groundwater quality (full hydrochemistry suite) and sampling of stygofauna species. BHP is currently reviewing its stygofauna monitoring program that it has undertaken since 2003 (groundwater quality and stygofauna sampling and analysis). BHP considers that to improve understanding of species tolerance, a research project would be appropriate, where the research</p> 	<ul style="list-style-type: none"> Indicators have been selected in the context of natural variance. The hydrological indicators used in this EPWRMP are based on historical ranges of groundwater levels and water quality (as Total Dissolved Solids (TDS)) observed in the Ethel Gorge aquifer. The trigger and threshold values have been established to manage the potential impacts to the stygofauna community habitat and are set to maintain hydrological conditions (groundwater levels and salinity) in the Ethel Gorge aquifer within acceptable historical ranges. These hydrological conditions are the basis of maintaining the Ethel Gorge TEC habitat), and are therefore the key indicators that will be monitored. Consistent with the EPA's <i>Environmental outcomes and outcomes-based conditions: Interim Guidance</i> (EPA 2021b), the groundwater level and groundwater salinity indicators are used by BHP as a surrogate indicator for stygofauna, in particular for the condition of the stygofauna habitat in the Ethel Gorge TEC. The groundwater criteria are lead indicators, as they provide an early measure of potential changes to the stygofauna community. To ensure that the groundwater indicators represent the condition of the Ethel Gorge TEC habitat and the community, BHP also undertakes groundwater quality and stygofauna species sampling as part of its regular stygofauna monitoring program. As the Ethel Gorge is a regional water asset, the water-related components (indicators - triggers and thresholds, monitoring and reporting are the same for each project addressed in the EPWRMP that discharges surplus water to Ophthalmia Dam. This approach enables BHP to pro-actively manage its activities and impacts at the regional level. BHP has established monitoring and management zones to enable

Surveys and studies	Survey and study findings	Key assumptions and uncertainties	Rationale for choice of components
	<ul style="list-style-type: none"> • The discharge of surplus water from the Eastern Ridge, Whaleback (including Orebody29/30/35) and Jimblebar (including Orebody 31) mining hubs into Ophthalmia Dam is approved under Ministerial Statements and relevant DWER Licences. The discharge of this water has the potential to change the water levels and quality within the downstream habitat of the stygofauna community. • There are two main threatening processes to stygofauna associated with mining developments in the Ethel Gorge area: <ol style="list-style-type: none"> 1. The stygofauna community may be impacted by changes to groundwater levels associated with groundwater abstraction and/or discharge of surplus water into Ophthalmia Dam. The area has experienced substantial changes in groundwater levels historically, in connection with groundwater abstraction, dewatering activities, recharge through the Dam, and climatic variation. However, to date, no measurable impacts on the stygofauna community have been observed during the monitoring period (Stantec 2017). 2. The stygofauna community may be impacted by changes to groundwater quality associated with abstraction and/or discharge of surplus water into Ophthalmia Dam. Monitoring suggests that groundwater salinity has increased in parts of the aquifer and decreased in others; however, no measureable impacts on the stygofauna community have been observed (Stantec 2017). • An increase in groundwater salinity is likely to be within the tolerance thresholds of the stygofauna community. Available scientific knowledge suggests that many stygofauna species can tolerate a variable salinity regime (Halse et. al. 2014). However, less resilient species may be vulnerable to salinity increases beyond the range of natural variability. Progressive technical studies are required to address these uncertainties within the framework of BHP's adaptive management approach. 	<p>is undertaken in a controlled environment (i.e laboratory) to gradually expose certain stygofauna species to increasing levels of salinity. A recent project commissioned by BHP indicates that certain species can be kept alive during transport and in a laboratory environment.</p> <p>Monitoring of water levels in the Ethel Gorge system monitoring and management zones was identified as an improvement activity in the EPWRMP Version 6.0. Monitoring of water levels in the Ethel Gorge system monitoring and management zones is now an ongoing, Business as Usual activity.</p>	<p>adaptive management of the Ethel Gorge system. Detail and rationale for the monitoring program is in Section 1.4.2.2.</p>

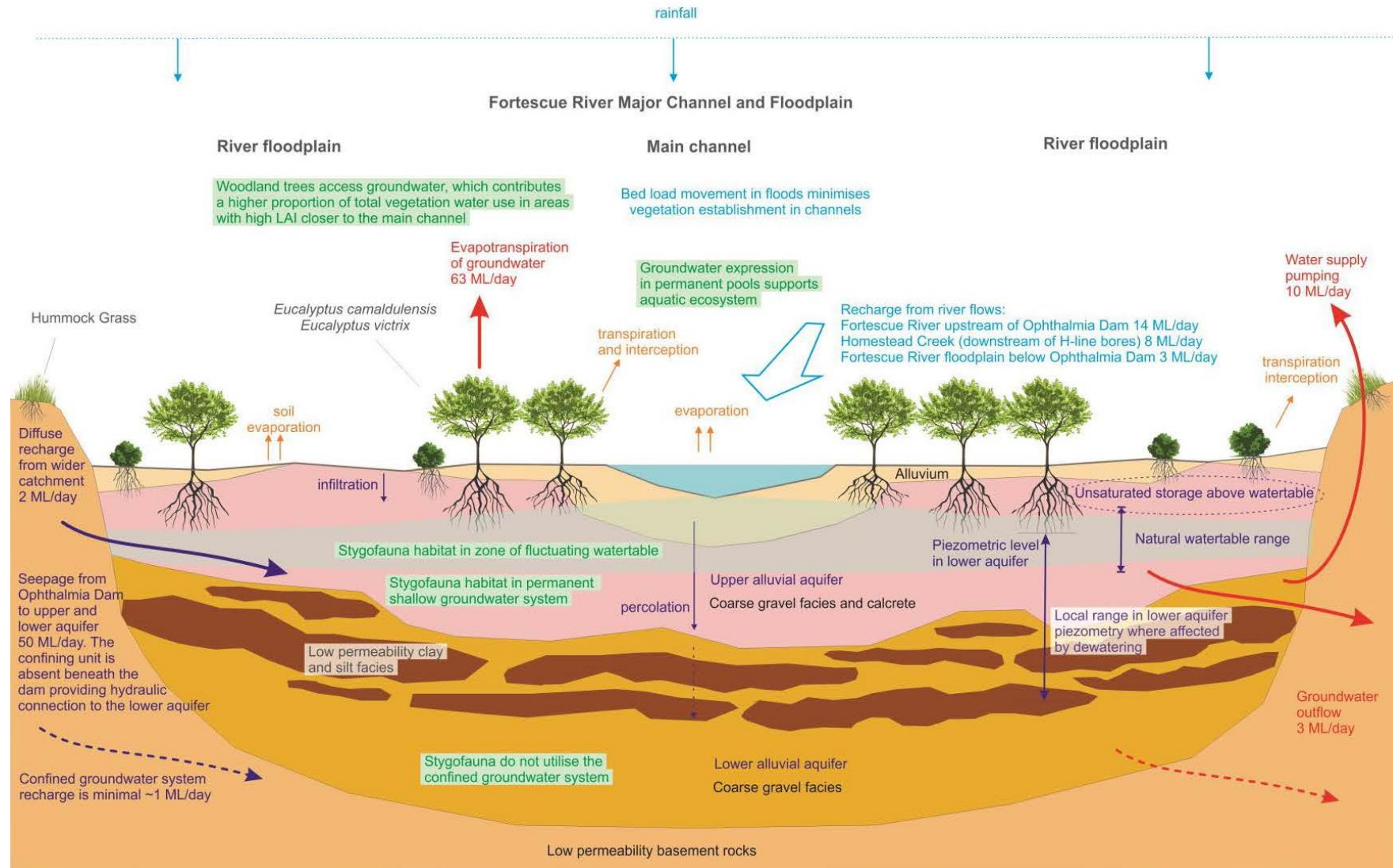


Figure 3: Ethel Gorge eco-hydrological conceptualisation

1.4.2.1 Monitoring program detail

Over 35 years of surveys, data collection and understanding of water in the Eastern Pilbara water management area dating back to 1981 when the Ophthalmia Dam was constructed, has been considered in the development of this EPWRMP.

Detail on the monitoring program is provided below and in Table 4 and Table 5. BHP has established monitoring and management zones (Table 4 and Figure 4) to enable adaptive management of the Ethel Gorge system.

As discussed in Table 3, adaptive management criteria (early response indicators, triggers and thresholds) are based on historical hydrological conditions in the Ethel Gorge aquifer. Adaptive management of the Ethel Gorge system allows for three stages of response: investigate, action and mitigate. The approach ensures that any change and/or response observed is characterised and understood prior to implementing corrective action. A summary of the monitoring for the Ethel Gorge Primary Habitat Management Zone is in Table 5. Operational triggers have also been established (Table 5) to support the management of the broader hydrological system and the range of potential changes to hydrological conditions in the primary Ethel Gorge receptor. These are not formal Ethel Gorge management criteria but are set as operational response criteria to aid in meeting the environmental outcomes for the Ethel Gorge TEC. A detailed monitoring program is provided in the *GWL Operating Strategy for Ophthalmia Borefield* (BHP 2018), required in accordance with the Licence to Take Water GWL65219(9) conditions for abstraction from this aquifer.

Table 4: Ethel Gorge monitoring and management zones

Monitoring and management zone	Location	Monitoring detail/rationale
Early Warning Monitoring Zone	Immediately downstream of Ophthalmia Dam (Figure 4)	<p>Purpose is to identify a measurable change in water levels and quality above predetermined acceptable ranges within the groundwater system resulting from infiltration through Ophthalmia Dam:</p> <ul style="list-style-type: none"> • Monitor groundwater levels and quality (salinity as TDS) downstream of dam. • Determines the management response to prevent potential down-gradient impacts.
Ethel Gorge Primary Habitat Monitoring Zone (Monitoring Zone 1)	Downstream of Early Warning Monitoring Zone (Figure 4)	<p>Represents primary Ethel Gorge habitat and supporting aquifer:</p> <ul style="list-style-type: none"> • Monitor changes to groundwater levels and quality (salinity as TDS). • Upper and lower monitoring thresholds are based on historic variance.
Shovelanna Creek Monitoring Zone (Monitoring Zone 2)	Shovelanna Creek aquifer, upstream of Ethel Gorge system (Figure 4)	<p>Purpose is to identify and characterise the hydrological stresses and pathway located between Ethel Gorge and the neighbouring operations:</p> <ul style="list-style-type: none"> • Monitoring to capture potential effects from OB25 dewatering and alterations to natural recharge.
Homestead Creek Monitoring Zone (Monitoring Zone 3)	Homestead Creek aquifer, upstream of Ethel Gorge system (Figure 4)	Monitoring of Shovelanna Creek to identify and characterise natural variance in water quality (salinity as TDS) originating to the east.
Ophthalmia Dam Monitoring Zone (Monitoring Zone 4)	Ophthalmia Dam (Figure 4)	Measurement of water level, outflow and water quality.
Management Zone	Ophthalmia Dam system and Ophthalmia Borefield (Figure 4 and Figure 5)	BHP uses Ophthalmia Dam system (Ophthalmia Dam, infiltration basins and recharge ponds) to infiltrate surplus water from mine dewatering, and uses the Ophthalmia Borefield to manage groundwater levels, to manage groundwater levels and groundwater quality in the Ethel Gorge aquifer.

Table 5: Ethel Gorge monitoring zone criteria

Monitoring zone	Location	Criteria (and management stage)		
		Early response indicator (Investigate)	Trigger (Action)	Threshold (Mitigate)
EPWRMP criteria				
Ethel Gorge Primary Habitat Monitoring Zone	Ethel Gorge TEC primary receptor	Water quality 2,500 mg/L TDS	Water quality 3,000 mg/L TDS	Water quality 4,000 mg/L TDS
		Water quantity Aquifer groundwater levels change 5 m ¹ or a rate of >4 m/year	Water quantity Aquifer groundwater levels change >6 m ¹ or a rate of >4 m/year	Water quantity Aquifer groundwater levels change >12 m ¹ or a rate of >8 m/year
Operational criteria				
Shovelanna Creek Monitoring Zone	Shovelanna Creek Aquifer	Water quality Statistically significant increase in TDS of 20% from long term seasonal average	-	-
Homestead Creek Monitoring Zone	Homestead Creek Aquifer	Water quality Statistically significant increase in TDS of 20% from an interpreted seasonal baseline Water quantity Change >+/- 6 m ¹ or at a rate of >4 m/year	-	-
Dam Monitoring Zone	Ophthalmia Dam and outflow values	Water quality Dam water TDS > 4,000 mg/L	Water quality Dam water TDS > 5,000 mg/L	-
Early Warning Monitoring Zone	Management Zone – downstream of Dam	Water quality Statistically significant increase in TDS of 20% from an interpreted seasonal baseline	Water quality Statistically significant increase in TDS of 50% from an interpreted seasonal baseline	-

1. Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone (Figure 4). Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall criteria.

1.4.2.2 Preventative management and corrective action controls

The specific water management options which are currently being used for both operational water management purposes and as the primary controls for mitigating water impacts to Ethel Gorge TEC are summarised below, with the locations presented in Figure 5. The application of the management measures and controls at these locations, including the process and limitations, is summarised in Table 6.

Ophthalmia Dam storage and infiltration: Surplus dewater is discharged to and stored in Ophthalmia Dam. Ophthalmia Dam is designed to retard the flow of some surface water from the Fortescue River and enable passive infiltration into the shallow alluvial aquifer which supports the Ethel Gorge TEC and the Newman drinking water supply. The controlled release of the dam water via three outlets directs water into the Fortescue River and the down gradient infiltration basins, returning water back into the environment when required and as a preventative control to mitigate the effects of increased salinity or inundation of the rail line.

