

BHP

Newman Hub (Orebody 32 Below Water Table)

MS1105 Water Management Plan

October 2022



Document amendment record

Version	Section/page	Version description	Key changes	Date
0	All	Draft version for Traditional Owner review with <i>Newman Hub (Orebody 32 Below Water Table) Derived Proposal Request Ministerial Statement 1105</i> draft referral document	Not applicable	22/04/2022
1	p3, 10, 11, 19, 20, 23	Updated draft with minor changes	Update to maps to show revised pipeline alignment Minor changes to Section 1.4.2 Rationale section to include latest groundwater modelling findings and Section 4 Stakeholder consultation	24/10/2022

Abbreviations and Definitions

Term	Meaning
BHP	BHP Iron Ore Pty Ltd
BWT	Below water table
ANZECC & ARMCANZ	Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)
CAR	Compliance Assessment Report
CEO	Chief Executive Officer
Clearing	As defined in section 51A of the <i>Environmental Protection Act 1986</i> (WA)
DBCA	Department of Biodiversity Conservation and Attractions
DE	Development Envelope
DP	Derived Proposal
DWER	Department of Water and Environmental Regulation
ECL	Environmental Concern Level
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP Act	<i>Environmental Protection Act 1986</i> (WA)
FTS	fluorotelomer sulfonic acid
GIS	Geographic Information System
HEPA	Heads of EPA
LOR	Limits of Reporting
MS	Ministerial Statement
Mtpa	Million tonnes per annum
NEMP	National Environmental Management Plan
PDWSA	Public Drinking Water Source Area
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

Term	Meaning
WA	Western Australia
WAIO	Western Australia Iron Ore
WMP	Water Management Plan
WTP	Wastewater Treatment Plant

Executive summary

OB32 Water Management Plan	
Proposal name	Orebody 32 Below Water Table
Proponent name	BHP Iron Ore Pty Ltd
Ministerial Statement	1105
Purpose of the EMP	To meet the requirements of implementation Conditions 6 (Condition Environmental Management Plans) and 10 (Water Environmental Management Plan) of Ministerial Statement 1105
Key environmental factors and EMP 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 Orebody 32 (OB32) and within Ethel Gorge aquifer are below relevant 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	<p>6-1 Prepare and submit Condition Environmental Management Plans</p> <p>10-2 Prepare a Water Environmental Management Plan</p>
Key components of the plan	<p>Outcomes-based components, including early warning, trigger and threshold criteria for water quality (PFAS concentrations) in:</p> <ul style="list-style-type: none"> • groundwater along the pathway to OB32 • groundwater in OB32 dewatering bores • combined dewatered groundwater discharge prior to discharge to Ophthalmia Dam • surface water in Ophthalmia Dam.
Proposed construction date	Q1, 2023
EMP required pre-construction?	Yes

