

BHP

Newman Hub (Western Ridge) MS1105 Water (PFAS) Management Plan

January 2023



Version Control

Version	Description of version	Key changes	Issue date
Draft v0	Draft for comment	Original document	14/10/2022
Version 1	Version submitted to EPA	Update to regular reporting, stakeholder consultation table and document title	16/01/2023

Abbreviations and Definitions

Term	Meaning
BHP	BHP Iron Ore Pty Ltd
CAR	Compliance Assessment Report
CEO	Chief Executive Officer
Clearing	As defined in section 51A of the <i>Environmental Protection Act 1986 (WA)</i>
DBCA	Department of Biodiversity Conservation and Attractions
DE	Development Envelope
DP	Derived Proposal
DWER	Department of Water and Environmental Regulation
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP Act	<i>Environmental Protection Act 1986 (WA)</i>
FTS	fluorotelomer sulfonic acid
GIS	Geographic Information System
HEPA	Heads of EPA
MS	Ministerial Statement
Mtpa	Million tonnes per annum
NEMP	National Environmental Management Plan
PEAHR	Project Environmental Aboriginal Heritage Review
PFAS	per- and poly-fluoro alkyl substances (PFAS)
PFHxS	Perfluoro hexane sulfonate
PFOA	Perfluoro octanoate
PFOS	Perfluoro octane sulfonate
TEC	Threatened Ecological Community
TRH	Total Recoverable Hydrocarbons
WA	Western Australia
WAIO	Western Australia Iron Ore
WMP	Water Management Plan

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Executive Summary

Western Ridge Water Management Plan	
Proposal name	Western Ridge
Proponent name	BHP Iron Ore Pty Ltd
Ministerial Statement	1105
Purpose of the WMP	To meet the requirements of implementation Conditions 6 (Condition Environmental Management Plans) and 10 (Water Environmental Management Plan) of Ministerial Statement 1105 (MS 1105).
Key environmental factors and WMP outcomes	<p>Inland Waters</p> <p>Concentrations of Per- and Poly-fluoro Alkyl Substances (PFAS) in groundwater in the Public Drinking Water Source Areas (PDSWA) within Western Ridge and within Ethel Gorge aquifer are below PFAS National Environmental Management Plan (NEMP) human health (drinking water) guideline values.</p> <p>Inland Waters and Subterranean Fauna</p> <p>PFAS concentrations in Ophthalmia Dam and the Ethel Gorge aquifer are below PFAS NEMP ecological (freshwater) 95% species protection guideline values and site-specific ecological criteria (under development).</p>
Condition clauses	6-1 Prepare and submit Condition Environmental Management Plans 10-2 Prepare a Water Environmental Management Plan
Key components of the plan	Table 4
Proposed construction date	Q1 2024
EMP required pre-construction?	Yes

1 Context, scope and rationale

BHP Iron Ore Pty Ltd (BHP) has prepared this Water Management Plan (WMP) to meet the requirements under Part IV of the *Environmental Protection Act 1986* (EP Act). The plan is submitted as a draft with the referral documentation for the Newman Hub (Western Ridge) Derived Proposal (the Proposal) (BHP 2022). The intent for the WMP is to meet the requirements of the Strategic Proposal MS1105 Condition 6 (Condition Environmental Management Plans) and Condition 10 (Water Environmental Management Plan).

BHP has prepared this WMP to be consistent with the *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (hereafter, the Instructions) (EPA 2021).

1.1 Proposal

Future mining expansions at Newman were identified in BHP's Pilbara Public Environmental Review Strategic Proposal (PERSP) (BHP Billiton 2016) and in the EPA's report on the Strategic Proposal (EPA Report 1619). The Proposal is within the Strategic Proposal boundary and forms part of the future expansion proposal of Newman identified in Schedule 1 of MS1105.

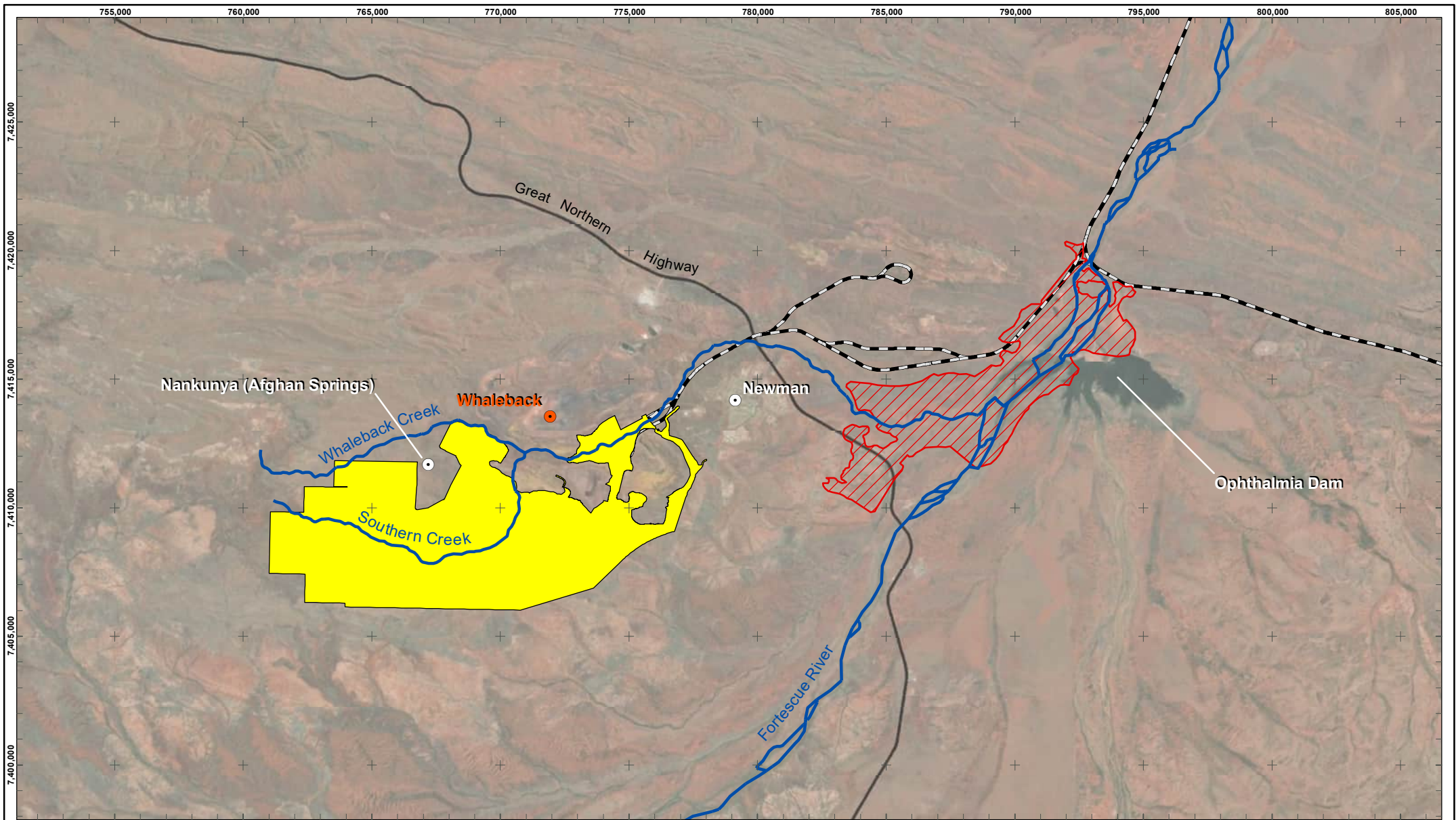
The Proposal is located approximately 2 km southwest of Newman (with nearest mine pits approximately 7 km southwest of Newman town), in the Pilbara region of Western Australia (Figure 1). The scope of the WMP is the proposed operations at Western Ridge (Figure 2).

BHP proposes to develop the Proposal to mine four iron ore deposits, namely Eastern Syncline, Bill's Hill, Silver Knight and Mount Helen, with a life of 31 years. The Proposal includes the following main elements and activities:

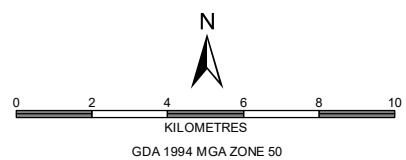
- mine pit excavation above and below the water table
- dewatering for below water table mining and surplus water discharge and supporting infrastructure including water bores and pipelines
- surface water management including creek diversions and culverts
- overburden storage areas, ore stockpiles and topsoil stockpiles and associated stacking, reclaiming and loading activities
- haul and access roads
- borrow pits and laydown areas
- ground disturbance and earthworks (vegetation, habitat and landform removal)
- ore processing infrastructure including 30 Mtpa crusher
- ore transportation infrastructure including overland conveyor
- ancillary infrastructure including ore sampling station
- administration and workshop buildings, repair yards, vehicle maintenance areas, assembly areas
- water abstraction, water supply, water storage, water treatment, drainage and stormwater management
- waste management
- support infrastructure including power distribution infrastructure, powerlines and communication towers.

Mining will be undertaken as typical open pit operation.

Consistent with the hub approach proposed for the Strategic Proposal, the Proposal will utilise existing Mount (Mt) Whaleback infrastructure including ore processing at Mt Whaleback, and non-process infrastructure including existing approved surplus water pipeline to Ophthalmia Dam, heavy vehicle maintenance facilities, Ammonium Nitrate Fuel Oil (ANFO) storage, potable water supply, laboratory analysis services, medical services and sub-station power supply. Any minor modifications required to existing Newman infrastructure to accommodate the Proposal will be addressed separately under existing approvals that regulate Mt Whaleback operations.