Recharge Ponds: The ponds located within Ethel Gorge receive discharge water from the Eastern Ridge mining operations mine dewatering and enable passive but relatively quick infiltration into the underlying alluvial aquifer through the shallow and permeable calcrete formations. The facility mitigates impacts from changes to water levels in the Ethel Gorge TEC from mining below the water table at the Eastern Ridge mining operations.

Infiltration Basins: Controlled release of Ophthalmia Dam water into the infiltration basins located immediately down-gradient of the dam. The ponds induce vertical leakage and support water levels and water quality (low salinity) in the Ethel Gorge alluvial aquifer. The basins have historically been effective as a “fast response” tool to increase water levels and lower salinity.

Ophthalmia Borefield: Ophthalmia borefield located within Ethel Gorge provides part of the Newman drinking water supply. Abstraction from the borefield provides a mitigating control to reduce elevated groundwater levels in the Ethel Gorge aquifer (if required), whilst delivering a protected drinking water supply.

Fortescue River seasonal release: Ophthalmia Dam has been designed to allow for the controlled release of water into the upper Fortescue River tributaries, including Shovelanna Creek via the eastern dam wall valve. The temporary release of dam water immediately following a wet season (typically December through March) allows for additional storage capacity during the dry period, particularly when dewatering volumes are predicted to be greater than outflows. Three months of controlled release into the Upper Fortescue River following the wet season is considered appropriate and unlikely to develop permanent or ponding water downstream in the Fortescue River. The seasonal release is considered unlikely to have an impact on riparian vegetation.

Table 6: Ethel Gorge Management measures and controls

Management measure or control	Process	Limitations
Capture and release of higher salinity water in Ophthalmia Dam during rain events.	Store surplus water in Ophthalmia Dam during dry seasons (April to November) and practise controlled release of water into Fortescue River during the wet seasons with preference to occur in conjunction with natural flow events (November to March).	<ul style="list-style-type: none"> Requires a rain event which overtops the dam. Requires a buffer in the dam for fresh runoff to sufficiently dilute the dam surplus prior to discharge.
Capture and infiltrate fresh water through the Ophthalmia Dam floor to mitigate increased aquifer salinity down-gradient.	Capture fresh rainfall runoff into Ophthalmia Dam during wet seasons and periodically release into the infiltration ponds.	<ul style="list-style-type: none"> Requires dewatering surplus to be discharged elsewhere.

Management measure or control	Process	Limitations
Discharge dewatering water into the Dam and mix with captured fresh runoff to dilute before infiltration or controlled release.	Dilute dewatering surplus water in Ophthalmia Dam with fresh runoff. Followed by either passive infiltration into the Infiltration Ponds or controlled release downstream into the Fortescue River.	<ul style="list-style-type: none"> Requires a buffer in the dam for fresh runoff to sufficiently dilute the dam surplus prior to discharge.
Store and infiltrate dewatering water into the aquifer directly through Recharge Ponds.	Infiltrate surplus dewatering water through the 3 Recharge Ponds into the Ethel Gorge aquifer.	<ul style="list-style-type: none"> Requires dewatering water salinity to be below Ethel Gorge aquifer threshold salinity.
Maintain sufficient buffer in the Ethel Gorge aquifer to accommodate the infiltration of fresh runoff.	Control groundwater levels in the upper aquifer through the operation of Ophthalmia Borefield to lower levels and encourage fresh (low salinity) infiltration during rain events.	<ul style="list-style-type: none"> Abstraction rates limited by potable infrastructure and demand.

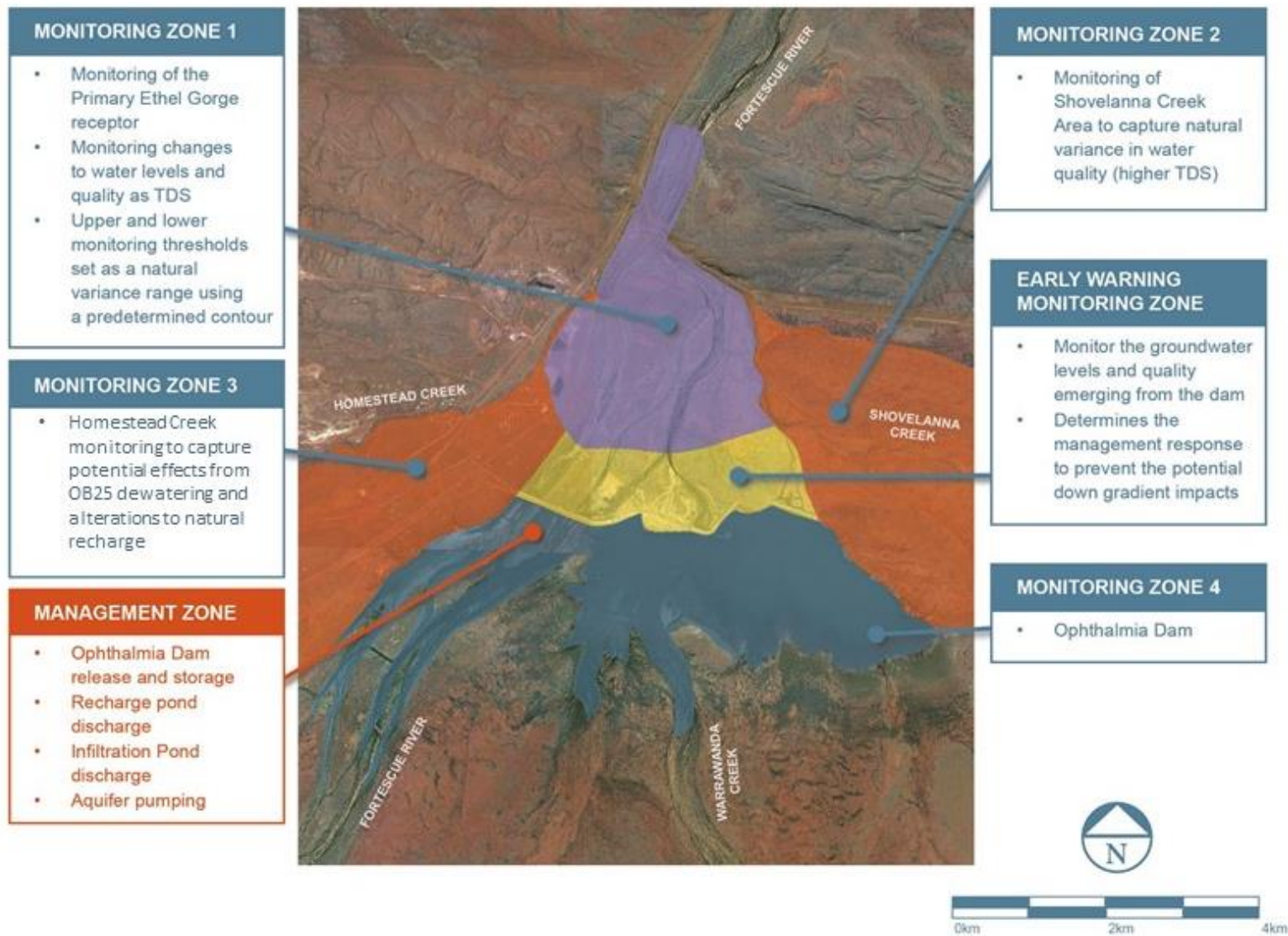


Figure 4: Ethel Gorge monitoring and management zones

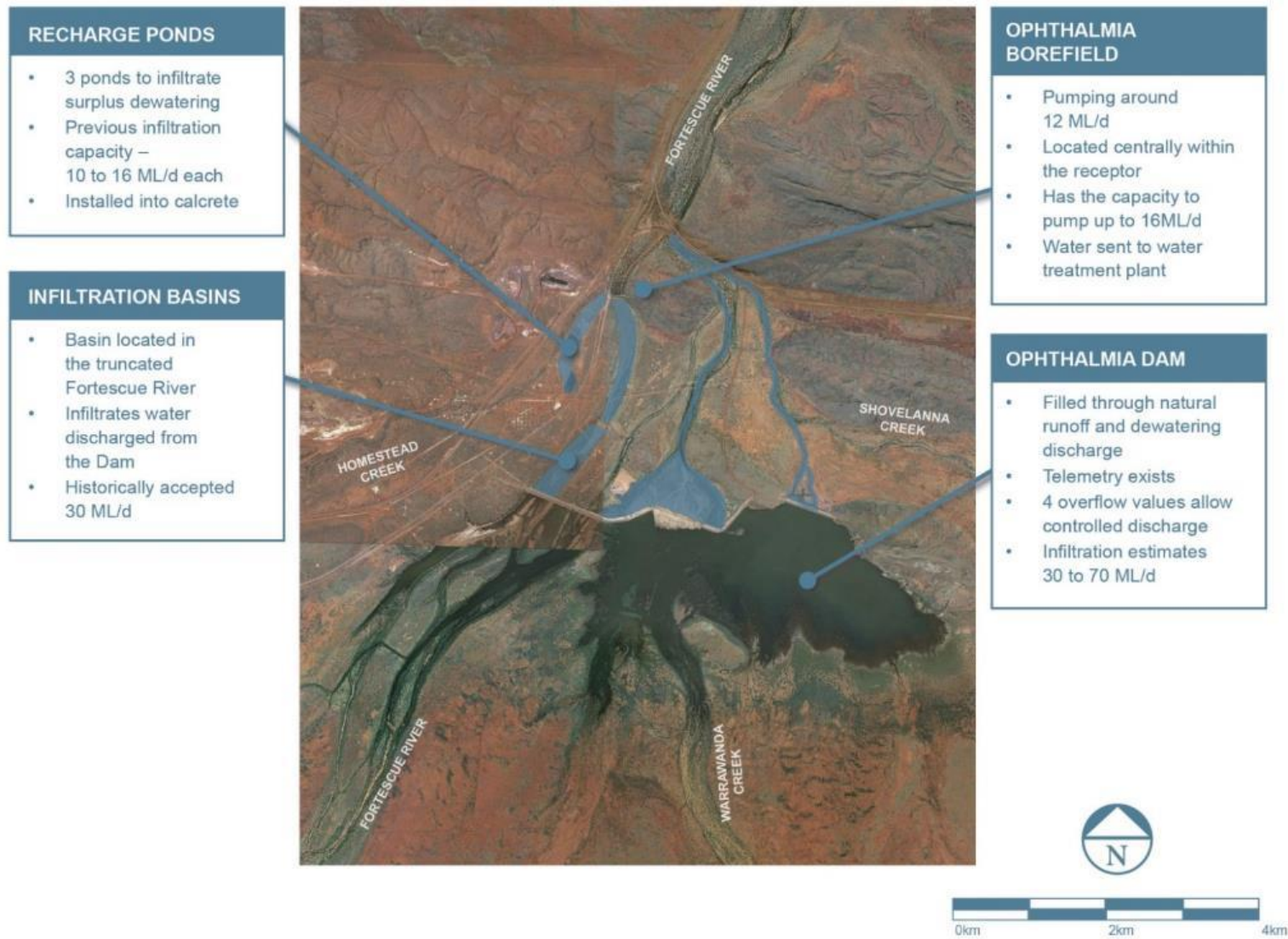


Figure 5: Ethel Gorge control locations

1.4.3 Rationale for Jimblebar Creek riparian vegetation components

Table 7 provides a concise description (in tabular format) of the rationale for the EMP components relating to Jimblebar Creek riparian vegetation in Section 2 (Schedule 2), including:

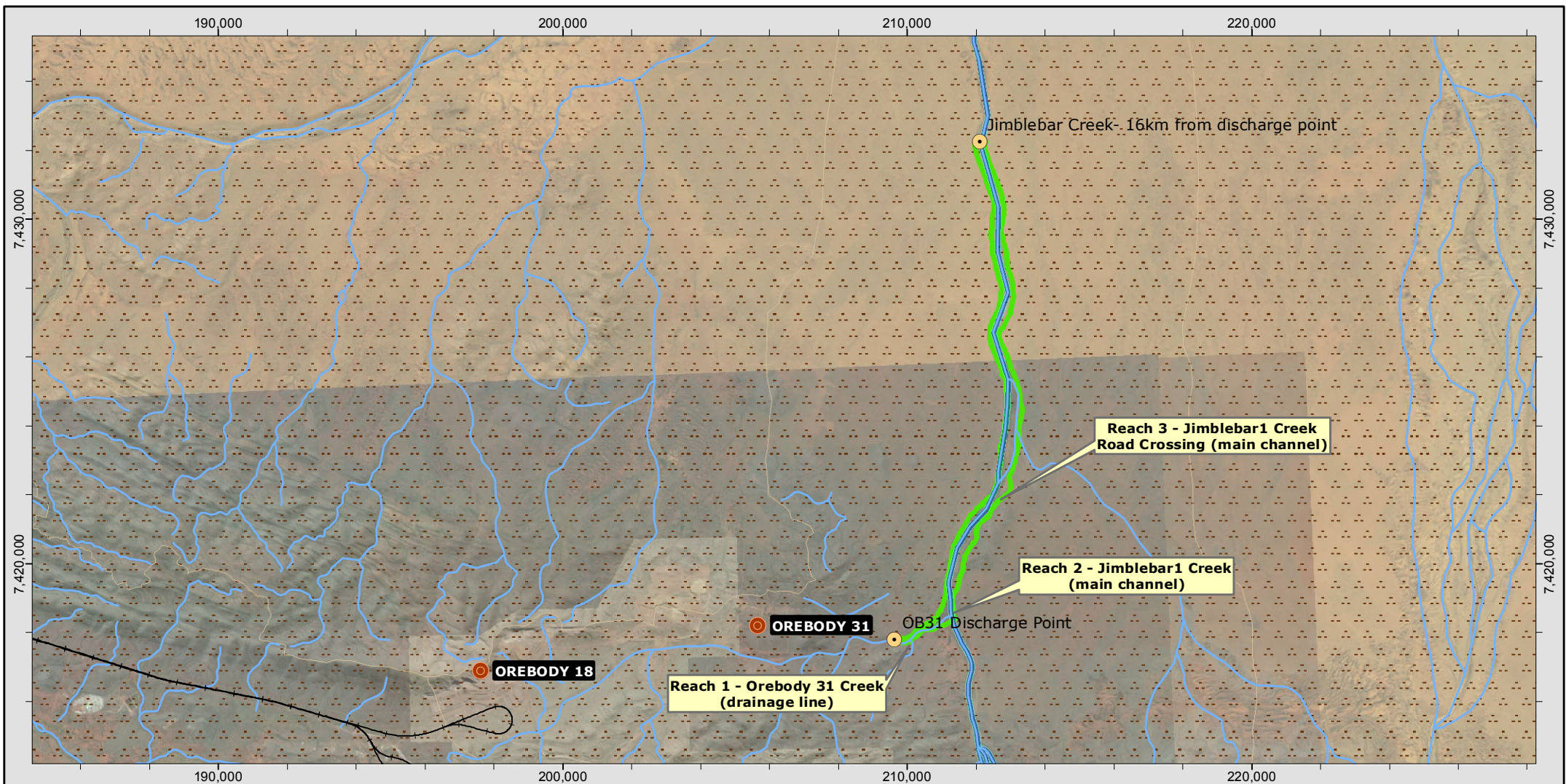
- environmental outcome;
- survey and study findings;
- key assumptions and uncertainties; and
- rationale for choice of indicators.