1 Context, scope and rationale

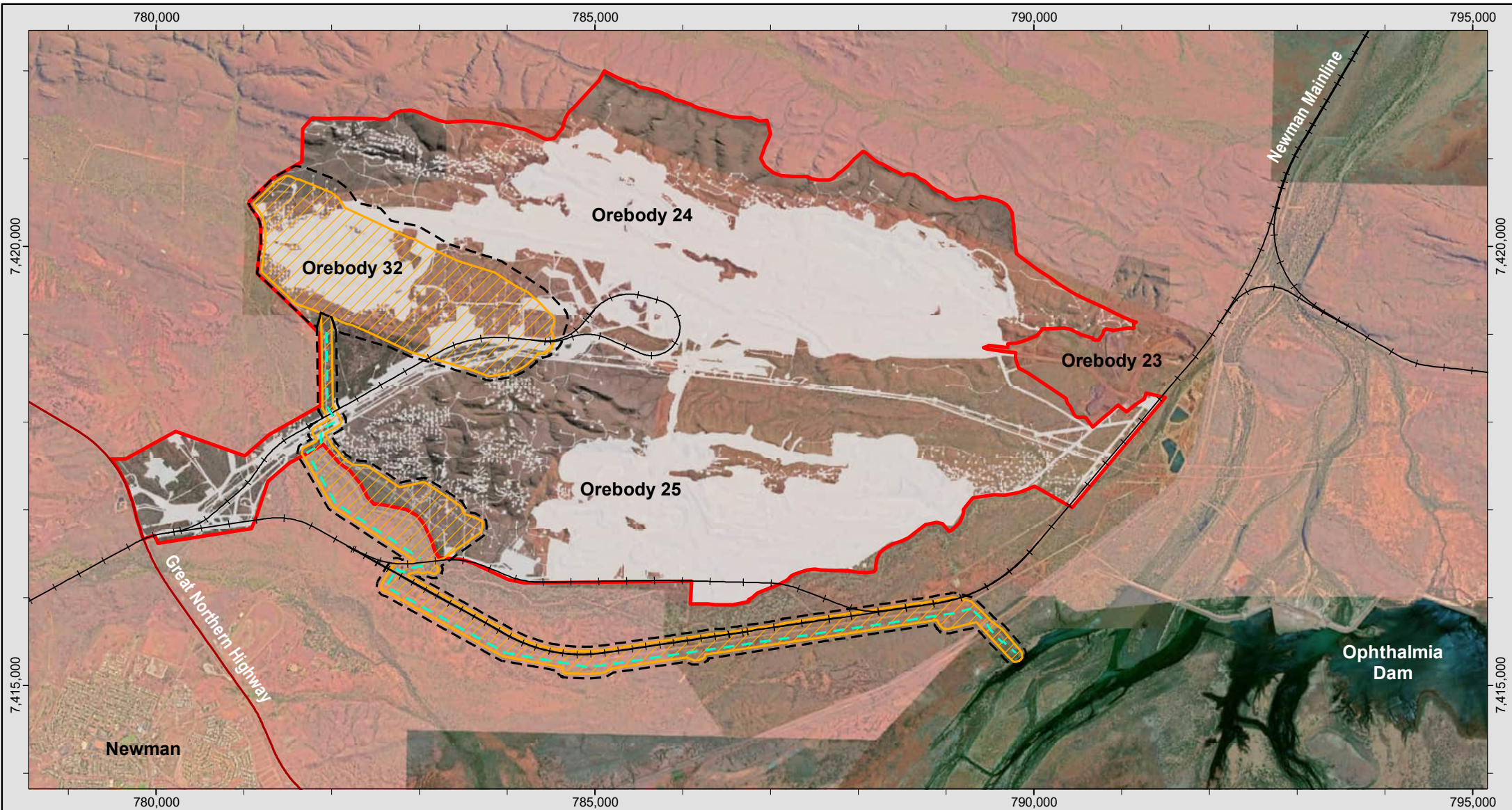
BHP Iron Ore Pty Ltd (BHP) has prepared this Water Management Plan (WMP) to meet the requirements under Part IV of the *Environmental Protection Act 1986* (EP Act). The plan is submitted as a draft with the referral documentation for the Orebody 32 Below Water Table (OB32 BWT) referred proposal (Proposal) (BHP, 2022). The intent for the WMP is to meet the requirements of the Strategic Proposal Ministerial Statement (MS) 1105 (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 2020).

1.1 Proposal

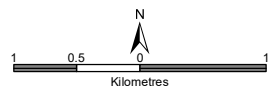
The OB32 BWT Proposal is an expansion to the existing OB32 above water table (AWT) mine and is located within the Project Boundary and is identified as a future proposal (future expansion to existing mining operations at Newman) in MS1105 for the Pilbara Expansion Strategic Proposal.

The Proposal is to expand the existing Orebody 32 AWT iron ore mine (authorised by the Eastern Ridge Revised Proposal, MS1037) 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 dewatered groundwater into Ophthalmia Dam.



Spatial Data - Studies Planning & Access
BHP IRON ORE

OB32 PFAS WATER MANAGEMENT PLAN
Proposal Location



Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Date:	24/10/2022	Project No:	A1084/001A	Figure:	1
Prepared:	M. English	Checked:	ENV Approvals		

LEGEND

- BHP rail
- Highways
- Proposed Development Envelope
- Proposed surplus water pipeline alignment
- Indicative Footprint
- Eastern Ridge MS1037 Development Envelope
- Indicative Cleared Area as at FY2021

1.2 Key environmental factors

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 OB32 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	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 potential PFAS sources that may be present nearby including in the existing Eastern Ridge mines and Whaleback mine sites.</p>
Inland Waters and Subterranean Fauna	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 MS1105, 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.

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

Water Environmental Management Plan Condition sub-clause	Applicable to this EMP	Environmental value/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	
(a) Fortescue Marsh;	No	
(b) hydrological regimes that support threatened and priority ecological communities;	Yes	Ethel Gorge aquifer (supports Ethel Gorge TEC)
(c) proclaimed Public Drinking Water Source Areas;	Yes	Newman Water Reserve
(d) permanent and ephemeral rock pools;	No	
(e) wetlands which are Ramsar listed, or listed in the Directory of Important Wetlands in Australia;	No	
(f) wild rivers;	No	
(g) wetland types which may be poorly represented;	No	
(h) natural springs;	No	
(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	Ethel Gorge TEC
(j) ecosystems which support significant amenity, recreation and cultural values.	No	
Water Environmental Management Plan Condition sub-clause	Applicable to this WMP	Mine activities
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	Groundwater abstraction (for mine dewatering) Discharge of surplus dewatered groundwater to Ophthalmia Dam

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 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 the potential sources of PFAS that may be present nearby including at existing Eastern Ridge mines to the east, south and southeast and Whaleback mine located to the southwest of the OB32 BWT 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 potential contamination sources as a result of dewatering required for the Proposal.