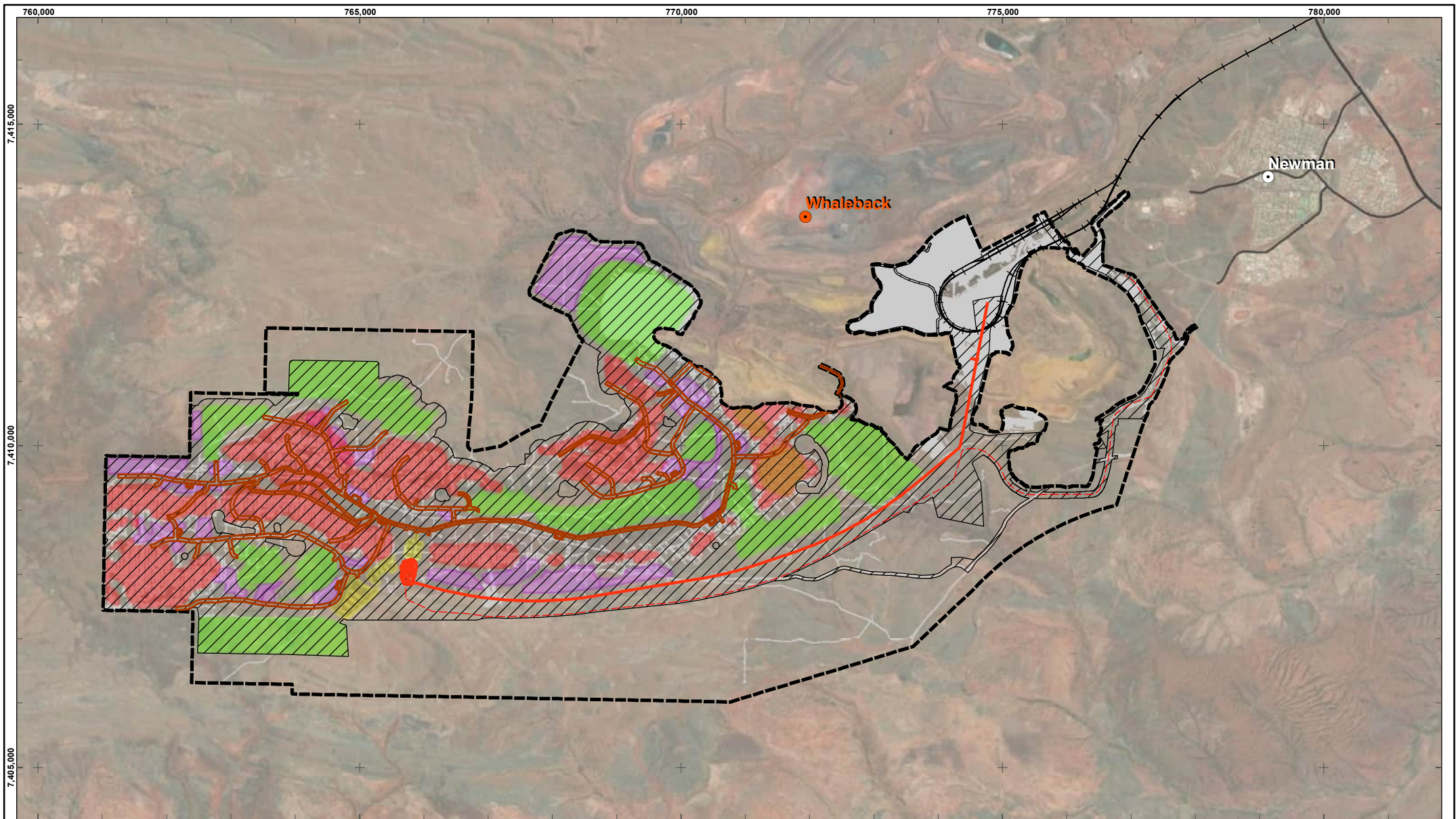
- BHP operations
- BHP rail
- Development Envelope
- Great Northern Highway
- Threatened Ecological Community
- Waterways



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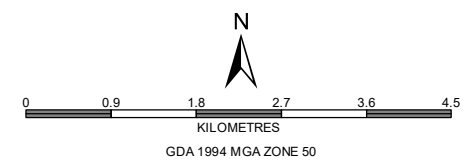
**WESTERN RIDGE
PFAS WATER MANAGEMENT PLAN**
Proposal location

PLANNING & STANDARDS - IRON ORE			
SCALE @ A4:	1:200,000	PREPARED:	M. ENGLISH
DATE:	20/09/2022	REQUESTOR:	ENV. APPROVALS
		REVIEWED:	N. McALINDEN
		FIGURE:	1
		NO:	979/230B



- BHP operations
- Development Envelope
- Existing rail
- Indicative Cleared Area as at FY2021
- Indicative Footprint
- Roads

- Proposed infrastructure**
- Proposed powerline
- Overland conveyor
- Haul road
- OSA
- Pit
- ROM Pad
- Topsoil storage
- Proposed mining disturbance



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**WESTERN RIDGE
PFAS WATER MANAGEMENT PLAN**
Development Envelope and
Indicative Footprint of the Proposal

PLANNING & STANDARDS - IRON ORE

SCALE @ A4:	1:80,000	PREPARED:	M. ENGLISH	FIGURE:	2
DATE:	20/09/2022	REQUESTOR:	ENV. APPROVALS	NO:	979/231B
		REVIEWED:	N. McALINDEN		

1.2 Key environmental factor

The key environmental factors relevant to this WMP are Inland Waters and Subterranean Fauna, specifically in relation to the potential for direct and indirect impacts to groundwater from per- and poly-fluoro alkyl substances (PFAS) in groundwater at Western Ridge and surface water in Ophthalmia Dam, which recharges the Ethel gorge aquifer which supports the Ethel Gorge Threatened Ecological Community (TEC).

Table 1 describes the activities, values and potential impacts on the key environmental factors addressed in this WMP.

Table 1: Key environmental factors, values and activities

Key environmental factor	Environmental values	Proposal activities	Actual/Potential impacts
Inland Waters and Subterranean Fauna	Newman Water Reserve P1 Public Drinking Water Source Area (PDWSA)	Groundwater abstraction for mine dewatering to enable below water table mining.	<p>Direct impacts</p> <p>Potential change to groundwater quality as a result of PFAS migration from known historical PFAS sources at adjacent Whaleback mine site.</p>
	Ethel Gorge aquifer and Ethel Gorge TEC	Discharge of surplus dewatered groundwater to Ophthalmia Dam Managed Aquifer Recharge (MAR) system.	<p>Direct impacts</p> <p>Potential change to surface water quality in Ophthalmia Dam as a result of PFAS in surplus dewatered groundwater, discharged to the dam.</p> <p>Potential change to groundwater quality in the Ethel Gorge aquifer from groundwater recharge and releases from Ophthalmia Dam</p> <p>Indirect impacts</p> <p>Potential changes to stygofauna habitat and species</p>

1.3 Condition requirements

BHP's strategic approach is to manage the environment at the subregional or hub level. BHP proposes the following conditions in the Strategic Proposal Ministerial Statement (MS) 1105, as relevant to the Proposal:

- Condition 6 - Condition Environmental Management Plan/s (entire condition)
- Condition 10 - Water Environmental Management Plan.

The relevant sub-clauses of Condition 10 (Water Environmental Management Plan) of Strategic Proposal MS1105 and where they are addressed in this WMP are outlined in Table 2 below.

Table 2: MS1105 Condition 10 relevant condition objective sub-clauses

Water Environmental Management Plan Condition sub-clause	Applicable to this WMP	Section/s
10-1 The proponent shall manage the implementation of the proposal to meet the following environmental objective: (1) maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected, including where relevant avoiding and minimising direct and indirect impacts of the proposal, on:	Yes	Table 4
(a) Fortescue Marsh;	No	N/A
(b) hydrological regimes that support threatened and priority ecological communities;	Yes	Table 4
(c) proclaimed Public Drinking Water Source Areas;	Yes	Table 4
(d) permanent and ephemeral rock pools;	No	N/A
(e) wetlands which are Ramsar listed, or listed in the Directory of Important Wetlands in Australia;	No	N/A
(f) wild rivers;	No	N/A
(g) wetland types which may be poorly represented;	No	N/A
(h) natural springs;	No	N/A
(i) ecosystems which support conservation significant flora/ vegetation and fauna species or communities, including migratory waterbirds, bats, groundwater dependent biota and subterranean fauna; and	Yes	Table 4
(j) ecosystems which support significant amenity, recreation and cultural values.	No	N/A
10-2 The Proponent shall prepare a Water Management Plan required by condition 6-1 that satisfies the requirements of condition 6-2, to meet the objectives specified in Condition 10-1, in consultation with the agency responsible for administration of the Wildlife Conservation Act 1950 and Biodiversity Conservation Act 2016.	Yes	This WMP
10-3 The Water Management Plan required by condition 6-1 shall include provisions required by condition 6-2 to address impacts on hydrological regimes and water quality, where relevant, including from, but not limited to: water abstraction; managed aquifer recharge; disposal of mine dewater to surface water systems; diversion of surface water systems; discharge of wastes to storage or evaporative basins and dewatering of aquifers and exposure of potentially acid forming material or the creation of acid and metalliferous drainage.	Yes	This WMP
10-4 The proponent shall continue to implement the version of the Water Management Plan most recently approved by the CEO until the CEO has confirmed by notice in writing that the plan required by condition 6-1 satisfies the requirements of condition 6-2 to meet the objectives specified in condition 10-1.	Yes	This WMP

BHP has provided the condition requirements (outcomes-based) of Condition 6 - Condition Environmental Management Plans in the provisions table (see Section 2), which the Instructions allow for, if there are multiple conditions and/or condition clauses.

1.4 Rationale and approach

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

PFAS is not considered to be a specific risk driver at the site because this Proposal is a greenfield development and the results of the environmental baseline investigations indicate a low risk related to PFAS. In addition, BHP has implemented a PFAS phase-out program across all its operations and so the potential for the introduction of PFAS-containing compounds and the subsequent release to the environment of PFAS through mining operations is considered very low. However, given the emerging nature of PFAS, and known low concentration historical contamination at the Mt Whaleback mine located north to northwest of the Development Envelope, additional focus has been placed upon its identification and management, if present. This WMP therefore intends to monitor for PFAS in groundwater within the Development Envelope, to provide an early detection system, should PFAS migrate from known historical contamination at Mt Whaleback, as a result of dewatering required for the Proposal. This WMP does not consider groundwater abstraction or management of surplus water as these activities will be managed by other regulatory mechanisms.

This WMP has been developed in accordance with the precautionary principle and includes triggers, actions, and responses for PFAS, which may enter or migrate onto the site (via dewatering). The WMP applies a risk based management approach to manage potential detections.

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 is shown in Figure 3.

BHP applied a risk-based approach to identify and prioritise the components of this WMP. The purpose of the components is to protect the environmental values identified in Table 1. In developing the components, BHP has used available scientific information from recent investigations, studies and has applied learnings from the management of PFAS in groundwater at other BHP and/or third party mine sites.

This WMP does not duplicate monitoring and/or controls in other statutory decision-making processes for water-related activities at the proposed Western Ridge operations and in the Newman PDWSA (Figure 3). This includes regulation administered by the Department of Water and Environmental Regulation (DWER), i.e. EP Act Part V, *Rights in Water and Irrigation Act 1914* (RiWI Act) and the *Contaminated Sites Act 2003*.