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Table 7: Rationale for EMP components - Jimblebar Creek riparian vegetation

Surveys and studies	Survey and study findings	Key assumptions and uncertainties	Rationale for choice of indicators
<p>Environmental value: Jimblebar Creek riparian vegetation</p> <p>EMP environmental outcome: Minimise impacts to the riparian vegetation along Jimblebar Creek</p>			
<p>Onshore (2015). <i>Jimblebar Creek Riparian Flora and Vegetation Baseline Survey</i></p> <p>Onshore (2016). <i>Riparian Vegetation Health Assessment</i></p>	<p>Jimblebar Creek system</p> <ul style="list-style-type: none"> Jimblebar Creek is a major ephemeral tributary in the upper portion of the Fortescue River catchment (Figure 1), which drains into the Fortescue Marsh around 80 km north of Orebody 31. South of Orebody 31, a drainage line flows in an easterly direction to Jimblebar Creek (Figure 6). Downstream of the junction with the Orebody 31 drainage line, Jimblebar Creek disperses into a wide, flat floodplain, forming smaller drainage channels or flowing overland before merging with the Upper Fortescue River approximately 40 km to the north of Orebody 31 and onto the Fortescue Marsh. <p>The following factors have been considered in defining the main channel of Jimblebar Creek:</p> <ul style="list-style-type: none"> the modern Jimblebar Creek drainage system is braided, with multiple channels defined within its banks, the preferred low-flow channel may change over time, such as following cyclonic events in the catchment; the whole channel has an important function in providing bank storage; and consistency with the surplus dewater management authorised extent in Schedule 1, Table 2 of MS1021: 'Dewater discharge to extend no further than 16 km from the discharge point and remain in the main drainage channel of Jimblebar Creek under natural no-flow conditions'. <p>Analysis has shown that surplus water discharge flows are not expected to extend beyond the low-flow channels of Jimblebar creek.</p> <p>The main channel has been defined using the following inputs:</p> <ul style="list-style-type: none"> aerial photography; 2 m contours of the channel and surrounding area; 250 km hydrographic GIS layer; vegetation community mapping of communities contain key riparian tree species, <i>Acacia citrinoviridis</i>, <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> (from <i>Jimblebar Creek Riparian Flora and Vegetation Baseline Survey</i> (Onshore 2015); and review by in-house technical experts. <p>To characterise the hydrology of the Orebody 31 and Jimblebar creek systems within the 16 km authorised extent, the creek system has been divided into three reaches (Figure 6):</p> <ul style="list-style-type: none"> Reach 1: Orebody 31 Creek: drainage line from discharge point to junction with Jimblebar Creek. Reach 2: Jimblebar Creek – from junction with Orebody 31 drainage line to Road Crossing on Jimblebar Creek. Reach 3: Jimblebar Creek – from Road Crossing to Discharge Limit (16 km). <p>Further detail on the conceptualisation of the Jimblebar Creek system is provided in Appendix 1.</p> <p>Jimblebar Creek riparian vegetation</p> <ul style="list-style-type: none"> The Jimblebar Creek Riparian Vegetation refers to the riparian vegetation along the main drainage channel of Jimblebar Creek from the Orebody 31 discharge point (on the Orebody 31 drainage line), to the discharge extent (authorised in MS1021), 16 km downstream of the discharge point (Figure 6). The baseline flora and vegetation survey completed in September 2014 by Onshore Environmental (2015) recorded a total number of 167 plant taxa (including varieties and subspecies) from 39 families and 97 genera. Species representation was greatest among the Poaceae (34 taxa), Fabaceae (31 taxa), and Malvaceae (16 taxa) families, with the most species genera including <i>Acacia</i> (15 taxa), <i>Senna</i> (8 taxa), <i>Eragrostis</i> (5 taxa) and <i>Eremophila</i> (5 taxa). The flora did not include any plant taxa gazetted as Threatened Flora pursuant to subsection (2) of section 23F of the <i>Wildlife Conservation Act 1950</i> (WC Act), or listed under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act). The Priority 2 flora taxon <i>Ipomoea racemigera</i> was recorded from one location on a sandy bank along the main river channel, and three plant taxa were determined to represent range extensions based on the current known distribution of the total flora; <i>Chamaecrista symonii</i> (the nearest record is approximately 200 km north-east of the study area), <i>Eragrostis speciosa</i> (the nearest record is from the 	<p>The potential impact to riparian vegetation from surplus water discharge is waterlogging, which affects riparian species needing 'air' in the root zone. The baseline environmental survey identified two species of trees which can access and use groundwater, <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i> (Onshore 2015). The health of these species is not expected to be negatively impacted by the addition of surplus water to Jimblebar Creek. The baseline environmental survey also recorded <i>Acacia citrinoviridis</i> (Onshore 2015), which has the potential to be impacted by ongoing saturation of the root zone.</p>	<p>BHP has established the management principle: <i>At least three months of no discharge outside of natural flow conditions within Jimblebar Creek.</i></p> <p>This has been established on the advice of flora experts; that is that the main risk to riparian vegetation is ongoing saturation of their root-zone. This management principle has been established in order to minimise the risk of this occurring and therefore minimise the risk of impacts to the riparian vegetation along Jimblebar Creek.</p> <p>BHP has established vegetation health indicators (triggers and thresholds) based on the vegetation condition score of the indicator tree species (<i>Eucalyptus victrix</i>, <i>Eucalyptus camaldulensis</i>, <i>Acacia citrinoviridis</i>) recorded during the 2014 survey (Table 8).</p> <p>BHP has also established triggers and thresholds for the water quality of discharged water to minimise the impacts on vegetation health. BHP will monitor water quality (pH and salinity - TDS) by measuring a spot sample at the discharge point monthly during a discharge event.</p> <p>Additionally, BHP will undertake the following monitoring to confirm that the discharge water remains within the main drainage channel of Jimblebar Creek and extends no further than 16 km from the discharge point under natural no-flow conditions:</p> <ul style="list-style-type: none"> Wetting front - Measuring device to record water presence at 16 km location following commencement of a discharge of surplus mine water to Jimblebar Creek under natural no-flow conditions discharge event. Main drainage channel - Review of photography (i.e. aerial / drone / on ground) following commencement of a discharge of surplus mine water to Jimblebar Creek under natural no-flow conditions.

Surveys and studies	Survey and study findings	Key assumptions and uncertainties	Rationale for choice of indicators
	<p>western Fortescue Marsh approximately 100 km to the north-west), and <i>Halgania erecta</i> (the nearest record occurs approximately 60 km east south-east of the study area).</p> <ul style="list-style-type: none"> • The survey also recorded three introduced (weed) species; <i>*Cenchrus ciliaris</i> (Buffel Grass), <i>*Cenchrus setiger</i> (Birdwood Grass) and <i>*Bidens bipinnata</i> (Beggartick). <i>*Cenchrus ciliaris</i> (Buffel Grass) was well represented on levee banks along Jimblebar Creek where it formed tussock grassland. The other two weeds were less common. • Vegetation condition ranged from excellent (432 ha or 35 percent) and very good (131 ha or 11 percent), to good (664 ha or 54 percent). Vegetation associations along the main drainage channel of Jimblebar Creek were rated as good and very good, with fringing sand plain vegetation associations rated as excellent. There was evidence of grazing by domestic cattle and camels. • Three tree species are dominant along Jimblebar Creek; <i>Acacia citrinoviridis</i>, <i>Eucalyptus camaldulensis</i> and <i>Eucalyptus victrix</i>. These trees were assessed within five 20 m by 20 m plots in September 2014 (Table 8). Tree density ranged from 175 to 425 trees per hectare, averaging 320 trees per hectare. <i>Acacia citrinoviridis</i> was present at all five sites, while <i>Eucalyptus victrix</i> was present at three sites and <i>Eucalyptus camaldulensis</i> was recorded from two sites. The largest trees in terms of both height and stem circumference were <i>Eucalyptus camaldulensis</i>. Tree health was predominantly rated as healthy (score 5) with the exceptions being two <i>Eucalyptus camaldulensis</i> trees (scores of 3 and 4 reflecting occasional dead leaves or tips of branches stressed or dying), and scattered <i>Acacia citrinoviridis</i> trees (scores of 3 and 4). All <i>Eucalyptus victrix</i> trees were given the highest score of 5 reflecting good health. • In September 2014 a total number of 29 plant taxa were recorded along the five 20 m by 1 m belt transects assessed, including 28 natives and one introduced weed species, <i>*Cenchrus ciliaris</i> (Buffel Grass). Species richness for individual transects ranged from three to 18 taxa and averaged 10 taxa. Mean plant density averaged 1.27 plants per m² (1,270 per ha equivalent) and mean ground cover was 46 percent. • Surface water discharge into Jimblebar Creek will create a wetting front that extends downstream along the main drainage channel for a distance determined by the volume and duration of the input. There are a number of potential impacts, the majority of which will be exacerbated closer to the point of discharge. Potential impacts include: <ul style="list-style-type: none"> - Localised areas along the drainage channel that become inundated for extended periods will experience changes to the composition and/or density of riverine vegetation due to the increased and prolonged availability of water to vegetation. - Areas where soil moisture is elevated but do not become inundated may experience an increase in the diversity of annual plant taxa. - Extended periods of elevated soil moisture trigger seed germination and seedling establishment for hard seeded plant species such as <i>Acacia</i> and <i>Senna</i>. - Areas with elevated soil moisture are more susceptible to colonisation by introduced weed species. - Deep rooted tree species such as <i>Eucalyptus victrix</i> and <i>Eucalyptus camaldulensis</i> show increased productivity in response to the higher sustained soil moisture levels, and a potentially shallower groundwater resource. - Shallow rooted tree species such as <i>Acacia citrinoviridis</i> and <i>Acacia aptaneura</i> will also show higher productivity as a response to the elevated soil moisture in the upper soil profile. - Extended periods of inundation can result in tree decline or death where the root zone becomes waterlogged for extended periods resulting in an anaerobic environment. Most trees require a period of seasonal drying of the soil profile to prevent decline or death. - Continuous discharge of surface water poses a risk to soils becoming waterlogged, reducing stability of the soil profile, and undermining the stability of tree roots. Trees become particularly vulnerable when exposed to additional surface flows following large summer rainfall events. 		



BHP BILLITON IRON ORE

EASTERN PILBARA WATER RESOURCE MANAGEMENT PLAN
Jimblebar Creek main drainage channel

Scale @ A4: 1:160,000	Prepared: P. GANT	Project No: A838/01 REV A
Date: 28/06/2017	Checked: S. BRUNT	Figure: 6
Revision: REV A	Reviewed: L. KINGSHOTT	

- BHP Mine Site
- Discharge Markers
- BHP Billiton Rail
- Watercourse
- Jimblebar Creek
- Jimblebar Creek Riparian Vegetation Boundary
- Hydrographic Catchments - Upper Fortescue

Liability
BHPiRO does not warrant that this map is free from errors or omissions. BHPiRO shall not be in any way liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

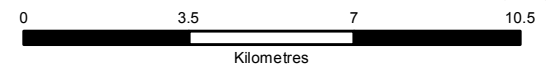


Table 8: Jimblebar Creek tree species data 2014

Site	Species	Number of trees	Mean tree height (m)	Mean condition score	Mean Stem Circumference at Breast Height (cm)
M1	<i>Acacia citrinoviridis</i>	3	4.00	5.00	17.33
M2	<i>Acacia citrinoviridis</i>	12	3.67	5.00	11.50
M3	<i>Acacia citrinoviridis</i>	14	2.11	4.71	7.64
M4	<i>Acacia citrinoviridis</i>	4	6.50	4.75	15.25
M5	<i>Acacia citrinoviridis</i>	8	3.50	5.00	18.88
M3	<i>Eucalyptus camaldulensis</i>	2	14.50	5.00	125.00
M4	<i>Eucalyptus camaldulensis</i>	3	14.33	5.00	107.67
M5	<i>Eucalyptus camaldulensis</i>	2	9.00	3.50	57.50
M1	<i>Eucalyptus victrix</i>	14	6.18	5.00	35.29
M2	<i>Eucalyptus victrix</i>	2	8.00	5.00	56.00

2 EMP Components

BHP has provided detail on the EMP components in tables, as outlined in the Instructions. BHP has used the 'Schedule' approach (which the Instructions state may be used), as this EMP (EPWRMP) covers multiple operations and Ministerial Statements.