This WMP has been developed in accordance with the precautionary principle and includes triggers, actions, and responses for PFAS, which may enter or migrate into the Development Envelope (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 2.

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 EMP (WMP) does not duplicate monitoring and/or controls in other statutory decision-making processes for water-related activities in the proposed OB32 BWT Development Envelope and in the Newman Water Reserve PDWSA (Figure 2). This includes regulation administered by the Department of Water and Environmental Regulation (DWER), including EP Act Part V, *Rights in Water and Irrigation Act 1914* (RiWI Act) and the *Contaminated Sites Act 2003*.

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 	
Site	Whaleback including Orebody 29/30/35	Eastern Ridge including Orebody 32 BWT (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 or Part V licence amendment (<i>to manage PFAS for OB32 BWT 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 (surplus discharge) Specifies monitoring (locations, flow rate, volume and water quality parameters) Specifies compliance reporting requirements, including comparison of monitoring against trigger values and details of investigations conducted, including outcomes, environmental impacts and remedial actions, in relation to trigger exceedances and a discussion of any trends identified 	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 (surplus discharge) Specifies monitoring (locations, flow rate, volume and water quality parameters) Specifies compliance reporting requirements, including comparison of monitoring against trigger values and details of investigations conducted, including outcomes, environmental impacts and remedial actions, in relation to trigger exceedances and a discussion of any trends identified
	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
Contaminated Sites Act <ul style="list-style-type: none"> PFAS National Environmental Management Plan (HEPA, 2020) Mount Whaleback Interim Site Management Plan for PFAS (Tetrattech Coffey, 2021a) 	Contaminated Sites Act <ul style="list-style-type: none"> PFAS National Environmental Management Plan (HEPA, 2020) 	

Figure 2: Water management framework

1.4.2 Rationale

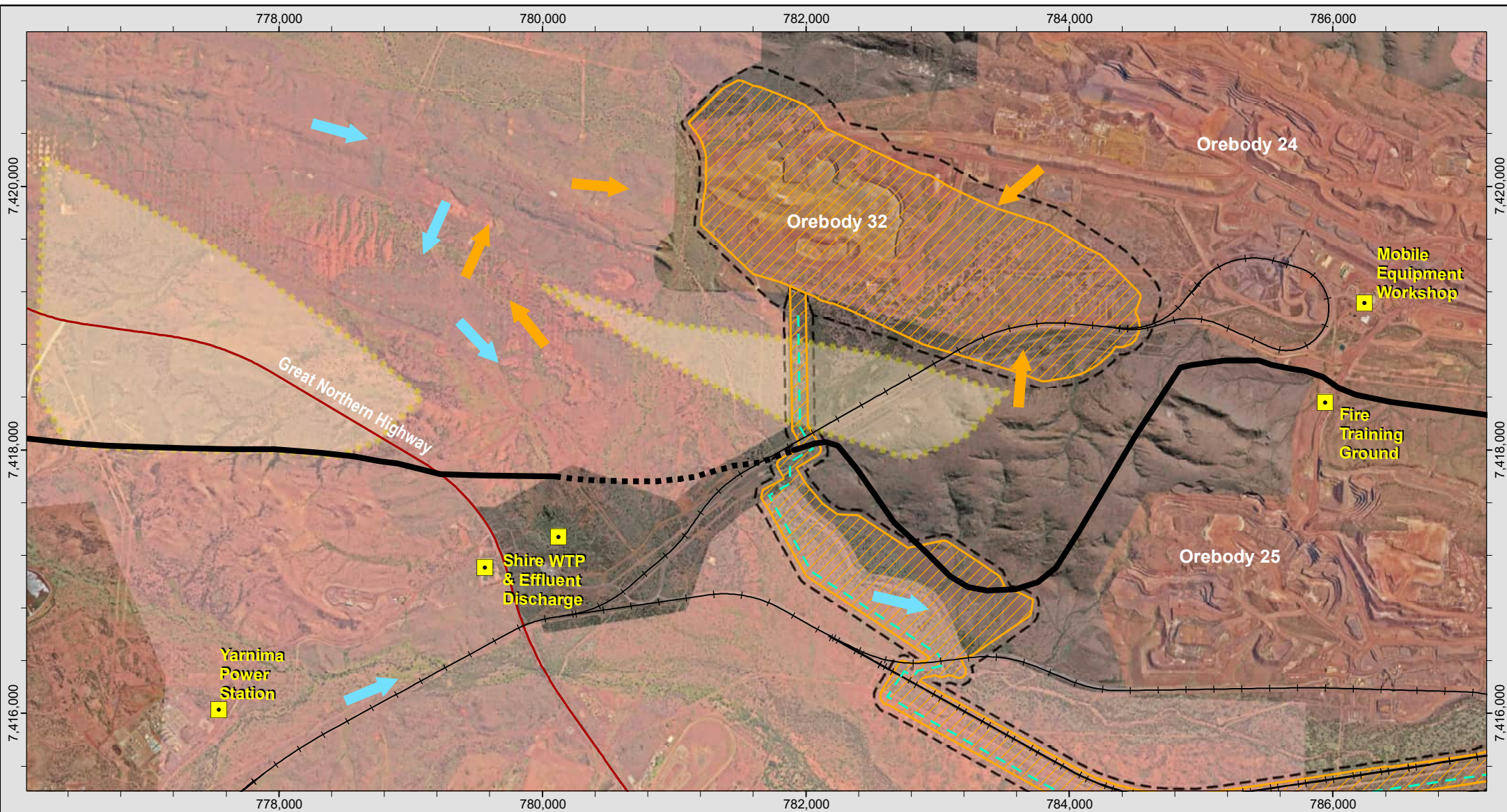
Table 3 provides the rationale for the WMP components in Section 2, including:

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

Table 3: Rationale for EMP Components

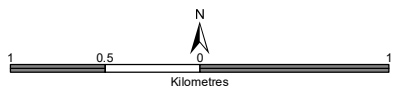
Studies	Study findings	Key assumptions and uncertainties	Rationale for choice of components
<p>Environmental values: Newman Water Reserve PDWSA, Ethel Gorge aquifer, Ethel Gorge TEC</p> <p>EMP environmental outcomes:</p> <ul style="list-style-type: none"> • PFAS concentrations in groundwater in the PDSWA 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>Baseline sampling for PFAS 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"> • Tetra Tech Coffey (2021b) <i>Eastern Ridge Mine Site: Limited Site Investigation for Per- and Polyfluoroalkyl Substances</i>, Report prepared for BHP, September 2021. • Tetra Tech Coffey (2021a) <i>Interim Site Management Plan for Per- and Poly-fluoro alkyl Substances for Mount Whaleback</i>, 26 May 2021. • CRC CARE (2022) <i>Stygofauna direct toxicity assessment</i>, Final report prepared for BHP, February 2022. 	<p>A brief summary of PFAS investigations undertaken by sampling and testing existing monitoring bores in and around the OB32 area as well as production bores in the vicinity is presented below.</p> <p>West of OB32: Sampling of eight existing monitoring wells to the west of OB32 between December 2020 and April 2021 indicated the presence of low levels of PFAS. PFOS concentrations slightly exceeded the PFAS National Environmental Management Plan (NEMP) (HEPA 2020) ecological freshwater 99% species protection guideline value of 0.00023 µg/L for PFOS in four of the eight wells sampled. None of these wells exceeded the PFAS NEMP human health drinking water quality guideline value (0.07 µg/L PFOS+PFHxS) or 95% species protection guideline value of 0.13 µg/L for PFOS. In addition, two production bores and four potable water bores to the west of OB32 were sampled between December 2020 and April 2021, which did not detect PFAS above the limits of reporting (LOR).</p> <p>East and southeast of OB32: Sampling of four existing monitoring wells between December 2020 and April 2021 to the east and southeast of OB32 indicated the presence of PFOS at levels slightly above the 99% ecological protection guideline value in one of the four wells sampled. None of these wells exceeded the drinking water or 95% ecological guideline value. Trace detections of other PFAS compounds were observed in one of the south-eastern wells.</p> <p>Due to the trace levels of PFAS detected in some of the existing wells and the absence of known or potential PFAS sources in some of these areas, it is considered possible that some of the reported PFAS concentrations are related to materials of construction used for drilling and installation of the existing groundwater wells (i.e. drilling muds and/or glue for the PVC casing installation, etc.).</p> <p>South of OB32: Sampling of existing monitoring wells to the south of OB32 between December 2020 and April 2021 indicated the presence of PFOS at levels above the 99% ecological protection guideline value in four of the eight wells sampled. However, none of these wells exceeded the drinking water or 95% ecological guideline value. These wells are located down-gradient and at a distance over 1.5 km to the south of OB32. In addition, low permeability geology is inferred to be present between these wells and OB32, which minimises the risk of PFAS present in these areas being mobilised towards OB32 during dewatering.</p> <p>Potential Sources of PFAS</p> <p>The baseline assessment for PFAS conducted at OB32 and surrounding Eastern Ridge areas (Tetra Tech Coffey, 2021b) indicated that there are no 'known' sources of PFAS within the OB32 BWT Development Envelope. However, there may be potential PFAS sources in other nearby existing Eastern Ridge mining areas and the Whaleback mine, all located a considerable distance away from the Development Envelope. These potential PFAS sources are shown in Figure 3. As illustrated in Figure 3, one of the PFAS sources is the Newman Shire wastewater treatment plant (WTP) and effluent discharge location, which is within BHP's tenement boundary, approximately 3 km southwest of OB32. There are two potential PFAS sources to the east within the existing OB25 mine, approximately 1.5 km west of OB32, as well as one within the Whaleback mine, approximately 4 km southwest of OB32. Additional investigations are currently being undertaken to verify these potential sources of PFAS.</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 (Tetra Tech Coffey, 2021b). PFAS concentrations in the Ethel Gorge aquifer and</p>	<p>Assumptions:</p> <ul style="list-style-type: none"> • PFAS has been detected at trace levels in a small number monitoring wells around OB32. As no known sources of PFAS are present within the OB32 BWT Development Envelope, the trace level detections of PFAS could be attributable 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 the OB32 BWT Proposal as BHP will phase-out PFAS usage at its Eastern Ridge operations by mid-2022. • Modelling conservatively assumes a 'constant plume' scenario (i.e. PFAS concentrations in groundwater will remain constant for the entire duration of the modelled dewatering simulation). This is considered very conservative as there are no known PFAS source areas within the OB32 BWT Development Envelope so PFAS concentrations in the environment (originating from BHP's mining operations) will reduce over time. • Modelling conservatively excludes other PFAS attenuation mechanisms such as sorption, diffusion and degradation. <p>Uncertainties:</p> <ul style="list-style-type: none"> • Groundwater modelling has inherent uncertainties due to the complexity of the subsurface hydrogeology and groundwater flow paths. It also does not consider the potential presence of unknown PFAS sources around OB32. However, the model is considered robust because of the conservative approach taken in assumptions regarding excluding attenuating mechanisms. • Operation of other dewatering activities at Whaleback will influence groundwater flow directions and is likely to reduce the risk of PFAS migration towards OB32. 	<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 OB32 BWT Proposal (Newman Water Reserve P1 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 OB32 BWT Development Envelope. • There are low concentrations of PFAS around OB32 and potential PFAS sources including at other existing Eastern Ridge mining areas and the nearby Whaleback mine. • There are existing very low levels of PFAS in Ophthalmia Dam and the Ethel Gorge aquifer. • The modelling indicates that the proposed dewatering may result in PFAS migrating to OB32, but will remain well below the human health drinking water and 95% ecological protection guideline values. • The modelling also indicates that the risk of dewatered groundwater from OB32 contributing to the exceedance of guideline values (both 95% ecological species protection and human health drinking water guideline values) at Ophthalmia Dam and the Ethel Gorge aquifer is very low. <p>Rationale for choice of indicators</p> <p>If PFAS migrates at unacceptable levels towards the orebody, it could impact on the groundwater quality within OB32 mining footprint, which is within the same P1 PDWSA as the other Eastern Ridge mines and 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 OB32, which will prevent the risk of</p>