Figure 3: Water management framework

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: Eastern Ridge MS1037 Condition 8, Pilbara Expansion Strategic Proposal MS1105 Condition 10 - proposed 		
	Newman town water supply		
	RiWI 5C Homestead Borefield GWL 177235(2) and Ophthalmia Borefield GWL65219(12) and Operating Strategies <ul style="list-style-type: none"> Limit on rate of groundwater abstraction Monitoring at the source (production bores) – abstraction rate, volume, groundwater quality Monitoring along pathway – groundwater levels 		
Country Areas Water Supply Act 1947 <ul style="list-style-type: none"> Specifies the geometry of proclaimed P1 and P3 areas; Manage land use activities within the P1 and P3 areas in accordance with WQPN 25; Catchment management, surveillance, & monitoring managed jointly between BHP and Water Corporation to correct or reduce external contamination risk. 		Water Services Act 2013 <ul style="list-style-type: none"> Provides framework to issue licence for the provision of water services (including drinking water); Licence requires risk management approach from source to consumption point including definition of treatment critical control points, monitoring, and response actions. Risk management approach includes source & catchment management; Requires MoU with WA DoH for the drinking water management system. 	
Site	Whaleback including Orebody 29/30/35	Eastern Ridge including Orebody 32 BWT (proposed)	Western Ridge (proposed)
	EP Act Part IV Orebody 29/30/35 MS963 <ul style="list-style-type: none"> Authorised extents (dewatering abstraction rate, Ophthalmia Dam discharge rate) 	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 IV MS1105 s. 45B(2) Notice <i>(new for OB32 BWT if approved)</i> <ul style="list-style-type: none"> Authorised extents TBC (dewatering abstraction rate, Ophthalmia Dam discharge rate) EP Act Part IV MS1105 (OB32 BWT) <i>(new for OB32 BWT if approved)</i> <ul style="list-style-type: none"> Condition 10 Water Environmental Management Plan (PFAS WMP) 	EP Act Part IV s. 45B(2) Notice <i>(new if approved)</i> <ul style="list-style-type: none"> Authorised extents TBC (dewatering abstraction rate, Ophthalmia Dam discharge rate) EP Act Part IV MS1105 <i>(new if approved)</i> <ul style="list-style-type: none"> Condition 10 Water Environmental Management Plan (PFAS WMP)
	EP Act Part V L4503/1975/14 <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) 	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) 	EP Act Part V licence <i>(new 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 GWL65148(11) and Operating Strategy <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 	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 	RiWI 5C GWL and Operating Strategy <i>(new if 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
	Contaminated Sites Act <ul style="list-style-type: none"> PFAS National Environmental Management Plan (HEPA, 2020) Mount Whaleback Interim Site Management Plan for PFAS (Tetra Tech Coffey, 2021a) 	Contaminated Sites Act <ul style="list-style-type: none"> PFAS National Environmental Management Plan (HEPA, 2020) 	

1.4.2 Rationale

Table 3 provides the rationale for the WMP components in Section 2, including:

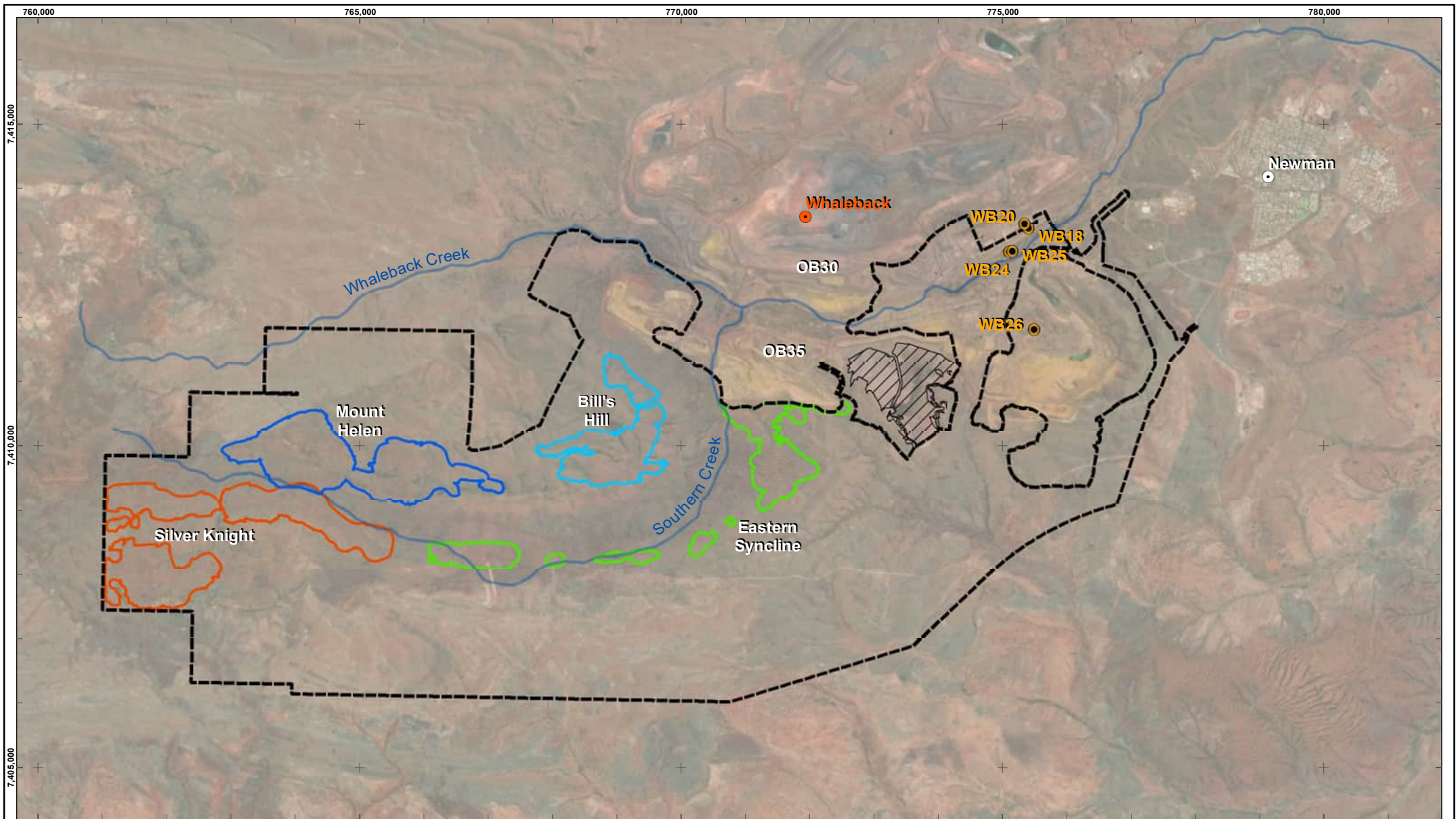
- environmental outcome
- study findings
- key assumptions and uncertainties
- rationale for choice of indicators.

Table 3: Rationale for EMP Components

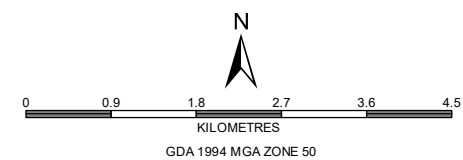
Studies	Study findings	Key assumptions and uncertainties	Rationale for choice of components
<p>Environmental values: Newman Water Reserve PDWSA, Ethel Gorge aquifer, Ethel Gorge TEC</p> <p>EMP environmental outcomes:</p> <ul style="list-style-type: none"> • PFAS concentrations in groundwater in the PDSWA are below PFAS NEMP human health (drinking water) guideline values. • PFAS concentrations in Ophthalmia Dam and the Ethel Gorge aquifer are below PFAS NEMP ecological (freshwater) 95% protection guideline values and site-specific ecologic criteria (under development). 			
<p>Although the Proposal is a greenfield mining area, as a precautionary measure, baseline sampling for PFAS and total recoverable hydrocarbons (TRH) was conducted in April 2021 using existing groundwater wells in the Development Envelope.</p> <p>The studies used to develop the WMP components related to groundwater are listed below:</p> <ul style="list-style-type: none"> • <i>PFAS and TRH Groundwater Baseline Assessment, Western Ridge – Afghan Springs Baseline Assessment</i>, Golder, May 2021 • <i>PFAS and TRH Groundwater Baseline Assessment, Western Ridge – Eastern Syncline Baseline Assessment</i>, Golder, May 2021 • <i>PFAS and TRH Groundwater Baseline Assessment, Western Ridge – Crusher Study Area Baseline Assessment</i>, Golder, May 2021 • <i>Western Ridge Per- and for Per- and Poly-fluoro alkyl Substances Mixing Assessment</i>, Golder, 3 June 2021 • <i>Interim Site Management Plan for Per- and Poly-fluoro alkyl Substances for Mount Whaleback</i>, Tetrattech Coffey, 26 May 2021 • CRC CARE (2022) Stygofauna direct toxicity assessment. Final Report prepared for BHP, February 2022. 	<p>The baseline assessment for PFAS and TRH conducted at Western Ridge (Golder 2021) indicated that there are no known sources of contamination in the Development Envelope. A brief summary is provided below:</p> <p>Eastern Syncline and Bill’s Hill Area (Golder 2021a): Sampling of three existing monitoring wells indicated there were no detections of PFAS or TRH above the limits of reporting (LOR).</p> <p>Nankunya (Afghan Springs) (Golder 2021b): Sampling of three existing monitoring wells at Nankunya (otherwise known as Afghan Springs), located north and outside of the Development Envelope, indicated the presence of trace concentrations of PFAS in one of three wells at concentrations several orders of magnitude below screening guideline values. TRH was detected in two of three wells at low levels below applicable guideline values. The PFAS compounds detected at trace levels, slightly above LOR, were 6:2 fluorotelomer sulfonic acid (6:2 FTSA), 8:2 fluorotelomer sulfonic acid (8:2 FTSA) and perfluoro octanoate (PFOA). PFOA was detected at a concentration of 0.0007 µg/L, which is over four orders of magnitude below the 99% ecological species protection guideline value of 19 µg/L and nearly three orders of magnitude below the drinking water guideline value of 0.56 µg/L in the PFAS National Environmental Management Plan (NEMP) (HEPA 2020). Golder concluded that the reported PFAS and TRH concentrations are possibly related to the drilling additives that were used during drilling and installation of the groundwater wells, (i.e., drilling muds and/or glue for the PVC casing installation).</p> <p>Western Ridge Crusher Study Area (Mount Helen and Silver Knight) (Golder 2021c): Sampling of nine existing monitoring wells indicated the presence of trace concentrations of PFAS in one of nine wells at concentrations several orders of magnitude below screening guideline values. The PFAS compound detected at trace level, slightly above LOR, was 6:2 FTSA. None of the other PFAS compounds were detected above the LOR. TRH was detected in four of nine wells at low levels below applicable guideline values (Golder 2021c). Golder concluded that the reported PFAS and TRH concentrations are possibly related to the drilling additives that were used during drilling and installation of the groundwater wells, (i.e., drilling muds and/or glue for the PVC casing installation).</p> <p>Ophthalmia Dam / Ethel Gorge aquifer</p> <p>Monitoring shows that PFAS levels in Ophthalmia Dam are variable but well below the Australian Drinking Water Guidelines / PFAS NEMP human health (drinking water) guideline value of (0.07 µg/L sum (PFOS + PFHxS)) (Tetrattech Coffey 2021b). PFAS concentrations detected in the Ethel Gorge aquifer are marginally above the PFAS NEMP 99% Species Protection ecological guideline value (0.00023 µg/L PFOS) (Tetrattech Coffey 2021b).</p> <p>Western Ridge Modelling Assessment (Golder 2021d): The potential risk of PFAS migrating from known PFAS sources from adjacent Whaleback Site was evaluated using groundwater modelling of the</p>	<p>Assumptions:</p> <ul style="list-style-type: none"> • PFAS has been detected at trace levels in a few monitoring wells within Western Ridge. As no known sources of PFAS are present within Western Ridge Development Envelope, the trace level detections of PFAS could be attributed to past anthropogenic activities or potential cross-contamination from well construction methods or materials of construction or drill additives. • PFAS containing compounds will not be used as part of Western Ridge Proposal as BHP has substantially phased-out PFAS usage at its operations • Modelling conservatively assumes that source area PFAS concentrations at adjacent Whaleback mine site remains constant for the duration of the modelled dewatering simulation. This is considered conservative as PFAS products have been removed from the Whaleback site and so concentrations in the environment will reduce over time. • Modelling conservatively excludes other PFAS attenuation mechanisms such as sorption, diffusion and degradation. • PFAS contamination at the Mt Whaleback site is limited to within the top 10 m of the saturated zone within the known source areas. This is a reasonable assumption considering the affinity of PFAS to remain near the air-water interface and the fact that advective transport will dominate any vertical dispersive processes. <p>Uncertainties:</p> <ul style="list-style-type: none"> • Groundwater modelling has inherent uncertainties due to the complexity 	<p>Type of components</p> <p>BHP has chosen outcome-based components to address the requirements of Condition 6 and meet the objectives specified in Condition 10 of MS1105. The outcome-based approach has been chosen on the basis of the following:</p> <ul style="list-style-type: none"> • it is possible to specify environmental outcomes relating to PFAS in groundwater and surface water. <p>Risk-based approach</p> <p>BHP has used a risk-based approach to identify the components, and has considered the following:</p> <ul style="list-style-type: none"> • There are important water values that may be affected by water-related activities from the Western Ridge Proposal (Newman Water Reserve Priority 1 PDWSA which includes the Homestead and Ophthalmia Borefields) and Ophthalmia Dam which recharges the Ethel Gorge aquifer (which supports the Ethel Gorge TEC). • There are no known sources of PFAS within the Development Envelope and BHP has phased-out PFAS compounds from its supply chain. Exceedances of water quality criteria attributable to the Proposal are therefore very low risk. • There are existing very low ambient levels of PFAS in Ophthalmia Dam and the Ethel Gorge aquifer, which exceed the 99% ecological species protection level. • The modelling indicates that the proposed dewatering may result in PFAS migrating (from adjacent Whaleback mine site) towards Western Ridge, but PFAS levels will be at or below the limits of reporting. • Considering the low concentration PFAS sources at the adjacent Whaleback mine site and the significant distance, the proposed dewatering is unlikely to result in PFAS migration (from adjacent Whaleback mine) at unacceptable concentrations towards Western Ridge ore bodies. Further, the risk of dewatered groundwater from Western Ridge contributing to the exceedance of guideline values (both 99% and 95% ecological species protection level as well as drinking water guideline values) at Ophthalmia Dam and the Ethel Gorge aquifer is very low. <p>Rationale for choice of indicators</p> <p>Dewatering activities related to the Proposal has the potential to mobilise PFAS from the adjacent Whaleback mine PFAS source areas towards the Western Ridge ore bodies. If PFAS migrates at unacceptable levels towards the orebody, it could impact on the groundwater quality at Western Ridge, which is within the same P1 PDWSA as the Whaleback mine. Further, if dewatered groundwater discharged to Ophthalmia Dam contains PFAS, it may impact on the quality of the surface water in the dam, which recharges the Ethel Gorge aquifer.</p> <p>BHP has selected early response indicators to minimise the risk of unacceptable levels (i.e. exceeding relevant guideline values) of PFAS migrating towards the ore bodies, which will prevent the risk of dewatered groundwater containing unacceptable levels of PFAS being discharged to Ophthalmia Dam.</p> <p>The primary indicator is the level of PFAS in groundwater and /or surface water. Multi-level PFAS monitoring (Figure 5) will serve as the indicator to monitor the movement of PFAS from offsite sources towards the Western Ridge orebodies and then towards the receiving environment (i.e. Ophthalmia Dam / Ethel Gorge aquifer). The various stages and approaches for monitoring are identified below:</p>