As discussed in Table 3, as the Ethel Gorge is a regional water asset, the water-related components (indicators - triggers and thresholds, monitoring and reporting) are the same for each operation addressed in the EPWRMP that contains Ministerial Statement condition/s relating to the discharge of surplus water to Ophthalmia Dam. Separate schedules (1a, b, c and d) have been developed for compliance purposes against each MS.

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Table 9: Schedule 1a - Outcome-based EMP components: Ethel Gorge TEC (MS1021)

Purpose: To meet the requirements of Conditions 8-1 and 8-2 of Ministerial Statement 1021 (Orebody 31 Iron Ore Mine)

Rationale: Hydrological conditions (groundwater levels and salinity) are the basis of maintaining the habitat of the Ethel Gorge TEC

EPA Factor and objective:	Inland Waters – To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected Subterranean Fauna - To protect subterranean fauna so that biological diversity and ecological integrity are maintained
Environmental outcome	Condition 8-1: Manage the discharge of surplus mine dewater from the Orebody 31 Iron Ore Mine in a manner that minimises impacts to the Ethel Gorge Threatened Ecological Community
Key environments values:	Ethel Gorge TEC
Key impacts and risks:	Ethel Gorge TEC has the potential to be impacted from receiving surplus water discharge, resulting in changes to the extent and/or quality of the stygobiont habitat

MS1021 Condition clauses - Outcome-based components			
Indicators: • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring (including timing / frequency of monitoring)	Reporting
Condition 8-2 (4) criteria that will trigger the implementation of management actions;	Condition 8-2 (5) trigger management actions to be implemented in the event that the trigger criteria required by condition 8-2(4) have been reached. Condition 8-4 In the event that the monitoring specified in the Plan indicates that the trigger criteria specified in the Plan has been exceeded, the proponent shall: (1) immediately implement the trigger management actions specified in the Plan and continue implementation of those actions until the trigger criteria are not exceeded or until the CEO has confirmed by notice in writing that it has been demonstrated that the objective in condition 8-1 is being and will continue to be met and implementation of the trigger management actions is no longer required; (2) investigate to determine the likely cause of the trigger criteria being exceeded and to identify any additional trigger management actions required to prevent the trigger criteria being exceeded in the future;	Condition 8-2 (2) descriptions of biological and physical environmental indicators to be monitored; (3) monitoring methodologies that will be implemented to measure the physical and biological indicators;	Condition 4-5 The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that potential non-compliance being known. Condition 4-6 The proponent shall submit to the CEO the first Compliance Assessment Report on 1 October following the date of issue of this Statement and then subsequent Compliance Assessment Reports on 1 October thereafter or as otherwise agreed in writing by the CEO. The Compliance Assessment Report shall: (1) be endorsed by the proponent's CEO or a person delegated to sign on the CEO's behalf; (2) include a statement as to whether the proponent has complied with the conditions; (3) identify all potential non-compliances and describe corrective and preventative actions taken; (4) be made publicly available in accordance with the approved Compliance Assessment Plan; and (5) indicate any proposed changes to the Compliance Assessment Plan required by condition 4-1. Condition 8-4 In the event that the monitoring specified in the Plan indicates that the trigger criteria specified in the Plan has been exceeded, the proponent shall: (3) provide a report to the CEO within 30 days of an event, referred to in condition 8-4, occurring. The report shall include: (a) details of trigger management actions implemented; and (b) the findings of the investigation required by condition 8-4(2).

Outcome-based components			
Indicators: • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring (including timing / frequency of monitoring)	Reporting
Water Quality in the Ethel Gorge Primary Habitat Monitoring Zone – Total Dissolved Solids • Trigger criteria: 3000 mg/L • Threshold criteria: 4000 mg/L	Response actions to trigger/threshold criteria exceedance may include, but are not limited to: • Increase abstraction from Ophthalmia borefield • Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries • Increase discharge to: – Ophthalmia Dam;	Quarterly monitoring of Total Dissolved Solids (mg/L) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge). Groundwater quality and stygofauna species sampling as	Annual reporting An annual Compliance Assessment Report that meets the requirements of Condition 4-6 will be submitted as part of the Annual Environment Report, which will be submitted by 1 October each year to the DWER. Exception reporting Notification of threshold criteria ² potential exceedance or outcome potential non-compliance will be provided to the DWER within 7 days of that potential non-compliance being known.

Outcome-based components			
Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Trigger level actions • Threshold contingency actions 	<p>(including timing / frequency of monitoring)</p>	
	<ul style="list-style-type: none"> - Recharge Ponds; and/or - Infiltration Basins <p>Figure 5 depicts the above receptor action locations.</p>	<p>part of its annual stygofauna monitoring program.</p>	<p>In the event that monitoring indicates potential exceedance of threshold criteria² associated with MS1021, a report shall be submitted to the DWER within 30 days. The report shall include:</p> <ul 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 the investigations required by MS1021 condition 8-4(2); (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 will continue to be met.
<p>Water Quantity in the Ethel Gorge Primary Habitat Monitoring Zone (Figure 1a) - Groundwater level</p> <ul style="list-style-type: none"> • Trigger criteria¹ 6m¹ or a rate of >4m/year • Threshold criteria¹: >12m¹ or a rate of >8m/year 	<p>Response actions to trigger/threshold criteria exceedance due to increase in groundwater level may include, but are not limited to:</p> <ul style="list-style-type: none"> • Increase abstraction from Ophthalmia borefield • Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries • Decrease discharge to: <ul style="list-style-type: none"> - Ophthalmia Dam; - Recharge Ponds; and/or - Infiltration Basins <p>Figure 5 depicts the above receptor action locations.</p>	<p>Monthly monitoring of groundwater levels (mbgl) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge).</p>	

1. Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone (Figure 4). Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall criteria.
2. MS1021 Condition 8 refers only to criteria that will trigger the implementation of management actions and reporting requirements. BHP has additionally specified warning "trigger criteria" to be consistent with the requirements for MS1037 and MS1126 and contemporary EPA guidance. On this basis, the trigger criteria referred to in MS1021 are equivalent to the "threshold criteria" in MS1037 and MS1126 and as described in this EPWRMP. The management actions and reporting requirements in condition 8-4 of MS1021 will only apply to the exceedance of "threshold criteria". The warning "trigger criteria" which BHP has specified will require the implementation of actions by BHP in accordance with this EPWRMP and condition 8-7 of MS1021.
3. The requirements of MS1021 condition 8-2(1) are addressed through Section 1.4.2, including Figures 4 and 5.

Table 10: Schedule 1b - Outcome-based EMP components: Ethel Gorge TEC (MS1037)

Purpose: To meet the requirements of Conditions 8-1, 8-2 and 8-3 of Ministerial Statement 1037 (Eastern Ridge Revised Proposal)

Rationale: Hydrological conditions (groundwater levels and salinity) are the basis of maintaining the habitat of the Ethel Gorge TEC

EPA Factor and objective:	Inland Waters – To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected Subterranean Fauna - To protect subterranean fauna so that biological diversity and ecological integrity are maintained
Environmental outcome	Condition 8-1: Maintain the habitat of the Ethel Gorge Aquifer Stygobiont Community
Key environments values:	Ethel Gorge TEC
Key impacts and risks:	Ethel Gorge TEC has the potential to be impacted from receiving surplus water discharge, resulting in changes to the extent and/or quality of the stygobiont habitat

MS1037 Condition clauses - Outcome-based components			
Indicators: • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring (including timing / frequency of monitoring)	Reporting
<p>Condition 8-2</p> <p>(2) specify trigger criteria that must provide an early warning that the threshold criteria identified in condition 8-2(3) may not be met;</p> <p>(3) specify threshold criteria to demonstrate compliance with the environmental outcome specified in condition 8-1; Exceedance of the threshold criteria represents non-compliance with these conditions;</p>	<p>Condition 8-2</p> <p>(5) specify trigger level actions to be implemented in the event that trigger criteria have been exceeded;</p> <p>(6) specify threshold contingency actions to be implemented in the event that threshold criteria are exceeded;</p> <p>Condition 8-5</p> <p>In the event that monitoring indicates exceedance of threshold criteria specified in the Condition Environmental Management Plan/s, the proponent shall:</p> <p>(2) implement the threshold contingency actions specified in the Condition Environmental Management Plan/s 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;</p> <p>(3) investigate to determine the cause of the threshold criteria being exceeded;</p> <p>(4) investigate to provide information for the CEO to determine potential environmental harm or alteration of the environment that occurred due to threshold criteria being exceeded;</p>	<p>Condition 8-2</p> <p>(4) specify monitoring to determine if trigger criteria and threshold criteria are exceeded;</p>	<p>Condition 3-5</p> <p>The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that potential non-compliance being known.</p> <p>Condition 4-6</p> <p>The proponent shall submit to the CEO a Compliance Assessment Report by 1 October each year addressing compliance in the previous financial year, or as agreed in writing by the CEO.</p> <p>The Compliance Assessment Report shall:</p> <p>(1) be endorsed by the proponent's CEO or a person delegated to sign on the CEO's behalf;</p> <p>(2) include a statement as to whether the proponent has complied with the conditions;</p> <p>(3) identify all potential non-compliances and describe corrective and preventative actions taken;</p> <p>(4) be made publicly available in accordance with the approved Compliance Assessment Plan; and</p> <p>(5) indicate any proposed changes to the Compliance Assessment Plan required by condition 3-1.</p> <p>Condition 8-2</p> <p>(7) provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that condition 8-1 has been met over the reporting period in the Compliance Assessment Report required by condition 3;</p> <p>Condition 8-5</p> <p>In the event that monitoring indicates exceedance of threshold criteria specified in the Condition Environmental Management Plan/s, the proponent shall:</p> <p>(1) report the exceedance in writing to the CEO within 7 days of the exceedance being identified;</p> <p>(5) provide a report to the CEO within 21 days of the exceedance being reported as required by condition 8-5(1). The report shall include:</p> <p>(a) details of threshold contingency actions implemented;</p> <p>(b) the effectiveness of the threshold contingency actions implemented, against the threshold criteria;</p> <p>(c) the findings of the investigations required by MS 1037 condition 8-5(3) and 8-5(4);</p> <p>(d) measures to prevent the threshold criteria being exceeded in the future;</p> <p>(e) measures to prevent, control or abate the environmental harm which may have occurred; and</p> <p>(f) justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes will continue to be met.</p>

Outcome-based components			
Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> Trigger criteria Threshold criteria 	<ul style="list-style-type: none"> Trigger level actions Threshold contingency actions 	(including timing / frequency of monitoring)	
Water Quality in the Ethel Gorge Primary Habitat Monitoring Zone – Total Dissolved Solids <ul style="list-style-type: none"> Trigger criteria: 3000 mg/L Threshold criteria: 4000 mg/L 	Response actions to trigger/threshold criteria exceedance may include, but are not limited to: <ul style="list-style-type: none"> Increase abstraction from Ophthalmia borefield Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries Increase discharge to: <ul style="list-style-type: none"> Ophthalmia Dam; Recharge Ponds; and/or Infiltration Basins Figure 5 depicts the above receptor action locations.	Quarterly monitoring of Total Dissolved Solids (mg/L) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge). Groundwater quality and stygofauna species sampling as part of its annual stygofauna monitoring program.	Annual reporting An annual Compliance Assessment Report that meets the requirements of Condition 4-6 will be submitted as part of the Annual Environment Report, which will be submitted by 1 October each year to the DWER. Exception reporting Notification of threshold criteria potential exceedance or outcome potential non-compliance will be provided to the DWER within 7 days of that potential non-compliance being known. In the event that monitoring indicates potential exceedance of threshold criteria associated with MS1037, a report shall be submitted to the DWER within 21 days. The report shall include: <ol style="list-style-type: none"> details of threshold contingency actions implemented; the effectiveness of the threshold contingency actions implemented, against the threshold criteria; the findings of the investigations required by MS1037 condition 8-5(3) and 8-5(4); measures to prevent the threshold criteria being exceeded in the future; measures to prevent, control or abate the environmental harm which may have occurred; and justification of the threshold remaining, or being adjusted based on better understanding, demonstrating that outcomes will continue to be met.
Water Quantity in the Ethel Gorge Primary Habitat Monitoring Zone (Figure 1a) - Groundwater level <ul style="list-style-type: none"> Trigger criteria¹: >6m¹ or a rate of >4m/year Threshold criteria¹: >12m¹ or a rate of >8m/year 	Response actions to trigger/threshold criteria exceedance due to decrease in groundwater level may include, but are not limited to: <ul style="list-style-type: none"> Increase discharge to: <ul style="list-style-type: none"> Ophthalmia Dam; Recharge Ponds; and/or Infiltration Basins Response actions to trigger/threshold criteria exceedance due to increase in groundwater level may include, but are not limited to: <ul style="list-style-type: none"> Increase abstraction from Ophthalmia borefield Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries Decrease discharge to: <ul style="list-style-type: none"> Ophthalmia Dam; Recharge Ponds; and/or Infiltration Basins Figure 5 depicts the above receptor action locations.	Monthly monitoring of groundwater levels (mbgl) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge).	

1. Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone (Figure 4). Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall criteria.

Table 11: Schedule 1c - Outcome-based EMP components: Ethel Gorge TEC (MS1126)

Purpose: To meet the requirements of Conditions 6-1 and 6-2 of Ministerial Statement 1126 (Jimblebar Iron Ore Project - Revised Proposal)

Rationale: Hydrological conditions (groundwater levels and salinity) are the basis of maintaining the habitat of the Ethel Gorge TEC.

EPA Factor and objective:	Inland Waters – To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected Subterranean Fauna - To protect subterranean fauna so that biological diversity and ecological integrity are maintained
Environmental outcome	Condition 6-1: (1) protect subterranean fauna so that biological diversity and ecological integrity are maintained, and in particular: (a) avoid and minimise direct and indirect impacts on the Ethel Gorge aquifer stygobiont community Threatened Ecological Community.
Key environments values:	Ethel Gorge TEC
Key impacts and risks:	Ethel Gorge TEC has the potential to be impacted from receiving surplus water discharge, resulting in changes to the extent and/or quality of the stygobiont habitat

MS1126 Condition clauses - Outcome-based components

Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Trigger level actions • Threshold contingency actions 	<p>(including timing / frequency of monitoring)</p>	
<p>Condition 6-2 In order to meet the outcome specified in condition 6-1, the proponent shall implement the Subterranean Fauna provisions¹ of the <i>Eastern Pilbara Water Resource Management Plan</i> (Version 6, April 2018) (the <i>Subterranean Fauna Environmental Management Plan</i>).</p> <p>Condition 6-4 The exceedance of a threshold criteria (regardless of whether threshold contingency actions have been or are being implemented) represents noncompliance with these conditions.</p>	<p>Condition 6-2 In order to meet the outcome specified in condition 6-1, the proponent shall implement the Subterranean Fauna provisions¹ of the <i>Eastern Pilbara Water Resource Management Plan</i> (Version 6, April 2018) (the <i>Subterranean Fauna Environmental Management Plan</i>).</p> <p>Condition 6-3 In the event that monitoring, tests, surveys or investigations indicate exceedance of threshold criteria specified in the Subterranean Fauna Environmental Management Plan, the proponent shall:</p> <ol style="list-style-type: none"> (2) implement the threshold contingency actions specified in the <i>Subterranean Fauna Environmental Management Plan</i> within twenty-four (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 or alteration of the environment that occurred due to threshold criteria being exceeded; 	<p>Condition 6-2 In order to meet the outcome specified in condition 6-1, the proponent shall implement the Subterranean Fauna provisions¹ of the <i>Eastern Pilbara Water Resource Management Plan</i> (Version 6, April 2018) (the <i>Subterranean Fauna Environmental Management Plan</i>).</p>	<p>Condition 3-5 The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that potential non-compliance being known.</p> <p>Condition 3-6 The proponent shall submit to the CEO a Compliance Assessment Report by 1 October each year addressing compliance in the previous financial year, or as agreed in writing by the CEO.</p> <p>The Compliance Assessment Report shall:</p> <ol style="list-style-type: none"> (1) be endorsed by the proponent's CEO or a person delegated to sign on the CEO's behalf; (2) include a statement as to whether the proponent has complied with the conditions; (3) identify all potential non-compliances and describe corrective and preventative actions taken; (4) be made publicly available in accordance with the approved Compliance Assessment Plan; and (5) indicate any proposed changes to the Compliance Assessment Plan required by condition 3-1. <p>Condition 6-3 In the event that monitoring, tests, surveys or investigations indicate exceedance of threshold criteria specified in the Subterranean Fauna Environmental Management Plan, the proponent shall:</p> <ol style="list-style-type: none"> (1) report the exceedance in writing to the CEO within 7 days of the exceedance being identified; (5) provide a report to the CEO within twenty-one (21) days of the exceedance being reported as required by condition 6-3(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 the investigations required by MS 1126 condition 6-3(3) and 6-3(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 will continue to be met.

Outcome-based components			
Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> Trigger criteria Threshold criteria 	<ul style="list-style-type: none"> Trigger level actions Threshold contingency actions 	(including timing / frequency of monitoring)	
<p>Water Quality in the Ethel Gorge Primary Habitat Monitoring Zone – Total Dissolved Solids</p> <ul style="list-style-type: none"> Trigger criteria: 3000 mg/L Threshold criteria: 4000 mg/L 	<p>Response actions to trigger/threshold criteria exceedance may include, but are not limited to:</p> <ul style="list-style-type: none"> Increase abstraction from Ophthalmia borefield Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries Alter discharge regime to: <ul style="list-style-type: none"> Ophthalmia Dam; Recharge Ponds; and/or Infiltration Basins <p>Figure 5 depicts the above receptor action locations.</p>	<p>Quarterly monitoring of Total Dissolved Solids (mg/L) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge).</p> <p>Groundwater quality and stygofauna species sampling as part of its annual stygofauna monitoring program.</p>	<p>Annual reporting</p> <p>An annual Compliance Assessment Report that meets the requirements of Condition 3-6 will be submitted as part of the Annual Environment Report, which will be submitted by 1 October each year to the DWER.</p> <p>Exception reporting</p> <p>Notification of threshold criteria potential exceedance or outcome potential non-compliance will be provided to the DWER within 7 days of that potential non-compliance being known.</p> <p>In the event that monitoring, tests, surveys or investigations indicate potential exceedance of threshold criteria associated with MS1126, a report shall be submitted to the DWER within 21 days. The report shall include:</p> <ul 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 the investigations required by condition 6-3(3) and 6-3(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 will continue to be met.
<p>Water Quantity in the Ethel Gorge Primary Habitat Monitoring Zone (Figure 1a) - Groundwater level</p> <ul style="list-style-type: none"> Trigger criteria²: >6m¹ or a rate of >4m/year Threshold criteria²: >12m¹ or a rate of >8m/year 		<p>Monthly monitoring of groundwater levels (mbgl) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge).</p>	

1. EMP 'provisions' were renamed 'components' by the EPA in September 2020 (EPA 2021a).
2. Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone (Figure 4). Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall criteria.

Table 12: Schedule 1d - Outcome-based EMP components: Ethel Gorge TEC (MS1105)

Purpose: To meet the requirements of Conditions 9-1(d)(i) and 10-1(1)(i) of Ministerial Statement 1105 (Pilbara Expansion Strategic Proposal)

Rationale: Hydrological conditions (groundwater levels and salinity) are the basis of maintaining the habitat of the Ethel Gorge TEC

EPA Factor and objective:	Inland Waters – To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected Subterranean Fauna - To protect subterranean fauna so that biological diversity and ecological integrity are maintained
Environmental outcome:	Maintain groundwater levels and quality in the Ethel Gorge aquifer within historical variation Maintain the habitat of the Ethel Gorge TEC
Key environments values:	Ethel Gorge TEC
Key impacts and risks:	Ethel Gorge TEC has the potential to be impacted from receiving surplus water discharge, resulting in changes to the extent and/or quality of the stygobiont habitat

MS1105 Condition clauses - Outcome-based components			
Indicators: • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring (including timing / frequency of monitoring)	Reporting
<p>Condition 6-2</p> <p>(2) specify trigger criteria that will provide early warning for the implementation of trigger level actions if exceeded;</p> <p>(3) specify threshold criteria that provides a limit beyond which the environmental outcome is not achieved;</p>	<p>Condition 6-2</p> <p>(5) specify trigger level actions to be implemented in the event that trigger criteria have been exceeded;</p> <p>(6) specify threshold contingency actions to be implemented in the event that threshold criteria are exceeded;</p> <p>Condition 6-7</p> <p>In the event that monitoring, tests, surveys or investigations indicates exceedance of trigger criteria and/or threshold criteria specified in a Condition Environmental Management Plan(s), the proponent shall:</p> <p>(2) immediately implement the trigger level actions and/or threshold contingency actions specified in the Condition Environmental Management Plan(s) and continue implementation of those actions until the trigger criteria and/or threshold criteria are being met and implementation of the trigger level actions and/or threshold contingency actions are no longer required;</p> <p>(3) investigate to determine the cause of the trigger criteria and/or threshold criteria being exceeded;</p> <p>(4) identify additional measures required to prevent the trigger criteria and/or threshold criteria being exceeded in the future;</p> <p>(5) investigate to determine potential environmental harm or alteration of the environment that occurred due to threshold criteria being exceeded;</p>	<p>Condition 6-2</p> <p>(4) specify monitoring to determine if trigger criteria and threshold criteria are exceeded;</p>	<p>Condition 4-6</p> <p>The proponent shall submit to the CEO a Compliance Assessment Report annually by 1 October each year addressing compliance in the previous financial year, or as otherwise agreed in writing by the CEO.</p> <p>Condition 4-7</p> <p>The Compliance Assessment Report shall:</p> <p>(1) be endorsed by the proponent's CEO or a person delegated to sign on the CEO's behalf;</p> <p>(2) include a statement as to whether the proponent has complied with the conditions;</p> <p>(3) identify all potential non-compliances and describe corrective and preventative actions taken;</p> <p>(4) be made publicly available in accordance with the approved Compliance Assessment Plan; and</p> <p>(5) indicate any proposed changes to the Compliance Assessment Plan required by condition 4-1.</p> <p>Condition 6-2</p> <p>(6) provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that the relevant conditions referred to in the Section 45A¹ Notice for the proposal have been met over the reporting period in the Compliance Assessment Report required by condition 4-6; and</p> <p>(7) provide for reporting of exceedances of the trigger and threshold criteria.</p> <p>Condition 6-7</p> <p>In the event that monitoring, tests, surveys or investigations indicates exceedance of trigger criteria and/or threshold criteria specified in a Condition Environmental Management Plan(s), the proponent shall:</p> <p>(1) report the exceedance in writing to the CEO within seven (7) days of the exceedance being identified;</p> <p>(6) provide a report to the CEO within ninety (90) days of the exceedance being reported. The report shall include:</p> <p>(a) details of any trigger level actions or threshold contingency actions implemented;</p> <p>(b) the effectiveness of the trigger level actions or threshold contingency actions implemented, monitored and measured against trigger criteria and threshold criteria;</p> <p>(c) the findings of the investigations required by conditions 6-7(3) and 6-7(5);</p> <p>(d) additional measures to prevent the trigger or threshold criteria being exceeded in the future; and</p> <p>(e) measures to prevent, control or abate the environmental harm or alteration of the environment which may have occurred.</p>

Outcome-based components			
Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> Trigger criteria Threshold criteria 	<ul style="list-style-type: none"> Trigger level actions Threshold contingency actions 	(including timing / frequency of monitoring)	
Water Quality in the Ethel Gorge Primary Habitat Monitoring Zone – Total Dissolved Solids <ul style="list-style-type: none"> Trigger criteria: 3000 mg/L Threshold criteria: 4000 mg/L 	Response actions to trigger/threshold criteria exceedance may include, but are not limited to: <ul style="list-style-type: none"> Increase abstraction from Ophthalmia borefield Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries Increase discharge to: <ul style="list-style-type: none"> Ophthalmia Dam; Recharge Ponds; and/or Infiltration Basins Figure 5 depicts the above receptor action locations.	Quarterly monitoring of Total Dissolved Solids (mg/L) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge). Groundwater quality and stygofauna species sampling as part of its annual stygofauna monitoring program.	Annual reporting An annual Compliance Assessment Report that meets the requirements of Condition 4-6 will be submitted as part of the Annual Environment Report, which will be submitted by 1 October each year to the DWER. Exception reporting Notification of trigger and/or threshold criteria potential exceedance will be provided to the DWER within 7 days of that exceedance being known. In the event that monitoring indicates potential exceedance of trigger and/or threshold criteria associated with MS1105, a report shall be submitted to the DWER within 90 days. The report shall include: <ol style="list-style-type: none"> details of any trigger level actions or threshold contingency actions implemented; the effectiveness of the trigger level actions or threshold contingency actions implemented, monitored and measured against trigger criteria and threshold criteria; the findings of the investigations required by conditions 6-7(3) and 6-7(5); additional measures to prevent the trigger or threshold criteria being exceeded in the future; and measures to prevent, control or abate the environmental harm or alteration of the environment which may have occurred.
Water Quantity in the Ethel Gorge Primary Habitat Monitoring Zone (Figure 1a) - Groundwater level <ul style="list-style-type: none"> Trigger criteria: >6m² or a rate of >4m/year Threshold criteria: >12m² or a rate of >8m/year 	Response actions to trigger/threshold criteria exceedance due to increase in groundwater level may include, but are not limited to: <ul style="list-style-type: none"> Increase abstraction from Ophthalmia borefield Seasonal (following a wet season (typically December through March)) controlled release from Ophthalmia Dam to upper Fortescue tributaries Decrease discharge to: <ul style="list-style-type: none"> Ophthalmia Dam; Recharge Ponds; and/or Infiltration Basins Figure 5 depicts the above receptor action locations.	Monthly monitoring of groundwater levels (mbgl) within the Ethel Gorge Primary Habitat Monitoring Zone (Figure 4) during operations (i.e. active dewatering / surplus water discharge).	

1. Now section 45B in current version of EP Act

2. Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat monitoring zone (Figure 4). Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall criteria.