Studies	Study findings	Key assumptions and uncertainties	Rationale for choice of components
	<p>Ophthalmia Dam vary from non-detect levels to being marginally above the PFAS NEMP 99% ecological protection guideline value (Tetra Tech Coffey, 2021b).</p> <p>OB32 Modelling Assessment (Golder, 2022): The risk of PFAS migrating from potential PFAS sources from within existing Eastern Ridge mining areas and the nearby Whaleback mine was evaluated using groundwater modelling of the planned dewatering scenario at OB32. A subsurface mixing assessment approach was used to estimate the PFAS concentrations in OB32 dewatering bores over a pumping period up to 2046. The modelling incorporated all available PFAS data from existing groundwater monitoring bores and targeted site investigations undertaken in and around OB32.</p> <p>The modelling assessment indicated that during the initial year of dewatering transient detections of PFOS at levels slightly above the 99% ecological protection guideline value may be observed in the combined dewatered groundwater discharge. These PFAS concentrations are estimated to be well below (in excess of a factor of 100) the PFAS NEMP human health drinking water guideline value, the 95% ecological protection guideline value and the site-specific ecological environmental concern level of 0.238 µg/L. After the initial year of dewatering, the PFAS concentrations are predicted to rapidly decrease to below detectable levels.</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.</p> <p>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 & ARMCANZ 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 & ARMCANZ) 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 protection criterion for stygofauna is slightly higher than the published 95% ecological protection level of 0.13 µg/L.</p>		<p>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 4) will serve as the indicator to monitor the movement of PFAS from potential PFAS sources towards OB32 dewatering bores and then towards the receiving environment (i.e. Ophthalmia Dam/ Ethel Gorge aquifer). The various stages and approaches for monitoring are identified below:</p> <ul style="list-style-type: none"> a) Level 1: Select monitoring bores along the inferred groundwater flow path (located between potential PFAS sources and OB32). 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 criteria and threshold criteria to inform response actions. b) Level 2: Dewatering bores at OB32. If Level 1 monitoring indicates PFAS has moved close to OB32 dewatering bores, then monitoring of dewatering bores will be undertaken. Monitoring results will be compared against early warning criteria and trigger criteria to inform response actions. 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 OB32 dewatering bores) will be undertaken. This data is considered representative of discharge water quality from OB32. Monitoring results will be compared against early warning criteria, trigger criteria and threshold criteria to inform management actions. 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>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 Water Reserve PDWSA within the OB32 BWT Development Envelope 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.</p>