Studies	Study findings	Key assumptions and uncertainties	Rationale for choice of components
	<p>planned dewatering scenario at Western Ridge. A subsurface mixing assessment approach was used to estimate the PFAS concentrations in Western Ridge dewatering bores over the pumping period between 2020 and 2050.</p> <p>The assessment indicated that the modelled PFAS compounds, present at the Whaleback Site (perfluorooctane sulfonate [PFOS] and perfluorohexane sulfonate [PFHxS]), will not be observed at Western Ridge dewatering bores at levels exceeding relevant guideline values. i.e. No PFOS and PFOS+PFHxS exceedances for 99% species protection guideline and drinking water guideline, respectively, will be observed at Western Ridge dewatering bores.</p> <p>The modelling indicated that the dewatering at Eastern Syncline may capture a small fraction of water from the contaminated sources at Whaleback Site, however, the PFAS levels will be at or below the limit of reporting (LOR) of 0.0002 µg/L.</p> <p>Stygofauna PFAS Direct Toxicity Assessment (CRC Care, 2022): BHP engaged CRC Care to undertake an independent study to investigate the toxicity of PFAS to stygofauna. Stygofauna sampling was conducted in March 2021 and a total of 17 groundwater samples were analysed to evaluate the species abundance of stygofauna. A total of 252 individual specimens were identified across nine different families. Copepods were used for toxicity testing because cyclopoid copepod, <i>Diacyclops humphreysi</i>, was found in abundance and was the predominant species identified in the wells sampled within the Ethel Gorge TEC. The ecotoxicity testing involved the assessment of mortality of stygofauna species <i>Diacyclops humphreysi</i>, at varying PFOS concentrations ranging from 0.05 to 1,000 µg/L and a control (0 µg/L). The study investigated the toxic effects of PFOS on stygofauna species because the PFAS NEMP ecological freshwater species protection guideline values are for this PFAS compound.</p> <p>The study found that the stygofauna species can tolerate a range of PFAS concentrations. Based on the toxicity studies, the LC₅₀ (i.e. lethal concentration to 50% of the stygofauna population) was estimated to be 237 +/- 48 µg/L PFOS. The LC₁₀ (i.e. lethal concentration to 10% of the stygofauna population) was estimated to be 139 µg/L. These lethal concentrations are approximately six orders of magnitude (i.e. million times) above the PFAS levels detected in the Ethel Gorge TEC. The study report has been peer reviewed by national and international independent subject matter experts and was confirmed to have followed Australian Standards for toxicity assessments. The toxicity testing was scored against the ANZECC & ARM CANZ guidelines. The total score was 81.9% indicating high quality of data from this study.</p> <p>BHP is currently developing site-specific ecological criteria for PFOS using the results of the CRC Care stygofauna toxicity studies. Applying nationally endorsed methods for deriving water quality guidelines (ANZECC & ARM CANZ) for toxicants, which considers the uncertainties related to this study (i.e. only one stygofauna species was tested) and the absence of replicate studies, a conservative assessment factor of 1000 could be applied to the lethal concentrations to derive an environmental concern level. Specifically, an environmental concern level of 0.238 µg/L PFOS would be derived by dividing the LC₅₀ PFAS concentration of 238 µg/L by a conservative assessment factor of 1000. This site-specific ecological</p>	<p>of the subsurface hydrogeology and groundwater flow paths. It also does not consider the potential presence of unknown PFAS sources within adjacent Whaleback site, which may be closer to the Western Ridge Ore bodies.</p> <ul style="list-style-type: none"> • Operation of other dewatering activities within adjacent Whaleback site. Groundwater modelling indicates that dewatering at Orebody 35 (within adjacent Whaleback site) at a rate of 18 million litres per day (ML/d) (equivalent to 6.57 GL/a) will significantly reduce the potential, albeit low risk of PFAS migration towards Western Ridge ore bodies. 	<p>a) Level 1: Select Monitoring Bores along the inferred groundwater flow path (located between Whaleback and Western Ridge Ore Bodies). This monitoring will serve as an early warning indicator of PFAS migration. Monitoring results will be compared against historical trends, groundwater modelling predictions, early warning criteria, trigger and threshold criteria to inform response actions.</p> <p>b) Level 2: Dewatering bores at the Western Ridge Ore Bodies. If Level 1 monitoring indicates PFAS has moved close to the Western Ridge Ore Bodies, then monitoring of dewatering bores will be undertaken. Monitoring results will be compared against early warning criteria and trigger criteria to inform response actions.</p> <p>c) Level 3: Combined Dewatered Groundwater prior to discharge to Ophthalmia Dam. If Level 2 monitoring indicates PFAS is present above trigger levels, then monitoring of combined dewatered groundwater discharge (i.e. blended water from all Western Ridge dewatering bores) will be undertaken. This data is considered representative of discharge water quality from Western Ridge ore bodies. Monitoring results will be compared against early warning criteria, trigger and threshold criteria to inform management actions.</p> <p>d) Level 4: Surface Water Quality in Ophthalmia Dam. If Level 3 monitoring indicates PFAS is present above trigger levels in the combined dewatered groundwater discharge, then monitoring of surface water at multiple locations within Ophthalmia Dam will be undertaken. Monitoring results will be compared against trigger and threshold criteria to inform management actions.</p> <p>BHP has based the PFAS criteria on guideline values in the PFAS NEMP (Version 2.0), which provides nationally agreed guidance (by all heads of EPAs) on the management of PFAS contamination in the environment (HEPA 2020). The guideline values in the PFAS NEMP are currently being reviewed. If applicable, BHP will update the criteria in the WMP based on any changes to the PFAS NEMP and any other relevant guidelines. The focus is on the human health (drinking water) criteria in groundwater within the Newman PDWSA within Western Ridge and the Ethel Gorge aquifer and on applicable ecological criteria for the Ethel Gorge aquifer.</p> <p>Pathway monitoring locations have been selected based on modelled groundwater flow paths towards the various orebodies. The locations shown are indicative and are subject to change due to the dynamic nature of the mining environment. To ensure data quality, monitoring will be undertaken at a minimum of two locations (within Whaleback) along the inferred groundwater flow path from Whaleback towards Western Ridge and two locations (within Western Ridge) closest to the boundary between Whaleback and Western Ridge as well as one sentinel monitoring well adjacent to each active orebody within Western Ridge.</p>

Studies	Study findings	Key assumptions and uncertainties	Rationale for choice of components
	protection criterion for stygofauna is slightly higher than the published 95% ecological protection level of 0.13 µg/L.		