Table 13: Schedule 2 - Outcome-based EMP components: Jimblebar Creek Riparian Vegetation (MS1021)

Purpose: To meet the requirements of Conditions 7-1 and 7-2 of Ministerial Statement 1021 (Orebody 31 Iron Ore Mine)

Rationale: Vegetation condition score is representative of vegetation health and the quality of discharge water may affect vegetation health

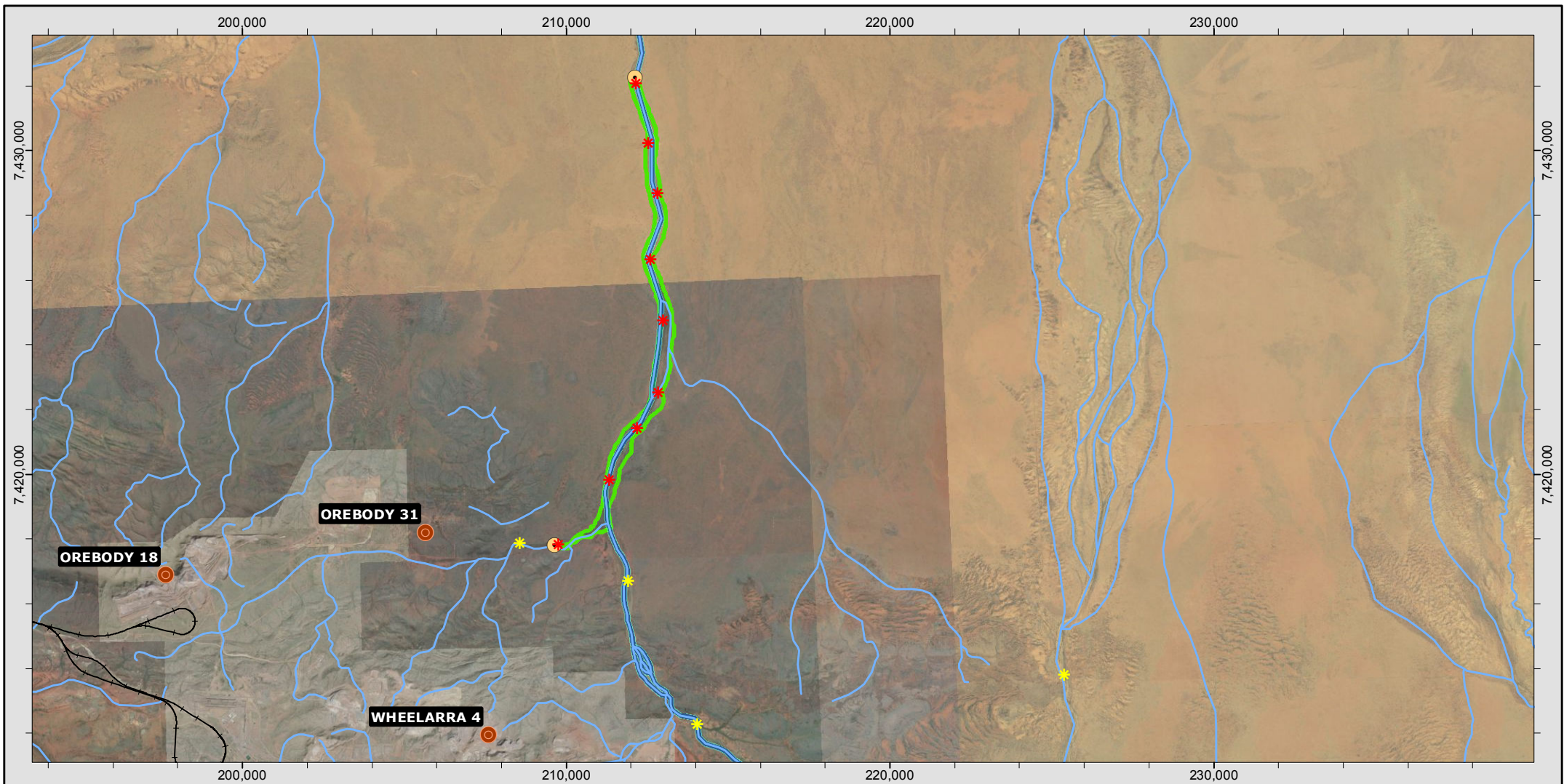
EPA Factor and objective:	Inland Waters – To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected Flora and Vegetation - To protect flora and vegetation so that biological diversity and ecological integrity are maintained
Environmental outcome	Condition 7-1: Manage the discharge of surplus mine dewater from the Orebody 31 Iron Ore Mine in a manner that minimises impacts to the riparian vegetation along Jimblebar Creek
Key environments values:	Riparian vegetation along Jimblebar Creek
Key impacts and risks:	Impact to riparian vegetation health as a result of surplus water discharge

MS1021 Condition clauses - Outcome-based components			
Indicators: • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring (including timing / frequency of monitoring)	Reporting
<p>Condition 7-2 (4) criteria that will trigger the implementation of management actions;</p>	<p>Condition 7-2 (5) trigger management actions to be implemented in the event that the trigger criteria required by condition 7-2(4) have been reached.</p> <p>Condition 7-4 In the event that the monitoring specified in the Plan indicates that the trigger criteria specified in the Plan has been exceeded, the proponent shall: (1) immediately implement the trigger management actions specified in the Plan and continue implementation of those actions until the trigger criteria are not exceeded or until the CEO has confirmed by notice in writing that it has been demonstrated that the objective in condition 7-1 is being and will continue to be met and implementation of the trigger management actions is no longer required; (2) investigate to determine the likely cause of the trigger criteria being exceeded and to identify any additional trigger management actions required to prevent the trigger criteria being exceeded in the future;</p>	<p>Condition 7-2 (2) descriptions of biological and physical environmental indicators to be monitored; (3) monitoring methodologies that will be implemented to measure the physical and biological indicators;</p>	<p>Condition 4-5 The proponent shall advise the CEO of any potential non-compliance within seven (7) days of that potential non-compliance being known.</p> <p>Condition 4-6 The proponent shall submit to the CEO the first Compliance Assessment Report on 1 October following the date of issue of this Statement and then subsequent Compliance Assessment Reports on 1 October thereafter or as otherwise agreed in writing by the CEO. The Compliance Assessment Report shall: (1) be endorsed by the proponent's CEO or a person delegated to sign on the CEO's behalf; (2) include a statement as to whether the proponent has complied with the conditions; (3) identify all potential non-compliances and describe corrective and preventative actions taken; (4) be made publicly available in accordance with the approved Compliance Assessment Plan; and (5) indicate any proposed changes to the Compliance Assessment Plan required by condition 4-1.</p> <p>Condition 7-4 In the event that the monitoring specified in the Plan indicates that the trigger criteria specified in the Plan has been exceeded, the proponent shall: (3) provide a report to the CEO within 30 days of an event, referred to in condition 7-4, occurring. The report shall include: (a) details of trigger management actions implemented; and (b) the findings of the investigation required by condition 7-4(2).</p>

Outcome-based components			
Indicators: • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring (including timing / frequency of monitoring)	Reporting
<p>Indicator tree species– occurrence within Riparian Vegetation monitoring zone(s):</p> <ul style="list-style-type: none"> Trigger criteria: A vegetation condition score of ≤ 2 across 3 or more or 30%, whichever is lesser, of monitoring (impact) sites during one sample period, unless decline is consistent with regional decline in vegetation (established from comparison with reference sites). Threshold criteria: A vegetation condition score of ≤ 2 across 5 or more, or 50%, whichever is lesser, of monitoring (impact) sites 	<p>If related to surplus water discharge risk:</p> <p>Trigger level actions</p> <ul style="list-style-type: none"> reduce surplus water discharge <p>Threshold contingency actions</p> <ul style="list-style-type: none"> cease surplus water discharge 	<p>Frequency: Following dewater discharge into creekline during natural no-flow conditions, and within 6 months of discharge event.</p> <p>Parameters: Vegetation health of key indicator species: <i>Eucalyptus victrix</i>, <i>Eucalyptus camaldulensis</i>, <i>Acacia citrinoviridis</i></p> <p>Methodology: Qualitative assessment of vegetation health of key indicator species, with vegetation health in each monitoring site (Figure 7) allocated a score of 0-5,</p>	<p>Annual reporting An annual Compliance Assessment Report that meets the requirements of Condition 4-6 will be submitted as part of the Annual Environment Report, which will be submitted by 1 October each year to the DWER.</p> <p>Exception reporting Notification of threshold criteria¹ potential exceedance or outcome potential non-compliance will be provided to the DWER within 7 days of that potential non-compliance being known.</p>

Outcome-based components			
Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> Trigger criteria Threshold criteria 	<ul style="list-style-type: none"> Trigger level actions Threshold contingency actions 	(including timing / frequency of monitoring)	
during one sample period, unless decline is consistent with regional decline in vegetation (established from comparison with reference sites).		with 0 comprising 'most plants dead' and 5 comprising 'no evidence of stress'.	In the event that monitoring indicates potential exceedance of trigger criteria, a report shall be submitted to the DWER within 30 days. The report shall include:
Water Quality at Discharge Point(s): pH <ul style="list-style-type: none"> Trigger criteria: <6 or >9 Threshold criteria: <5.5 or >9.5 	Trigger level actions <ul style="list-style-type: none"> reduce surplus water discharge Threshold contingency actions <ul style="list-style-type: none"> cease surplus water discharge 	Monthly monitoring of pH (pH units) at discharge point(s) (Figure 6) during operations (i.e. surplus water discharge).	<ul 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 the investigations required by MS1021 condition 7-4(2); (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 will continue to be met.
Water Quality at Discharge Point(s) – Total Dissolved Solids <ul style="list-style-type: none"> Trigger criteria: 3,000 mg/L Threshold criteria: 5,000 mg/L 	Trigger level actions <ul style="list-style-type: none"> reduce surplus water discharge Threshold contingency actions <ul style="list-style-type: none"> cease surplus water discharge 	Monthly monitoring of total dissolved solids (mg/L) at discharge point(s) (Figure 6) during operations (i.e. surplus water discharge).	

- MS1021 Condition 7 refers only to criteria that will trigger the implementation of management actions and reporting requirements. BHP has additionally specified warning "trigger criteria" to be consistent with the requirements for MS1037 and MS1126 and contemporary EPA guidance. On this basis, the trigger criteria referred to in MS1021 are equivalent to the "threshold criteria" in MS1037 and MS1126 and as described in this EPWRMP. The management actions and reporting requirements in condition 7-4 of MS1021 will only apply to the exceedance of "threshold criteria". The warning "trigger criteria" which BHP has specified will require the implementation of actions by BHP in accordance with this EPWRMP and condition 7-7 of MS1021.
- The requirements of MS1021 condition 7-2(1) is addressed through Section 1.4.3, Figure 6 and Figure 7.



BHP BILLITON IRON ORE

EASTERN PILBARA WATER RESOURCE MANAGEMENT PLAN
Jimlebar Creek Riparian Vegetation monitoring sites

Scale @ A4: 1:170,000	Prepared: P. GANT	Project No: A838/01 REV A
Date: 26/06/2017	Checked: T. CARROLL	Figure: 7
Revision: REV A	Reviewed: L. KINGSHOTT	

Indicative monitoring sites

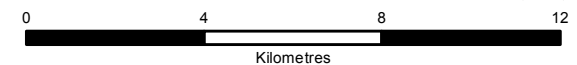
- * Impact Site
- * Reference Site
- BHP Mine Site
- Discharge Markers
- BHP Billiton Rail
- Watercourse

— Jimlebar Creek

— Jimlebar Creek Riparian Vegetation Boundary

Liability
BHPBIO does not warrant that this map is free from errors or omissions. BHPBIO shall not be in any way liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994



3 Adaptive management and review of the EMP

3.1 Adaptive management approach

BHP applies an adaptive management framework for implementing management measures identified in this EPWRMP. This EPWRMP iteratively collates the key findings and knowledge of the eco-hydrology technical studies and changes in water-affecting activities to inform the required adaptive management to enable achievement of outcome-based objectives. The adaptive management is risk-based and is expected to proactively counteract, mitigate or manage potential impacts (both predicted and actual) to an acceptable level.

As outlined in Figure 8, the EPWRMP considers the following aspects:

- hydrological changes (baseline, current and future conditions of groundwater, soil moisture and surface water) potentially resulting from BHP groundwater abstraction and surface water diversion;
- receiving receptors (water resources, environment, social and third-party operations), identified value and hydrological dependency (groundwater, soil moisture and/or surface water);
- potential impacts (predicted and actual); and
- required risk-based adaptive management techniques that are feasible (tested and practicable) to mitigate potential impacts to acceptable levels during operations and closure.