Spatial Data - Studies Planning & Access
BHP IRON ORE

OB32 PFAS WATER MANAGEMENT PLAN
Location of Orebody 32 and potential PFAS sources

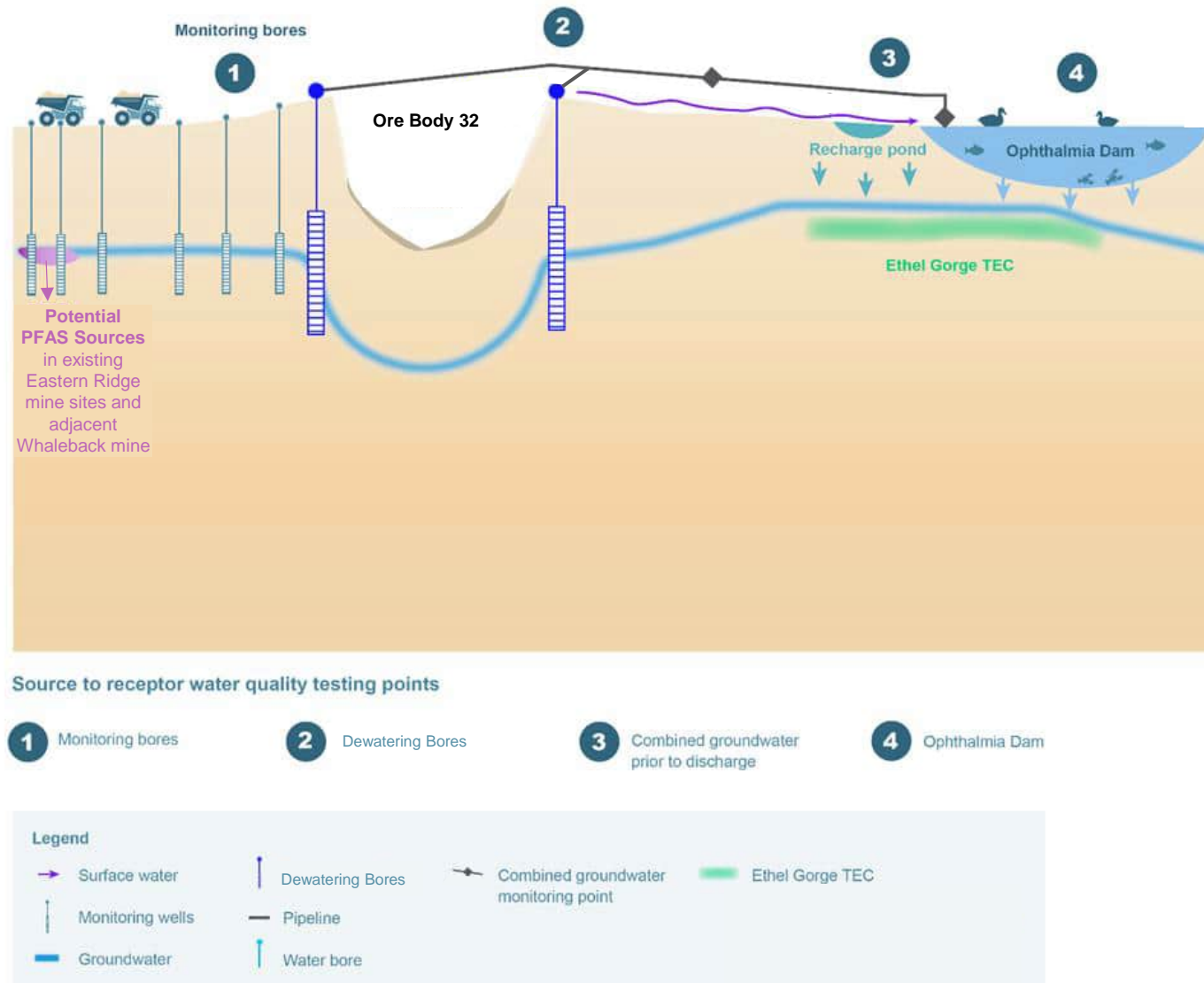


Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Date:	24/10/2022	Project No:	A1084/002A	Figure:	3
Prepared:	M. English	Checked:	ENV Approvals		

LEGEND

- BHP rail
- Highways
- Inferred Fault
- Jeerinah low permeability flow barrier
- Proposed surplus water pipeline alignment
- Potential PFAS sources
- Proposed Development Envelope
- Indicative Footprint
- Pre-dewatering Groundwater Flow Direction
- Inferred dewatering induced Groundwater Flow Direction



Note that this figure is conceptual only. OB32 mine is located to the west of existing Eastern Ridge PFAS sources and northeast of existing Whaleback mine

Figure 4: Conceptual site model illustrating water quality monitoring stages

2 EMP Components

BHP has provided detail of the EMP 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.