- BHP operations
- PFAS sources
- Development Envelope
- Bill's Hill
- Eastern Syncline
- Mount Helen
- Silver Knight
- Orebody 30
- Orebody 35
- Waterways



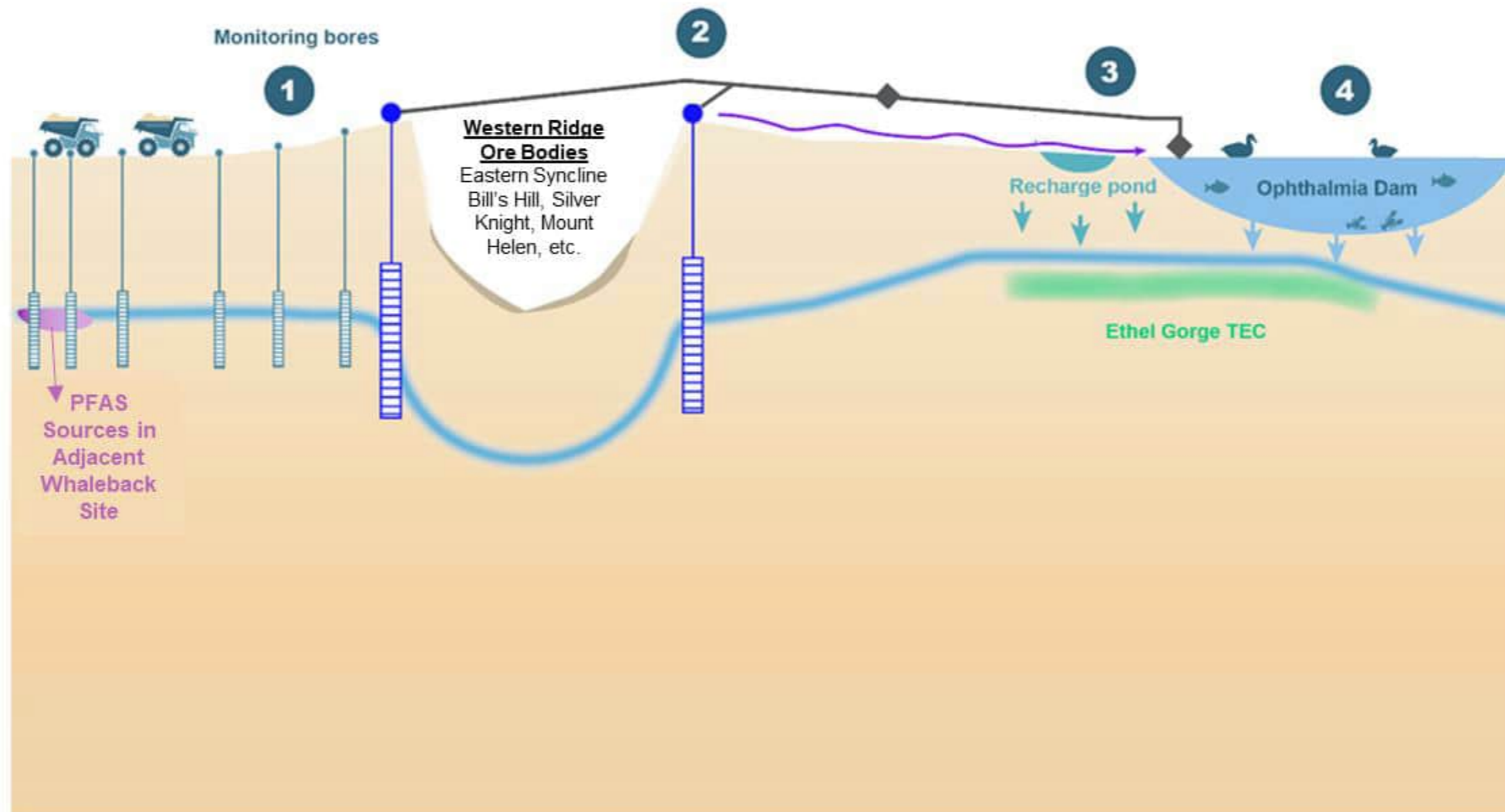
BHP PUBLIC

**WESTERN RIDGE
PFAS WATER MANAGEMENT PLAN**
Location of Western Ridge orebodies and known PFAS sources within adjacent Whaleback mine site

PLANNING & STANDARDS - IRON ORE

SCALE @ A4: 1:80,000	PREPARED: M. ENGLISH	FIGURE: 4	
DATE: 20/09/2022	REQUESTOR: ENV. APPROVALS	NO: 979/232B	
	REVIEWED: N. McALINDEN		

Figure 5: Conceptual Site Model illustrating Water Quality Monitoring Stages¹



Source to receptor water quality testing points

- 1** Monitoring bores
- 2** Dewatering Bores
- 3** Combined groundwater prior to discharge
- 4** Ophthalmia Dam

Legend

Surface water	Dewatering Bores	Combined groundwater monitoring point	Ethel Gorge TEC
Monitoring wells	Pipeline		
Groundwater	Water bore		

¹ Note that this figure is conceptual only. Western Ridge is located south-southwest of the existing Whaleback mine site.

2 EMP Components

BHP has provided detail of the WMP components in Table 4, as per the preferred approach outlined in the Instructions. BHP has not used the 'Schedule' approach (which the Instructions state may be used), as this EMP (WMP) covers only one operation. BHP may adopt the 'Schedule' approach in future for this WMP, should additional activities, operations or Ministerial Statements apply.

In accordance with Condition 6-4 of MS1105, BHP will implement the components of the WMP and continue to implement the WMP until the CEO has confirmed by notice in writing that BHP has demonstrated the objectives specified in the relevant conditions referred to in the Section 45B Notice for the proposal have been met.

Table 4: Outcome-based components

Purpose: To meet the requirements of Condition 6-2 and Condition 10 of Ministerial Statement 1105.

Rationale: The primary indicator is the concentration of PFAS in groundwater and /or surface water. Multi-level PFAS monitoring will serve as the indicator to monitor the movement of PFAS from mine site sources towards the receiving environment (i.e. Ophthalmia Dam / Ethel Gorge aquifer).

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 outcomes	PFAS concentrations in groundwater in the PDSWA are below PFAS NEMP human health (drinking water) guideline values. PFAS concentrations in Ophthalmia Dam and the Ethel Gorge aquifer are below PFAS NEMP ecological (freshwater) 95% protection guideline values and specific ecological criteria
Key environmental values:	Newman Water reserve P1 PDWSA within Western Ridge Ethel Gorge aquifer and Ethel Gorge TEC
Key impacts and risks:	Risk of groundwater dewatering at Western Ridge mobilising PFAS from nearby Whaleback mine and impacting the groundwater quality at Western Ridge. If Western Ridge intercepts PFAS, there is the risk of surplus water discharge from Western Ridge to Ophthalmia Dam increasing PFAS concentrations in Ophthalmia Dam and the Ethel Gorge aquifer.

MS1105 Condition clauses - Outcome-based components			
Indicators	Response actions:	Monitoring (including timing / frequency of monitoring)	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions 		
<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 10-1</p> <p>10-1 The proponent shall manage the implementation of the proposal to meet the following objective:</p> <p>(1) Maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected, including where relevant avoiding and minimising direct and indirect impacts of the proposal on:</p> <p>(b) hydrological regimes that support threatened and priority ecological communities</p> <p>(c) proclaimed Public Drinking Water Source Areas</p> <p>(i) ecosystems which support conservation significant flora/vegetation and fauna species or communities, including migratory waterbirds, bats, groundwater dependent biota and subterranean fauna</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/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 4-5</p> <p>The proponent shall advise the CEO in writing of any potential non-compliance including exceedance of threshold criteria and/or failure to implement management actions in an Environmental Management Plan 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 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>7) 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 45A Notice for the proposal have been met over the reporting period in the Compliance Assessment Report required by condition 4-6; and</p> <p>(8) provide for reporting of exceedances of the trigger and threshold criteria.</p>