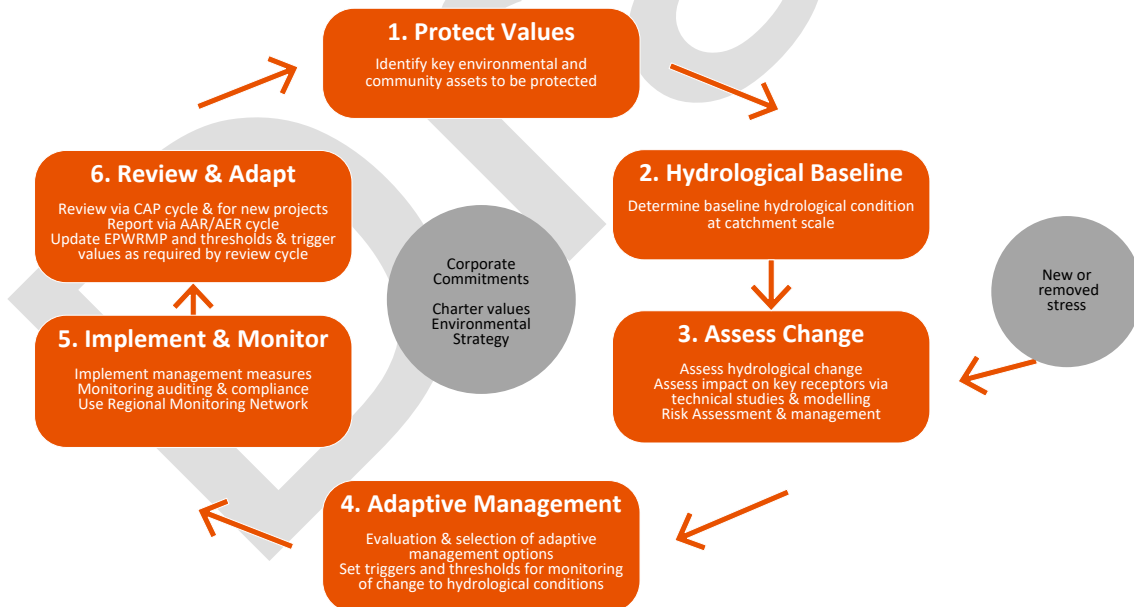


Figure 8: EPWRMP adaptive management approach

Adaptive management for the key receptors allows for three stages of response: investigation, action and mitigation. The approach ensures that any change and/or response observed is characterised and understood prior to implementing corrective action, if required. To address uncertainties, this EPWRMP applies an adaptive management approach to manage the range of potential hydrological changes resulting from BHP operations and potential impacts on a receiving receptor.

This approach can accommodate the uncertainty associated with predicting dewatering and surplus water volumes and the resulting area of influence whilst maintaining the value of the receiving receptor which may be impacted by changes in hydrological processes or by water quality. This is achieved through a combination of:

1. preventative water management controls, such as surplus water returned to the aquifer;
2. allowing for the application of precautionary principles to be considered as the scientific knowledge evolves through baseline assessments and the monitoring of predicted and actual outcomes; and
3. utilising practicable and feasible water mitigation controls to mitigate and offset impacts.

This approach provides a systematic and iterative process for decision-making and establishing management objectives, particularly where uncertainty exists, to achieve the desired outcome.

As the EPWRMP is a requirement of MS conditions, BHP will seek formal approval from the DWER to amend the EPWRMP based on information gained through adaptive management.

3.2 Review and revision of this EMP

BHP will review this EMP (EPWRMP) and revise it if required, to ensure that it achieves the identified environmental outcomes and meets MS conditions. A review may arise from any or all of the following:

- Where required by a MS condition.
- If initiated by BHP as part of the adaptive management process.
- If triggered by a MS condition (e.g. for exceedance of a threshold criteria).

Changes to the endorsed version of the EMP may arise from, but are not limited to the any or all of the following:

- BHP reviews the EMP if the EPA or relevant government agencies develop new, or amend existing guidance or policy.
- BHP adds or amends components when new proposals are approved and conditioned through Part IV of the EP Act or due to a change to MS conditions.
- Approved Proposals are amended under the EP Act Part IV and brought under this EPWRMP.
- Stakeholder consultation.
- The level of scientific knowledge relating to a key environmental or social receptor.
- The CEO of DWER directs BHP to revise the EMP.
- The CEO of DWER confirms by notice in writing that it has been demonstrated that the objective and/or outcome in the relevant condition is being and will continue to be met and therefore implementation of certain condition requirements addressed in the EMP are no longer required.

In accordance with Condition 6-7 of MS1126, Condition 5-7 of MS1037, Conditions 7-7 and 8-7 of MS1021, and Conditions 9-4 and 10-4 of MS1105, BHP shall implement the latest revision of the EMP, which the CEO has confirmed by notice in writing, satisfies the requirements of Condition 6-1 of MS1126, Condition 5-2 of MS1037, Conditions 7-2 and 8-2 of MS1021, and Conditions 9-2 and 10-2 of MS1105.

4 Stakeholder consultation

BHP undertakes regular and ongoing stakeholder engagement as part of its core business activities. BHP aims to facilitate regular, open and honest dialogue to understand expectations, concerns and interests of stakeholders and incorporate them into business planning to help build strong, mutually beneficial relationships. The main objectives of the consultation programme are to:

- provide information and the opportunity to comment to relevant government agencies, local authorities and to other groups or individuals who may potentially be interested in a Proposal;
- where relevant, discuss and allow stakeholder comments on Proposals to be incorporated into this EPWRMP; and
- BHP will continue to engage with Traditional Owners through targeted consultation and via administration of Native Title agreements.

The specific consultation relevant to this EPWRMP is summarised in Table 14.

Table 14: Stakeholder consultation

Stakeholder	Date	Topics/issues raised	BHP response and outcome
Department of Parks and Wildlife (now Department of Biodiversity, Conservation and Attractions)	23 March 2016	Version 3.0 Email / telephone consultation: <ul style="list-style-type: none"> • The plan should provide greater context to justify using two parameters as trigger and threshold measures in identifying change in hydrological conditions in the Ethel Gorge aquifer. 	<ul style="list-style-type: none"> • The Ethel Gorge section of Appendix 3 – A description of the Receptors of importance has been updated to provide improved description of the hydrological conceptualisation of Ophthalmia Dam, which formed the basis for indicators. • Some minor text changes in Section 6.1 to provide further clarity
		<ul style="list-style-type: none"> • It is unclear if monitoring of hydrological parameters is occurring prior to the water being discharged/entering Ethel Gorge. 	<ul style="list-style-type: none"> • Discharges into the Dam are managed and monitored in accordance with Department of Environment Regulation (DER) Licences to Operate. • Further clarification of the role of these Licences has been included in the text.
		<ul style="list-style-type: none"> • The monitoring program should be expanded to include hydrological parameters at the source/s (i.e. mine sites, natural sources) prior to the water entering Ethel Gorge. • The inclusion of early (i.e. source) monitoring may facilitate early intervention and adaptive management of identified change/s to hydrological conditions (quality and quantity) of water (both mining and natural) prior to the water being discharged/entering Ethel gorge. 	<ul style="list-style-type: none"> • BHP acknowledges that the Plan to date has focused on the proposed monitoring within the actual Dam itself. • BHP has an extensive monitoring program within the region, in both adjacent operations and in the surrounding environment. Sections 4.5 and 5.1 have been updated to address how these broader programs are being used to monitor and manage Ophthalmia Dam and the associated Ethel Gorge TEC habitat. • The Plan includes early warning monitoring zone, and associated triggers and thresholds. Source monitoring is undertaken in

Stakeholder	Date	Topics/issues raised	BHP response and outcome
			accordance with DER Licence requirements.
Department of Water (now DWER)	7 February 2017	<p>Version 3.2</p> <p>Updated Plan sent to DoW via email:</p> <ul style="list-style-type: none"> • Consultation with DER and Department of Health (DoH) recommended for trigger levels and thresholds for algal blooms. 	<ul style="list-style-type: none"> • DoH have provided in principle agreement for thresholds during consultation on Protection of Human Health Posed by Any Recreational Use of Ophthalmia Dam. • DER will review EPWRMP as part of an upcoming submission.
Office of the Environmental Protection Authority (now DWER)	23 March 2017 26 May 2017	<p>Versions 3.2 and 4.0</p> <p>Meeting with officers of the OEPA:</p> <ul style="list-style-type: none"> • Alignment of the EPWRMP to EPA (2016) <i>Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans</i> template. • Discussed an asset-based approach to Schedules. 	<ul style="list-style-type: none"> • BHP revised the EPWRMP in consideration of OEPA comments, and provided this revised version, for review and comment.
DWER	6 April 2018	<p>Version 6.0</p> <p>Meeting with officer of the DWER:</p> <ul style="list-style-type: none"> • The DWER requested a Ministerial Statement based approach to Schedules, rather than an asset based approach. • Agreed to separate regional assets in to sub-schedules based on Ministerial Statement numbers. 	<ul style="list-style-type: none"> • BHP revised the EPWRMP in consideration of DWER comments, and provided this revised version, for review and comment.
DWER	17 November 2020	<p>Version 6.0 resubmission</p> <p>Letter from DWER endorsing version 6.0 for MS1037 and 1021:</p> <ul style="list-style-type: none"> • If BHP updates the EPWRMP in the future, it is recommended that consideration be given to the revisions provided in Attachment 1. 	<ul style="list-style-type: none"> • BHP is considering the DWER's recommended revisions relating to the discharge of surplus water to Jimblebar Creek from Orebody 31 (MS1021) as part of the review of the EPWRMP currently underway for the Jimblebar Hub Significant Amendment.

5 Changes to the EMP

Table 15 summarises the key changes in this version of the EPWRMP (Version 6.2) compared to the version that BHP submitted to DWER for endorsement in December 2021 (Version 6.1).

Table 15: Changes to the EMP

Complexity of changes	Minor revisions <input checked="" type="checkbox"/>	Moderate revisions	Major revisions
Number of key environmental factors	One	2-3 <input checked="" type="checkbox"/>	>3
Date revision submitted to EPA	June 2022		
Proponent's operational requirement timeframe for approval of revision	< One month	< Six months <input checked="" type="checkbox"/>	>Six months None
Reason for timeframe	The EPWRMP is currently being implemented for approved proposals that are in operations. BHP plans to start construction of the Orebody 32 Below Water Table Proposal in January 2023		

Item no.	EMP Section no.	EMP page no.	Summary of change	Reason for change
1.	All	All	Add in information for Orebody 32 Below Water Table derived proposal	The Orebody 32 Below Water Table proposal was referred to the EPA on DD MMM 2022 to be declared a derived proposal. As discussed in the <i>Newman Hub (Orebody 32 Below Water Table) Derived Proposal Request Ministerial Statement 1105</i> (BHP 2022), BHP has proposed to manage the potential impacts to the Ethel Gorge aquifer / TEC according to the EPWRMP.
2.	1.4.2, Table 3 2, Table 9 - Table 12	8 26-27, 29, 31, 33	Add in reference to existing stygofauna monitoring program	Clarify that in addition to monitoring groundwater levels and groundwater quality (salinity) in the Ethel Gorge aquifer, BHP also undertakes a stygofauna monitoring program which currently includes annual seasonal monitoring of groundwater quality (full hydrochemistry suite) and sampling of stygofauna species.

6 References

- Bennelongia (2013). *Characterisation and Mapping of Ethel Gorge Aquifer Stygobiont Threatened Ecological Community*. Report Prepared for BHP Billiton, December 2013. Report reference 2013/201.
- BHP Billiton (2015). *SEA Hydrology – Ecohydrological Change Assessment*. Public Environmental Review Strategic Proposal - Appendix 7 Main reports and maps. Perth, Western Australia.
- BHP Billiton (2016) *Pilbara Public Environmental Review Strategic Proposal*. BHP, Perth, WA.
- BHP (2018). *GWL Operating Strategy for Ophthalmia Borefield*. Version 2.0, January 2018. Perth, Western Australia.
- BHP (2020a). *Jimblebar Water Management Plan*. Version 0.1, May 2020. Perth, Western Australia.
- BHP (2020b). *Pilbara Water Resource Management Strategy*. Internal document number 0092277. Perth, Western Australia.
- BHP (2022). *Newman Hub (Orebody 32 Below Water Table) Derived Proposal Request Ministerial Statement 1105*. In preparation.
- Environmental Protection Authority (EPA) (2018a). *Pilbara Expansion Strategic Proposal*. Report and recommendations of the Environmental Protection Authority. Report 1619. Perth, Western Australia. Published 9 July 2018.
- Environment Protection Authority (EPA) (2021a). *How to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans: Instructions*. Version 2.0, 29 October 2021.
- Environment Protection Authority (EPA) (2021b). *Environmental outcomes and outcomes-based conditions: Interim Guidance*.
- Halse et al (2014). Pilbara stygofauna: deep groundwater of an arid landscape contains globally significant radiation of biodiversity. *Records of the Western Australian Museum, Supplement 78: 443-483*.
- Onshore (2015). *Jimblebar Creek Riparian Flora and Vegetation Baseline Survey*. Report prepared for BHP Billiton.
- Onshore (2016). *Riparian Vegetation Health Assessment*. Report prepared for BHP Billiton.
- Stantec (2017). *Ethel Gorge Stygofauna Monitoring Program: 2017*. Report prepared for BHP, November 2017.
- Stantec (2022). *Eastern Ridge and Jimblebar Stygofauna Monitoring 2020/2021*. Report prepared for BHP, V0.3, March 2022.

Appendices

Appendix 1 Jimblebar Creek system conceptualisation

A number of sources of data have been drawn upon to inform the creek system conceptualisation:

- Airborne EM transect was flown along Orebody 31 and Jimblebar Creek alignments.
- A desktop study of all available DTM, airborne geophysical and regional geological data.
- Ground-based geophysical surveys using ERI (Electrical Resistivity Imaging) and NMR (Nuclear Magnetic Resonance) techniques:
 - Five geophysical survey sections were completed - two surveys on Orebody 31 drainage line (a tributary of Jimblebar Creek) and three surveys on Jimblebar Creek. This work particularly informed the creek alluvial geometry and permeability distributions.
- Orebody 31 hydrodynamic trial - creek discharge trial:
 - As part of the Orebody 31 hydrodynamic trial, a creek discharge trial was undertaken. This generated a multi-faceted data set generated, particularly from the period September 2015 to January 2016 when the wetting front and discharge rate achieved equilibrium.
- A series of drone fly-over video captures of the creek line at various times during the hydrodynamic trial to confirm the location and distribution of the wetting front. The low flow channel dynamics was also reviewed to inform and validate aspects of this hydrological conceptualisation.