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 PFAS sources towards OB32 and 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 Ethel Gorge aquifer and Ethel Gorge TEC
Key impacts and risks	Risk of groundwater dewatering at OB32 mobilising PFAS and impacting the groundwater quality at OB32. If OB32 dewatering intercepts PFAS, there is the risk of surplus water discharge from OB32 to Ophthalmia Dam increasing PFAS concentrations in Ophthalmia Dam and the Ethel Gorge aquifer.

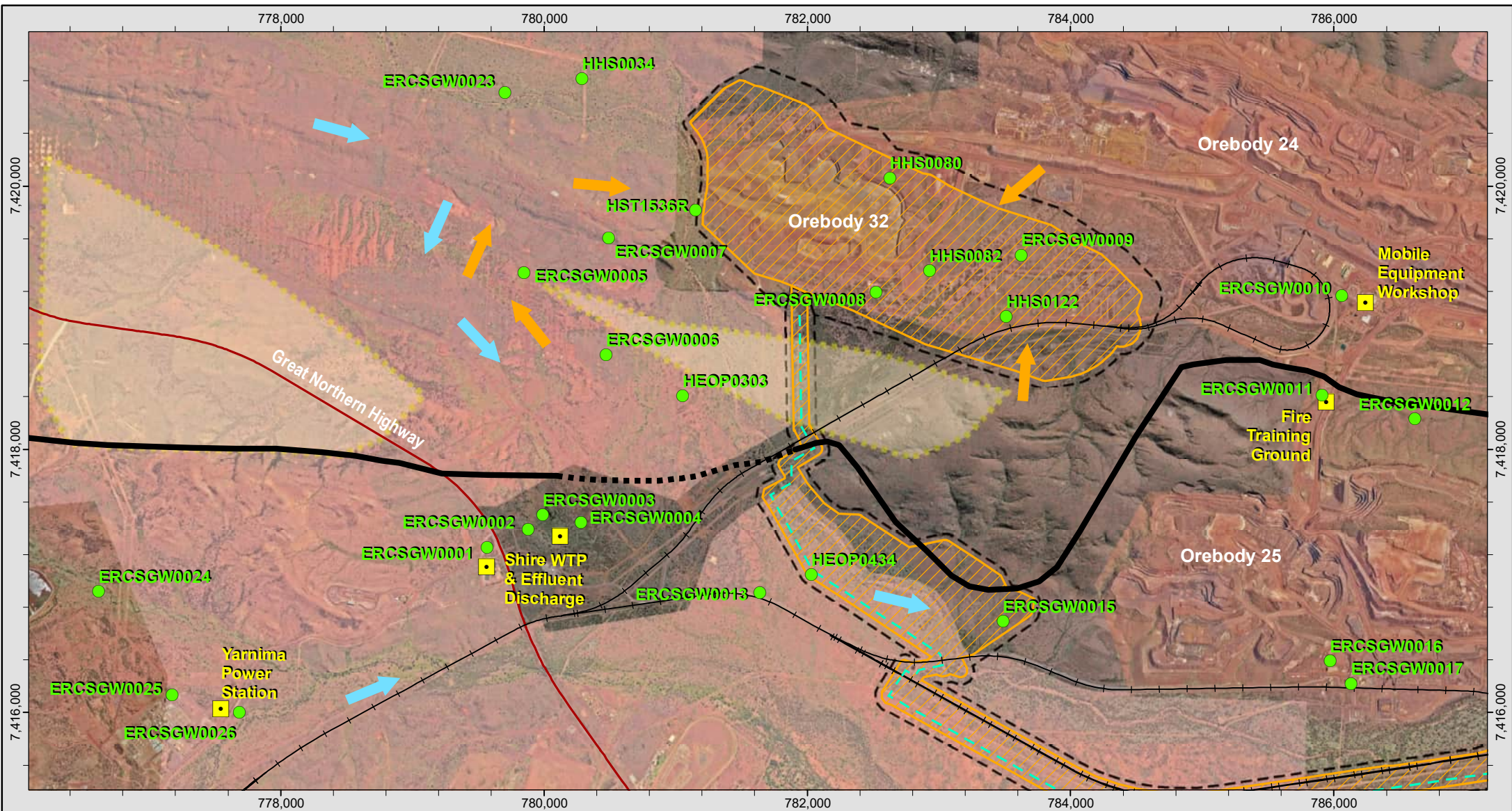
MS1105 Condition clauses - Outcome-based components			
Indicators:	Response actions:	Monitoring	Reporting
<ul style="list-style-type: none"> • Early warning criteria • Trigger criteria • Threshold criteria 	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions 	<p>(including timing / frequency of monitoring)</p>	
<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/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> <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>