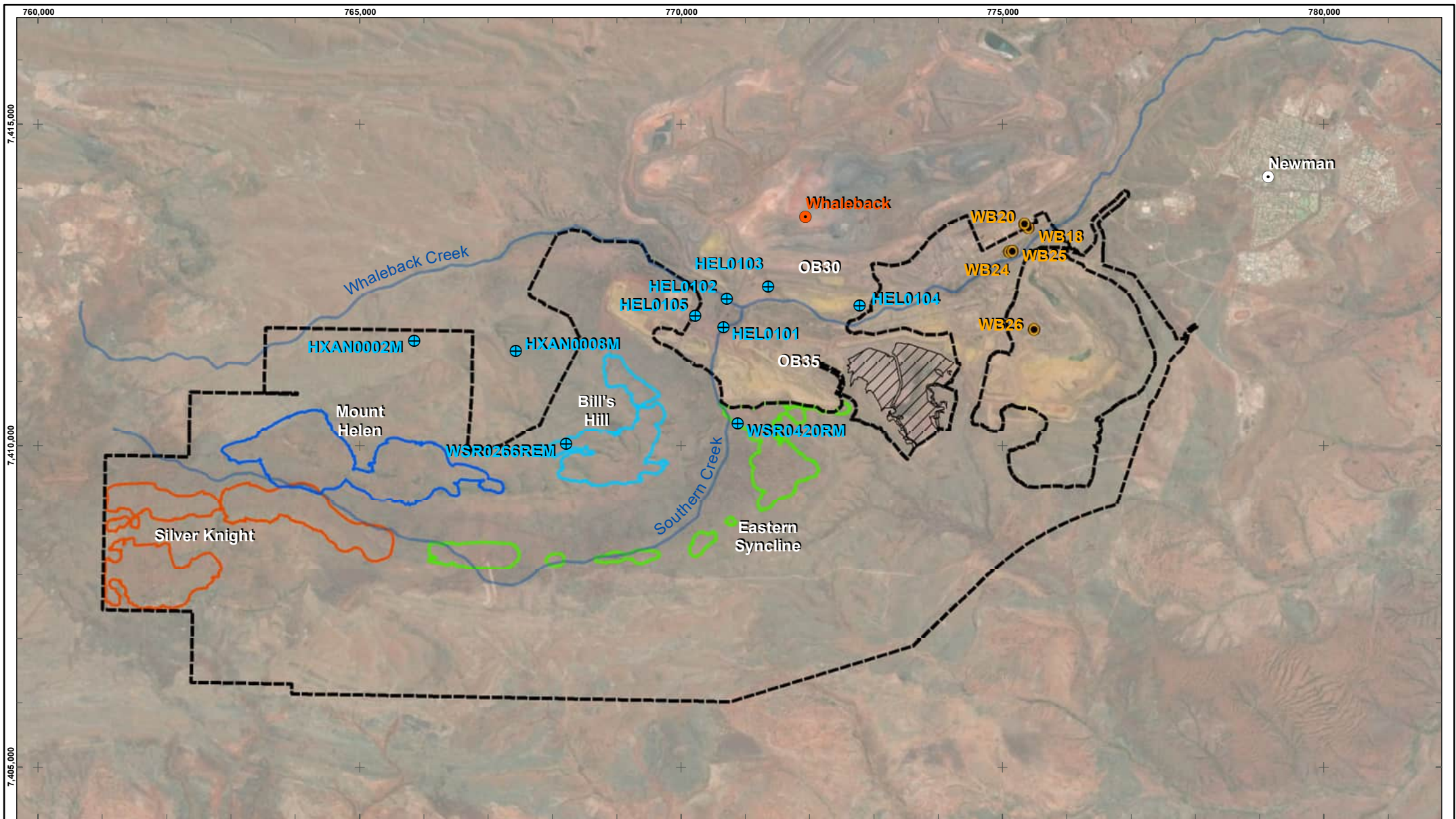
MS1105 Condition clauses - Outcome-based components			
Indicators	Response actions:	Monitoring (including timing / frequency of monitoring)	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions 		<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> <ul style="list-style-type: none"> (a) details of any trigger level actions or threshold contingency actions implemented; (b) the effectiveness of the trigger level actions or threshold contingency actions implemented, monitored and measured against trigger criteria and threshold criteria; (c) the findings of the investigations required by conditions 6-7(3) and 6-7(5); (d) additional measures to prevent the trigger or threshold criteria being exceeded in the future; and (e) measures to prevent, control or abate the environmental harm or alteration of the environment which may have occurred.
<p>Level 1: Pathway monitoring</p> <p>Early Warning Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in groundwater in boundary (between Western Ridge and Whaleback mine sites) monitoring wells or sentinel monitoring wells (closest to Western Ridge Dewatering Bores) exceed any of the criteria below. <p>Human health: 10% of PFAS NEMP 2.0 drinking water quality guideline value</p> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.007 µg/L ○ PFOA ≥ 0.056 µg/L <p>Ecological: PFAS NEMP 2.0 99% species protection guideline value</p> <ul style="list-style-type: none"> ○ PFOS ≥ 0.00023 µg/L <p>Trigger Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in groundwater in pathway monitoring wells within Western Ridge or in sentinel monitoring wells (closest to Western Ridge Dewatering Bores) exceed any of the criteria below. <p>Human health: 30% of PFAS NEMP 2.0 drinking water quality guideline value</p>	<p>Early warning response actions:</p> <p>Response actions to early warning criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 1 month to verify exceedance of early warning criteria and ensure it is not related to sampling and analysis errors or cross-contamination (due to well construction materials/methods etc.) • Complete a minimum 3 rounds of monitoring and undertake a trend assessment to evaluate risk of PFAS plume migration. If there is an increasing PFAS trend in a sentinel monitoring well, then implement Level 2 monitoring of Western Ridge dewatering bores closest to PFAS-impacted sentinel monitoring well(s). If there is no increasing trend, reduce monitoring frequency to semi-annual basis. <p>BHP may implement additional response actions depending on the particular circumstances.</p> <p>Trigger level actions:</p> <p>Response actions to the trigger criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 1 month to verify exceedance of trigger criteria and ensure it is not related to sampling and analysis errors or cross-contamination (due to well construction materials/methods etc.) • Complete a minimum 3 rounds of monitoring and undertake a trend assessment to evaluate risk of PFAS plume migration. <ul style="list-style-type: none"> ○ If there is an increasing PFAS trend in a sentinel well, then implement Level 2 monitoring of Western Ridge dewatering bores closest to PFAS-impacted sentinel monitoring well(s); 	<p>Parameters:</p> <p>PFAS (µg/L)</p> <p>Sampling Methodology: Consistent with DWER Contaminated sites guidelines (DWER, 2014 and 2017) and PFAS NEMP 2.0.</p> <p>Analytical Method: EP231 (ultra-trace, or equivalent suitable to meet lowest guideline value)</p> <p>Frequency: Quarterly</p> <p>Location(s):</p> <p>Figure 6 shows the indicative locations of monitoring wells along the groundwater flow path. Due to the dynamic nature of the mining environment, some of the identified wells may become inaccessible or unserviceable. In this instance, a suitable alternative monitoring well will be identified for monitoring purposes.</p>	<p>Exception Reporting</p> <p>If there has been a confirmed exceedance of a trigger and/or threshold criteria for Level 1 monitoring:</p> <ul style="list-style-type: none"> • Notify the CEO of DWER in writing within 7 days of confirming the exceedance of the trigger and/or threshold criteria. • Provide a report to the CEO within 90 days of the exceedance being reported to DWER, including the requirements of Condition 6-7(6) <p>Regular Reporting</p> <p>Submit an annual compliance assessment report as part of the Annual Environment Report to the DWER by 1 October each year. The compliance assessment report will include, but not be limited to the requirements of conditions 4-7, 6-2(7) and 6-2(8).</p>

MS1105 Condition clauses - Outcome-based components			
Indicators	Response actions:	Monitoring (including timing / frequency of monitoring)	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria <p>○ Sum (PFOS + PFHxS) ≥ 0.021 µg/L</p> <p>○ PFOA ≥ 0.168 µg/L</p> <p>Ecological: 100 times PFAS NEMP 2.0 99% species protection guideline value</p> <p>○ PFOS ≥ 0.023 µg/L</p> <p>Threshold Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in groundwater in pathway monitoring wells within Western Ridge or in sentinel monitoring wells (closest to Western Ridge Dewatering Bores) exceed any of the criteria below. <p>Human health: PFAS NEMP 2.0 drinking water quality guideline value</p> <p>○ Sum (PFOS + PFHxS) ≥ 0.07 µg/L</p> <p>○ PFOA ≥ 0.56 µg/L</p> <p>Ecological: PFAS NEMP 2.0 95% species protection guideline value</p> <p>○ PFOS ≥ 0.13 µg/L</p> <p>○ PFOA ≥ 220 µg/L</p>	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions <p>○ If the risk evaluation indicates that PFAS migration could reach the threshold criteria, BHP will evaluate and implement management/ remediation strategies that are practicable</p> <p>BHP may implement additional response actions depending on the particular circumstances.</p> <p>Threshold contingency actions:</p> <p>Response actions to threshold criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 1 month to verify exceedance of threshold level and ensure it is not related to sampling and analysis errors or cross-contamination (due to well construction materials/methods etc.) • Implement Level 2 monitoring of Western Ridge dewatering bores closest to PFAS-impacted sentinel monitoring well(s) within 2-weeks of identifying and confirming the exceedance of the threshold criteria. • Evaluate and implement management/ remediation strategies that are practicable. <p>BHP may implement additional response actions depending on the particular circumstances.</p>		
<p>Level 2: Western Ridge ‘Active’ Dewatering Bores</p> <p>Early Warning Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in dewatering bore exceed the limits of reporting (LOR) as shown below. <p>○ PFOS ≥ 0.0002 µg/L</p> <p>○ PFOA ≥ 0.0005 µg/L</p> <p>○ PFHxS ≥ 0.0005 µg/L</p> <p>Trigger Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in dewatering bore exceed any of the criteria below. <p>Human health: 10% of PFAS NEMP 2.0 drinking water quality guideline value</p> <p>○ Sum (PFOS + PFHxS) ≥ 0.007 µg/L</p> <p>○ PFOA ≥ 0.056 µg/L</p> <p>Ecological: 10 times PFAS NEMP 2.0 99% species protection guideline value</p>	<p>Early warning response actions:</p> <p>Response actions to the Early Warning criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 1 month to verify exceedance of early warning criteria and ensure it is not related to sampling and analysis errors or cross-contamination (due to well construction materials/methods etc.,) • Complete a minimum of two additional rounds of quarterly monitoring and assess whether detections consistently exceed early warning criteria. <ul style="list-style-type: none"> ○ If exceedances are consistent, then implement Level 3 monitoring of combined dewatered groundwater prior to discharge to Ophthalmia Dam and implement annual monitoring of Level 2 active dewatering bores; ○ If exceedances are not replicated during follow-on monitoring rounds, cease Level 2 monitoring. <p>BHP may implement additional response actions depending on the particular circumstances.</p> <p>Trigger level actions:</p> <p>Response actions to Trigger criteria include any or all of the following:</p>	<p>Parameters:</p> <p>PFAS (µg/L)</p> <p>Sampling Methodology: Consistent with DWER Contaminated sites guidelines</p> <p>Analytical Method: EP231 (ultra-trace, or equivalent suitable to meet lowest guideline value)</p> <p>Frequency: Triggered by Level 1 monitoring response actions</p> <p>Location(s):</p> <p>Active (i.e. operating bores) dewatering bores. (Please note that because Western Ridge is a greenfield site, dewatering bores have not yet been constructed. Indicative locations have been identified in Figure 7)</p>	<p>Exception Reporting</p> <p>If there has been a confirmed exceedance of the trigger criteria for Level 2 monitoring:</p> <ul style="list-style-type: none"> • Notify the CEO of DWER in writing within 7 days of confirming the exceedance of the trigger criteria. • Provide a report to the CEO within 90 days of the exceedance being reported to DWER, including the requirements of Condition 6-7(6). <p>Regular Reporting</p> <p>Submit an annual compliance assessment report as part of the Annual Environment Report to the DWER by 1 October each year. The compliance assessment report will include, but not be limited to the requirements of conditions 4-7, 6-2(7) and 6-2(8).</p> <p>BHP will notify KNAC of any exceedances at the Niyiyaparli Implementation Committee meetings.</p>