To characterise the hydrology of the Orebody 31 and Jimblebar Creek systems within the 16 km discharge limit (authorised extent), the creek system has been divided into three reaches:

- Reach 1: Orebody 31 Creek: drainage line from discharge point to junction with Jimblebar Creek.
- Reach 2: Jimblebar Creek – from junction with Orebody 31 drainage line to Road Crossing on Jimblebar Creek.
- Reach 3: Jimblebar Creek – from Road Crossing to Discharge Limit (16 km).

Reach 1 - Orebody 31 Creek

The Orebody 31 drainage line from the discharge point to the junction with Jimblebar Creek is approximately 4.35 km in length and has an overall channel width that averages approximately 200 m (Figure A1). This overall channel represents the available bank storage and riparian zone. Within this channel is a low flow channel which averages approximately 5 m in width. This length of creek averages 50 mm/day of infiltration plus evaporation on the surface area of the low flow channel and evapotranspiration within the riparian zone. There is no vertical infiltration into the deeper system, or neighbouring palaeochannels.

The modern Orebody 31 drainage line is narrow and steep-sided, incised into the recent silty sands of the surrounding alluvial system. The upper sandy alluvials are ~5 m deep, with the modern creek invert incised 3-4 m deep into the surrounding plain, with the average low-flow channel width of ~5 m (Figure A1). Low flow events are contained within this channel, and water infiltrated into the shallow alluvials through the bottom and banks of the creek system. The sandy alluvials in the banks of the creek system have the ability to accept significant volumes, given the likely permeability and storage characteristics of these silty sands.

Beneath the recent sandy alluvials is a laterally continuous silty clay unit, which is generally expected to limit vertical infiltration beyond the upper alluvial system given its low permeability. This is also likely to limit the

degree of connection between any perched creek aquifer from the deeper regional groundwater system. There are exceptions to the low permeability clay horizon, with the geophysical surveys picking up discrete incised palaeo-drainage channels, with distinctly higher permeability sands associated with a higher energy deposition environment with a drainage channel.

A hydrodynamic was undertaken at Orebody 31 in 2015/2016, including a discharge trial into Orebody 31 drainage line, and observation of the progress and nature of the wetting front within Orebody 31 creek, and onward into the Jimblebar Creek system.

Under discharge conditions, the Orebody 31 drainage line low flow channel areas contain permanent water, with ongoing infiltration into the shallow sandy alluvials beneath and beside the low flow channel – potentially to the width of the riparian zone associated with the creek-line. In the Orebody 31 drainage line reach, at a discharge rate of 10 ML/d (during the hydrodynamic trial), the typical hydrological conditions are shown in Figure A2.

Reaches 2 and 3 - Jimblebar Creek

Jimblebar Creek from the junction with Orebody 31 drainage line to the Road Crossing on Jimblebar Creek is approximately 3.9 km in length and has an overall channel width that averages approximately 300 m (Figure A3). This overall channel represents the available bank storage and riparian zone. Within this channel are several low flow channels, however a preferential low flow channel was observed during the hydrodynamic trial (and associated drone fly-overs), which averaged approximately 10 m in width. This reach averages 50 mm/day of infiltration plus evaporation on the surface area of the low flow channel and evapotranspiration within the riparian zone. There is assumed to be limited vertical infiltration into the deeper alluvial system.

Similarly, Jimblebar Creek from the Road Crossing to the Discharge Limit (16 km) is approximately 7.8 km in length and has very similar characteristics to Reach 2. The differentiation is because the hydrodynamic trial wetting front did not reach this section of creek. However, the low flow channel dynamics were still able to be observed via aerial photography after a natural creek flow event. This reach averages 40 mm/day of infiltration, plus evaporation on the surface area of the low flow channel and evapotranspiration within the riparian zone. There is assumed to be limited vertical infiltration into the deeper alluvial system.

The modern Jimblebar Creek drainage system is braided, with multiple channels defined within its banks. The low flow channel tends to meander within the banks of the creek system. The upper sandy alluvials are 5-6 m deep, with the modern creek invert incised 1-2 m into the surrounding plain, with the average low-flow channel width of ~10 m (Figure A3). Low flow events are contained within this channel, and water infiltrated into the shallow alluvials through the bottom and banks of the creek system.

The sandy alluvials in the banks of the creek system have the ability to accept significant volumes, given the likely permeability and storage characteristics of these silty sands – Figure A4 below illustrates this characteristic during the hydrodynamic trial. The drone footage clearly depicts the main low flow channel (the central channel from top to bottom of photo), as well as other ponded water areas associated with low points in the sandy creek beds, where infiltrated discharge is daylighting from the creek bed. This can be particularly noted on the right of image, just downstream of the gum-trees (red circles), where typical deeper washouts occur in the creek morphology. You can also note an upper fringe of semi-saturated sands related to capillary action upwards from the fully saturated sands beneath.

Beneath the recent sandy alluvials is a laterally continuous silty clay unit, which is generally expected to limit vertical infiltration beyond the upper alluvial system given its low permeability. This is also likely to limit the degree of connection between any perched creek aquifer from the deeper regional groundwater system.

Within the Jimblebar Creek system, the low flow channel meanders and is broader and shallower in surface water expression when compared to the Orebody 31 drainage line reach. Infiltration into the sandy alluvials of

the broader creek system surrounding the low flow channel will also occur. Figure A5 shows the typical hydrological conditions within Jimblebar Creek at a discharge rate of 10 ML/d (during the hydrodynamic trial).

Upon cessation of discharge, the wetting front will retreat (ceasing flow), although some creek low points maintain pools for a period of time after this. Ongoing infiltration, evaporation and evapotranspiration will result in the creek completely drying out over time.

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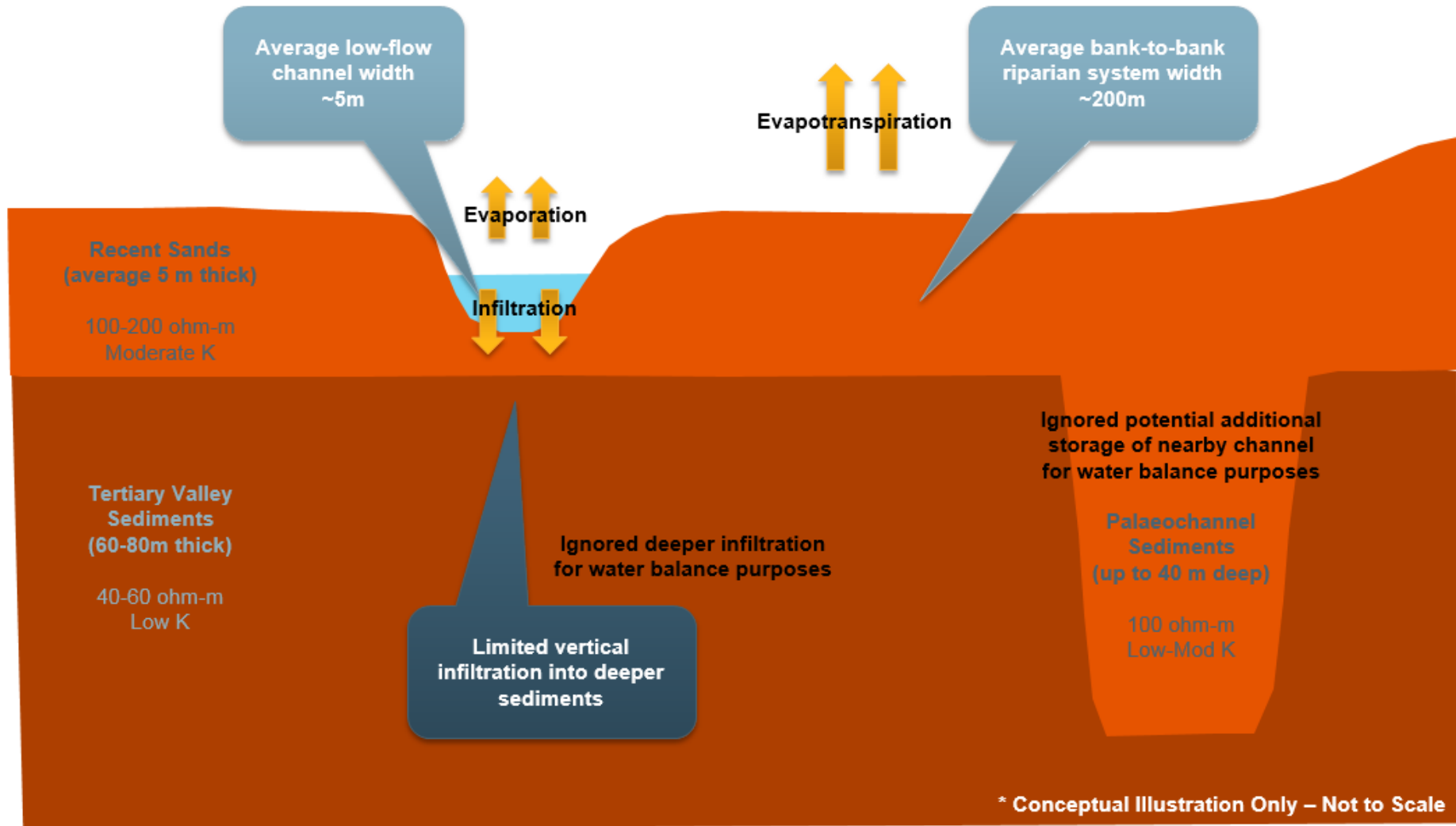


Figure A1: Hydrological Conceptualisation of Reach 1 - Orebody 31 drainage line



Figure A2: Orebody 31 drainage line (Reach 1) under discharge conditions (10 ML/d), January 2016

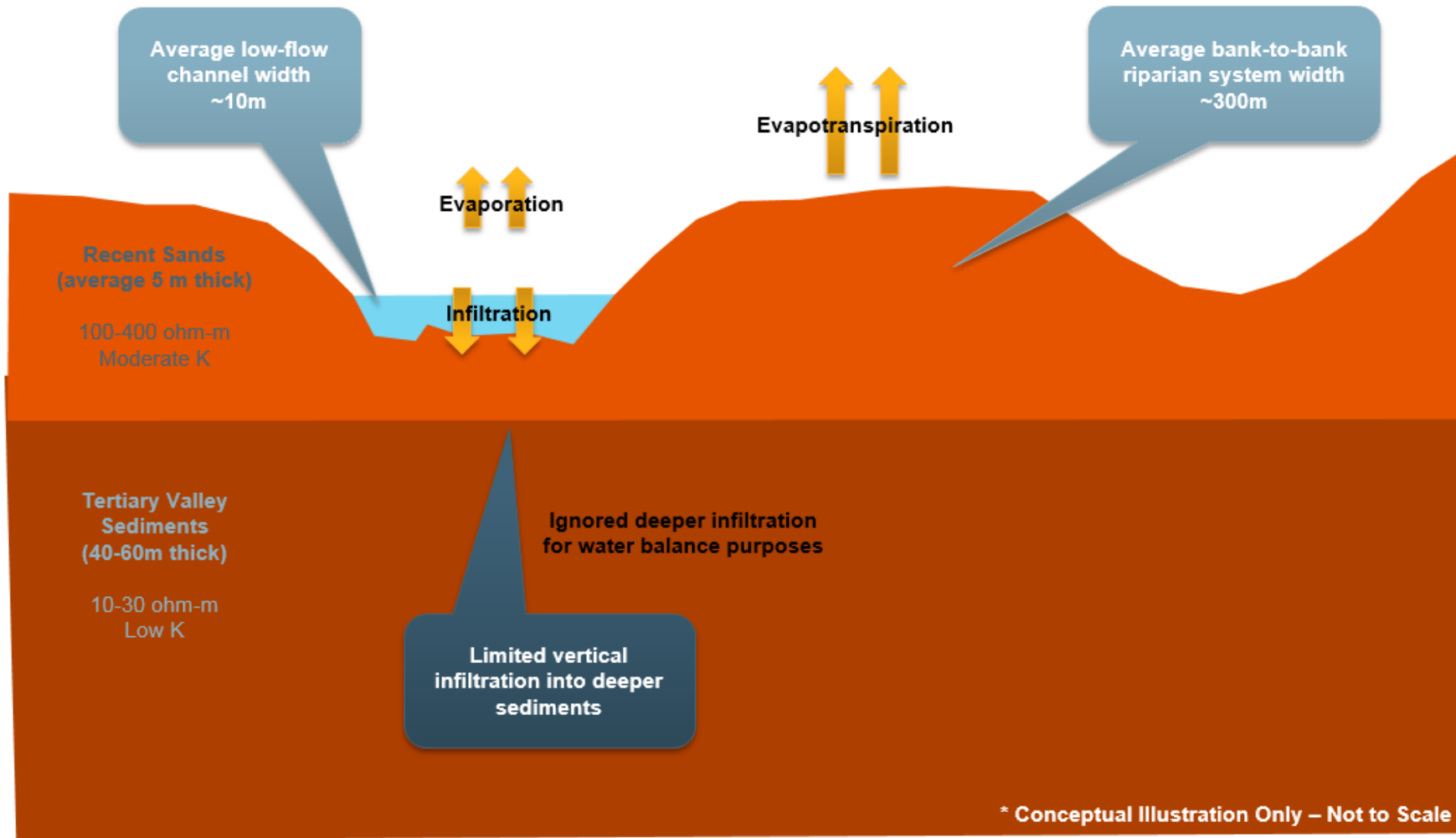


Figure A3: Hydrological Conceptualisation of Reaches 2 and 3 - Jimblebar Creek



Figure A4: Looking south up Jimblebar Creek (Reach 2), with sediments showing bank storage characteristics



Figure A5: Jimblebar Creek under discharge conditions (10 ML/d), January 2016