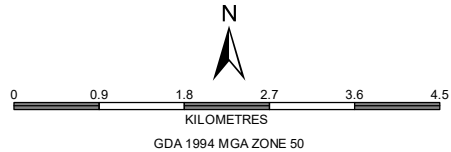
MS1105 Condition clauses - Outcome-based components			
Indicators	Response actions:	Monitoring (including timing / frequency of monitoring)	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions 		
<ul style="list-style-type: none"> ○ PFOS ≥ 0.0023 µg/L 	<ul style="list-style-type: none"> • Resampling within 1 month to verify exceedance of trigger criteria and ensure it is not related to sampling and analysis errors or cross-contamination (due to well construction materials/methods etc..) • Complete all response actions for early warning criteria exceedances. • Evaluate feasibility of options to redirect impacted dewatering bore or sump water away from the Ophthalmia Dam discharge for onsite reuse – to inform future response action. • Evaluate potential impacts of turning down or turning off impacted dewatering bores and associated geotechnical safety issues (if any) – to inform future response action. <p>BHP may implement additional response actions depending on the particular circumstances.</p>		
<p>Level 3: Combined Western Ridge Dewatered Groundwater Monitoring Point (prior to discharge to Ophthalmia Dam)</p> <p>Early Warning Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations exceed any of the criteria below. <p>Human health: 10% of PFAS NEMP 2.0 drinking water quality guideline value</p> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.007 µg/L ○ PFOA ≥ 0.056 µg/L <p>Ecological: PFAS NEMP 2.0 99% species protection guideline value</p> <ul style="list-style-type: none"> ○ PFOS ≥ 0.00023 µg/L <p>Trigger Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations exceed the criteria below. <p>Human health: 30% of PFAS NEMP 2.0 drinking water quality guideline value</p> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.021 µg/L ○ PFOA ≥ 0.17 µg/L <p>Ecological: 10 times PFAS NEMP 2.0 99% species protection guideline value</p> <ul style="list-style-type: none"> ○ PFOS ≥ 0.0023 µg/L <p>Threshold Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations exceeds the criteria below. <p>Human health: 30% of PFAS NEMP 2.0 drinking water quality guideline value</p>	<p>Early warning response actions:</p> <p>Response actions to the early warning criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 1 month to verify exceedance of trigger criteria and ensure it is not related to sampling and analysis errors or cross-contamination (due to well construction materials/methods etc..) • Complete a minimum 3 rounds of monthly monitoring and assess whether detections consistently exceed trigger levels. <ul style="list-style-type: none"> ○ If trigger level exceedances detections are consistent, then identify the dewatering bore(s) that may be resulting in these exceedances – to inform future response actions. ○ If exceedances are not replicated during follow-on monitoring rounds, cease Level 3 monitoring. • Implement Level 4 monitoring of surface water quality within Ophthalmia Dam. <p>BHP may implement additional response actions depending on the particular circumstances.</p> <p>Trigger level actions:</p> <p>Response actions to trigger criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 2 weeks to verify exceedance of trigger criteria and ensure it is not related to sampling and analysis errors or cross-contamination. • Implement Level 4 monitoring of surface water quality within Ophthalmia Dam. • Implement the following responses: <ul style="list-style-type: none"> ○ Turn down or turn off the impacted dewatering bore(s) that may be causing the exceedance, where geotechnically safe to do so (<i>geotechnical safety assessment undertaken as part of Level 2 trigger level actions</i>) (or) ○ Re-direct water from the impacted dewatering bore(s) for mining re-use, where acceptable (<i>onsite reuse assessment undertaken as part of Level 2 trigger level actions</i>) (and) ○ Implement monthly monitoring to assess improvements to discharge quality. 	<p>Parameters:</p> <p>PFAS (µg/L)</p> <p>Sampling Methodology: Consistent with DWER Contaminated sites guidelines</p> <p>Analytical Method: EP231 (ultra-trace, or equivalent suitable to meet lowest guideline value)</p> <p>Frequency: Triggered by Level 2 monitoring response actions</p> <p>Location(s):</p> <p>Combined dewatered groundwater monitoring point (blended groundwater from all Western Ridge operating dewatering bores) (Please note that because Western Ridge is a greenfield site, indicative locations have been identified in Figure 7).</p>	<p>Exception Reporting</p> <p>If there has been a confirmed exceedance of a trigger and/or threshold criteria for Level 3 monitoring:</p> <ul style="list-style-type: none"> • Notify the CEO of DWER in writing within 7 days of confirming the exceedance of the trigger and/or threshold criteria. • Provide a report to the CEO within 90 days of the exceedance being reported to DWER, including the requirements of Condition 6-7(6). <p>Regular Reporting</p> <p>Submit an annual compliance assessment report as part of the Annual Environment Report to the DWER by 1 October each year. The compliance assessment report will include, but not be limited to the requirements of conditions 4-7, 6-2(7) and 6-2(8).</p> <p>BHP will notify KNAC of any exceedances at the Niyaparli Implementation Committee meetings.</p>

MS1105 Condition clauses - Outcome-based components			
Indicators	Response actions:	Monitoring (including timing / frequency of monitoring)	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria <p>○ Sum (PFOS + PFHxS) ≥ 0.021 µg/L</p> <p>○ PFOA ≥ 0.17 µg/L</p> <p>Ecological: PFAS NEMP 2.0 95% species protection guideline value or site-specific ecological criteria (under development)</p> <p>○ PFOS ≥ 0.13 µg/L</p>	<p>Response actions:</p> <ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions <p>• If it is not safe to turn off impacted dewatering bores due to geotechnical safety reasons or onsite reuse is not practical, complete detailed human health and ecological risk assessment (HHERA) to support permitted discharge above trigger levels and undertake any further actions in accordance with the HHERA.</p> <p>BHP may implement additional response actions depending on the particular circumstances.</p> <p>Threshold contingency actions:</p> <p>Response actions to threshold criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 2 weeks to verify exceedance of threshold criteria and ensure it is not related to sampling and analysis errors or cross-contamination. • Implement Level 4 monitoring of surface water quality within Ophthalmia Dam. • Implement the following responses: <ul style="list-style-type: none"> ○ Turn down or turn off the impacted dewatering bore(s) that may be causing the exceedance, where geotechnically safe to do so (<i>geotechnical safety assessment undertaken as part of Level 2 trigger level actions</i>) (or) ○ Re-direct water from the impacted dewatering bore(s) for mining re-use, where acceptable (<i>onsite reuse assessment undertaken as part of Level 2 trigger level actions</i>) (and) ○ Implement monthly monitoring to assess improvements to discharge quality. • If it is NOT safe to turn off impacted dewatering bores due to geotechnical safety reasons and mining reuse is not feasible, then implement management/ remediation strategies that are practicable to reduce PFAS to acceptable levels prior to resuming discharge. • Undertake PFAS monitoring in groundwater monitoring wells within the Ethel Gorge aquifer/TEC in the vicinity of Ophthalmia Dam to evaluate the risk to the TEC. <p>BHP may implement additional response actions depending on the particular circumstances.</p>		
<p>Level 4: Surface water within Ophthalmia Dam</p> <p>Trigger Criteria:</p> <ul style="list-style-type: none"> • Average PFAS concentrations exceeds any of the criteria below. <p>Human health: 10% of PFAS NEMP 2.0 drinking water quality guideline value</p> <p>○ Sum (PFOS + PFHxS) ≥ 0.007 µg/L</p> <p>○ PFOA ≥ 0.056 µg/L</p> <p>Ecological: 10 times PFAS NEMP 2.0 99% species protection guideline value</p> <p>○ PFOS ≥ 0.0023 µg/L</p>	<p>Trigger level actions:</p> <p>Response actions to the trigger criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 1-month to verify exceedance of trigger level and ensure it is considered project attributable. i.e. exceedance is due to dewatering discharges and not surface water runoff sources from in and around Ophthalmia Dam or other cross-contamination. • Undertake PFAS monitoring in groundwater monitoring wells within the Ethel Gorge aquifer/TEC in the vicinity of Ophthalmia Dam. • Evaluate potential ecological risks to TEC-stygofauna community from PFAS in the dewatering discharge. • Evaluate impacts of cessation of dewatering discharge (i.e. ability to maintain minimum groundwater levels) to sustain the TEC. 	<p>Parameters:</p> <p>PFAS (µg/L)</p> <p>Sampling Methodology: Consistent with DWER Contaminated sites guidelines</p> <p>Analytical Method: EP231 (ultra-trace, or equivalent suitable to meet lowest guideline value)</p> <p>Frequency: Triggered by Level 3 monitoring response actions</p> <p>Location(s):</p>	<p>Exception Reporting</p> <p>If there has been a confirmed exceedance of the trigger and/or threshold criteria for Level 4 monitoring:</p> <ul style="list-style-type: none"> • Notify the CEO of DWER in writing within 7 days of confirming the exceedance of the trigger and/or threshold criteria. • Provide a report to the CEO within 90 days of the exceedance being reported to DWER, including the requirements of Condition 6-7(6). <p>Regular Reporting</p> <p>Submit an annual compliance assessment report as part of the Annual Environment Report to the DWER by 1 October each year. The compliance assessment report will include, but not be limited to the requirements of conditions 4-7, 6-2(7) and 6-2(8).</p>

MS1105 Condition clauses - Outcome-based components			
Indicators	Response actions:	Monitoring (including timing / frequency of monitoring)	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions 		
<p>Threshold Criteria:</p> <ul style="list-style-type: none"> • Average PFAS concentrations exceeds any of the criteria below. <p>Human health: 30% of PFAS NEMP 2.0 drinking water quality guideline value</p> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.021 µg/L ○ PFOA ≥ 0.17 µg/L <p>Ecological: PFAS NEMP 2.0 95% species protection guideline value or site-specific ecological criteria (under development)</p> <ul style="list-style-type: none"> ○ PFOS ≥ 0.13 µg/L 	<ul style="list-style-type: none"> • Complete detailed human health and ecological risk assessment (HHERA) to support permitted discharge above trigger levels and any other actions that are practicable to be implemented. • If detailed HHERA indicates unacceptable risk, then implement the following responses: <ul style="list-style-type: none"> ○ Turn down or turn off impacted production bore that may be causing the exceedance, where geotechnically safe to do so (<i>geotechnical safety assessment undertaken as part of Level 2 threshold response actions</i>) (or) ○ Re-direct water from the impacted production bore (s) for mining re-use where acceptable (<i>onsite reuse assessment undertaken as part of Level 2 threshold response actions</i>) (and) ○ Continue monthly monitoring to assess improvements to discharge water and surface water quality. • If detailed HHERA indicates unacceptable risk but it is NOT safe to turn off impacted dewatering bores due to geotechnical safety reasons, then implement management/ remediation strategies that are practicable to reduce PFAS to acceptable levels. <p>BHP may implement additional response actions depending on the particular circumstances.</p> <p>Threshold contingency actions:</p> <p>Response actions to threshold criteria exceedances include any or all of the following:</p> <ul style="list-style-type: none"> • Resampling within 2-weeks to verify exceedance of threshold level and ensure it is considered project attributable. i.e. exceedance is due to dewatering discharges and not surface water runoff sources from in and around Ophthalmia Dam or other cross-contamination. • Implement the following responses: <ul style="list-style-type: none"> ○ Turn down or turn off impacted production bore(s) that may be causing the exceedance, where geotechnically safe to do so (<i>geotechnical safety assessment undertaken as part of Level 2 threshold response actions</i>) (or) ○ Re-direct water from the impacted production bore (s) for mining re-use where acceptable (<i>onsite reuse assessment undertaken as part of Level 2 threshold response actions</i>) (and) ○ Continue monthly monitoring to assess improvements to discharge quality. • If it is NOT safe to turn off impacted dewatering bores due to geotechnical safety reasons and mining reuse is not feasible, then implement management/ remediation strategies that are practicable to reduce PFAS to acceptable levels prior to resuming discharge. • Undertake PFAS monitoring in groundwater monitoring wells within the Ethel Gorge aquifer/TEC in the vicinity of Ophthalmia Dam to evaluate the risk to the TEC. <p>BHP may implement additional response actions depending on the particular circumstances.</p>	<p>Three representative and accessible surface water sample locations from within Ophthalmia Dam</p>	<p>BHP will notify KNAC of any exceedances at the Nyiyaparli Implementation Committee meetings.</p>



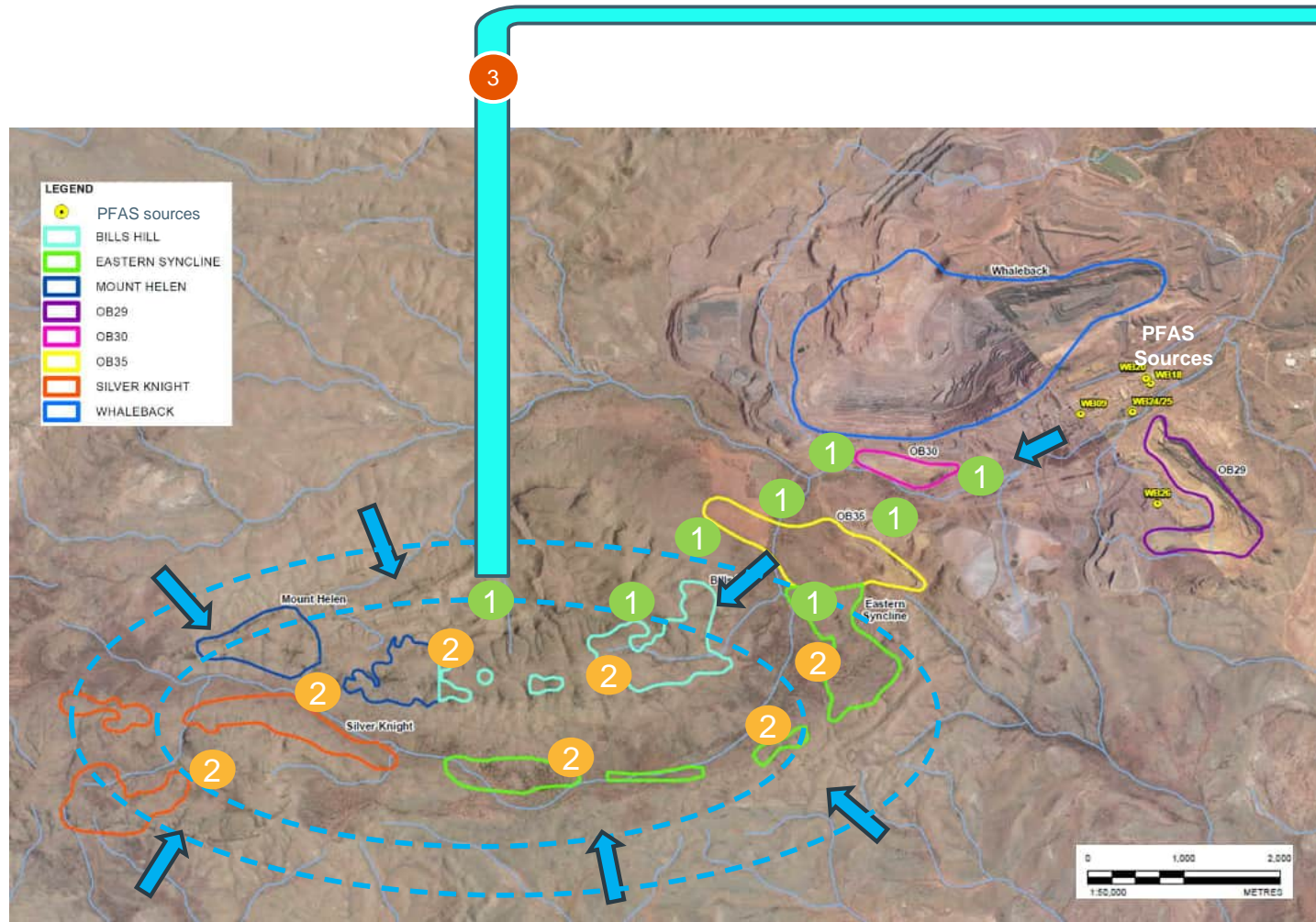
- BHP operations
- PFAS sources
- Development Envelope
- ⊕ Groundwater monitoring locations
- Tailings dam
- Waterways



BHP PUBLIC

**WESTERN RIDGE
PFAS WATER MANAGEMENT PLAN**
Indicative groundwater sampling locations

PLANNING & STANDARDS - IRON ORE			
SCALE @ A4:	1:80,000	PREPARED:	M. ENGLISH
DATE:	20/09/2022	REQUESTOR:	ENV. APPROVALS
		REVIEWED:	N. McALINDEN
		FIGURE:	6
		NO:	979/233B



1 Pathway Groundwater Monitoring Wells
Early Warning System

2 Dewatering Bores
Monitor active dewatering bores along migration pathway

3 Combined Discharge
Combined dewatered groundwater quality prior to discharge to Ophthalmia Dam

4 Ophthalmia Dam
Surface Water

BHP Spatial Data - Studies Planning & Access
BHP IRON ORE

WESTERN RIDGE PFAS WATER MANAGEMENT PLAN
Indicative and Conceptual Illustration of
Monitoring Locations

Date:	3/02/2022	Project No:	A979/252A	Figure:	7
Prepared:	S. Trinder	Checked:	S. Vancheeswaran		

LEGEND

- PFAS sources
- BILLS HILL
- EASTERN SYNCLINE
- MOUNT HELEN
- OB29
- OB30
- OB35
- SILVER KNIGHT
- WHALEBACK
- Waterways



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 WMP, which is consistent with the Instructions. Adaptive management is a structured, iterative process to decision making. The framework embeds a cycle of monitoring, reporting and implementing change where required. It allows an evaluation of the management and mitigation measures so that they are progressively improved and refined, or alternative solutions adopted, to ensure that environmental objectives and outcomes in the plan are achieved. The key steps of the adaptive management approach are outlined in Figure 8.

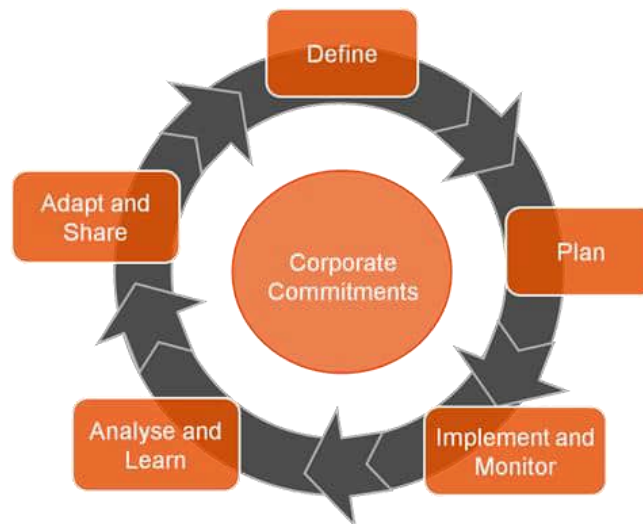


Figure 8: BHP's adaptive management approach

Where the WMP is a requirement of a Ministerial Statement (MS) condition, BHP notes that if it chooses to amend a WMP component in Table 4 based on information gained through adaptive management, it must seek formal approval from the Department of Water and Environmental Regulation (DWER).

3.2 Review and revision of this EMP

BHP will review this WMP (and revise it if required), to ensure that it achieves the identified environmental objectives and meets MS conditions. A review may arise from the following:

- where required by MS1105 condition 6-8(2) to review and revise the WMP when directed by the CEO;
- if initiated by BHP as part of the adaptive management process; and/or
- if triggered by a MS condition (e.g. for exceedance of a threshold criteria).

Changes to the endorsed version of the WMP may arise from the following:

- BHP reviews the WMP if the EPA or relevant government agencies develop new, or amend existing guidance or policy;
- BHP adds components when a change to the existing operation is proposed;
- BHP adds or amends components when there is a change to the proposal and/or MS conditions;

- the CEO of DWER directs BHP to revise the WMP; and/or
- 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 WMP are no longer required.

In accordance with Condition 6-9, BHP shall implement the latest revision of the WMP, which the CEO has confirmed by notice in writing, satisfies the requirements of Condition 6-2.

4 Stakeholder consultation

Consultation specifically undertaken for this WMP is summarised in Table 5. Other engagement regarding PFAS, including PFAS sampling results and the development of the multi-level control system) in 2021 and 2022 is summarised in the *Newman Hub (Western Ridge) Derived Proposal Request* document.

BHP will continue to consult with government agencies (including decision-making authorities) and Niyiyaparli Traditional Owners through targeted consultation and via administration of the Comprehensive Agreement, where relevant, in relation to the implementation and revision of this WMP.

Table 5: Summary of stakeholder consultation

Stakeholder	Date	Topics/issues raised	BHP response and outcome
KNAC Implementation Committee	June 2021	Overview of PFAS contamination, and management at Newman operations, phase out of PFAS containing products and interim site management plan.	BHP has developed and is implementing a PFAS Management Plan at Whaleback and has developed this Water (PFAS) Management Plan in relation to the Western Ridge Proposal.
KNAC Implementation Committee	September 2021	Presentation of PFAS Trigger Action Response Plan	BHP committed to provide regular updates and ongoing engagement
KNAC Implementation Committee	November 2021	Overview of contamination and investigations, current knowledge and data, human health risk assessment and ecological risk assessment studies, drinking water trigger action response plan, proposed and implemented controls and Traditional Owner engagement.	BHP committed to provide regular updates and ongoing engagement
KNAC Implementation Committee	March 2022	Quarterly update on contaminated sites including PFAS, HHRA scope and Traditional Owner involvement.	BHP committed to provide regular updates and ongoing engagement
KNAC	21 October 2022	Provision of draft Western Ridge PFAS Water Management Plan to KNAC for review and comment.	Response provided to KNAC in January 2023 prior to referral.

5 Changes to an EMP

This WMP (v1) is the original version submitted to the EPA for approval.

6 References

BHP (2022). *Newman Hub (Western Ridge) Derived Proposal Request Ministerial Statement 1105*.

BHP Billiton (2016) *Public Environmental Review Strategic Proposal*, BHP Billiton.

CRC CARE (2022) *Stygofauna direct toxicity assessment*. Final Report, February 2022.

Department of Environment and Regulation, 2014. *Assessment and Management of Contaminated Sites, Contaminated Sites Guidelines*. December 2014

EPA (2021). *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans*. Environmental Protection Authority. Perth, Western Australia.

Golder, 2021a. *PFAS and TRH Groundwater Baseline Assessment, Western Ridge – Afghan Springs Baseline Assessment*, Golder, May 2021

Golder, 2021b. *PFAS and TRH Groundwater Baseline Assessment, Western Ridge – Eastern Syncline Baseline Assessment*, Golder, May 2021

Golder, 2021c. *PFAS and TRH Groundwater Baseline Assessment, Western Ridge – Crusher Study Area Baseline Assessment*, Golder, May 2021

Golder, 2021d. *Western Ridge Per- and for Per- and Poly-fluoro alkyl Substances Mixing Assessment*, Golder, 3 June 2021

HEPA (2020), *PFAS National Environmental Management Plan 2.0*, 2020.

Tetrattech Coffey, 2021a. *Interim Site Management Plan for Per- and Poly-fluoro alkyl Substances for Mount Whaleback*, Tetrattech Coffey, 26 May 2021

Tetrattech Coffey, 2021b. *Limited Site Investigation for Per- and Poly-fluoro alkyl Substances, Eastern Ridge Mine Site* Tetrattech Coffey, 02 July 2021