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>Level 1: Pathway Monitoring</p> <p>Early Warning Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in pathway monitoring wells within OB32 or in sentinel monitoring wells (closest to OB32 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 pathway monitoring wells within OB32 or in sentinel monitoring wells (closest to OB32 dewatering bores) exceed 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 ≥ 0.168 µg/L <p>Ecological: 100 times PFAS NEMP 2.0 99% species protection guideline value</p> <ul style="list-style-type: none"> ○ PFOS ≥ 0.023 µg/L <p>Threshold Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in pathway monitoring wells within OB32 or in sentinel monitoring wells (closest to OB32 dewatering bores) exceed any of the criteria below. <p>Human health: PFAS NEMP 2.0 drinking water quality guideline value</p> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.07 µg/L ○ PFOA ≥ 0.56 µg/L <p>Ecological: PFAS NEMP 2.0 95% species protection guideline value</p> <ul style="list-style-type: none"> ○ PFOS ≥ 0.13 µg/L 	<p>Early warning response actions:</p> <p>Response actions to early warning criteria exceedances include any or all of the following, but are not limited to:</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 OB32 dewatering bores closest to PFAS-impacted sentinel monitoring well(s). If there is no increasing trend, reduce monitoring frequency to semi-annual basis. • BHP may implement additional response actions depending on the particular circumstances. <p>Trigger level actions:</p> <p>Response actions to trigger criteria exceedances include any or all of the following, but are not limited to:</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 the pathway monitoring well, then implement Level 2 monitoring of OB32 dewatering bores closest to PFAS-impacted sentinel monitoring well(s). ○ If the risk evaluation indicates that PFAS migration could exceed the threshold criteria in the sentinel monitoring well, BHP will evaluate and implement management/ remediation strategies that are practicable. • BHP may implement additional response actions depending on the particular circumstances. <p>Threshold contingency actions:</p> <p>Response actions to threshold criteria exceedances include any or all of the following, but are not limited to:</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 OB32 dewatering bores closest to PFAS-impacted sentinel monitoring wells within 2 weeks of identifying and confirming the exceedance of the threshold criteria. • Evaluate and implement management/ remediation strategies that are practicable. • BHP may implement additional response actions depending on the particular circumstances. 	<p>Parameters: PFAS (µg/L)</p> <p>Sampling Methodology: Compliant 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): Figure 5 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 	<ul style="list-style-type: none"> • Early response actions • Trigger level actions • Threshold contingency actions 		
<p>Level 2: OB32 'Active' Dewatering Bores</p> <p>Early Warning Criteria:</p> <ul style="list-style-type: none"> • PFAS concentrations in dewatering bore exceed any of the limits of reporting (LOR) below. <ul style="list-style-type: none"> ○ PFOS ≥ 0.0002 µg/L ○ PFOA ≥ 0.0005 µg/L ○ PFHxS ≥ 0.0005 µg/L <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> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.007 µg/L ○ PFOA ≥ 0.056 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>Early warning response actions:</p> <p>Response actions to the early warning criteria exceedances include any or all of the following, but are not limited to:</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. • BHP may implement additional response actions depending on the particular circumstances. <p>Trigger level actions:</p> <p>Response actions to trigger criteria include any or all of the following, but are not limited to:</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 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. • BHP may implement additional response actions depending on the particular circumstances. 	<p>Parameters: 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): Active (i.e. operating bores) dewatering bores. (Please note that because OB32 dewatering bores have not yet been constructed, indicative locations have been identified in Figure 6).</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>Level 3: Combined OB32 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 exceeds any of the criteria below. 	<p>Early warning response actions:</p> <p>Response actions to the early warning criteria exceedances include any or all of the following, but are not limited to:</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. • BHP may implement additional response actions depending on the particular circumstances. <p>Trigger level actions:</p> <p>Response actions to trigger criteria exceedances include any or all of the following, but are not limited to:</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. 	<p>Parameters: PFAS (µg/L)</p> <p>Sampling Methodology: Compliant 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): Combined dewatered groundwater monitoring point (blended groundwater from all OB32 operating dewatering bores) (Please note that because OB32 dewatering infrastructure has not been installed as it is part of this Proposal, only indicative locations have been identified in Figure 6).</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>

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>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 any of the criteria below. <p>Human health: PFAS NEMP 2.0 drinking water quality guideline value</p> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.07 µg/L ○ PFOA ≥ 0.56 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"> • 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 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>Threshold contingency actions:</p> <p>Response actions to threshold criteria exceedances include any or all of the following, but are not limited to:</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, 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>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> <ul style="list-style-type: none"> ○ Sum (PFOS + PFHxS) ≥ 0.007 µg/L ○ PFOA ≥ 0.056 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>Trigger level actions:</p> <p>Response actions to the trigger criteria exceedances include any or all of the following, but are not limited to:</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: PFAS (µg/L)</p> <p>Sampling Methodology: Compliant 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): Three representative and accessible surface water sample locations from within Ophthalmia Dam.</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> <ul style="list-style-type: none"> • Submit an annual compliance assessment report as part of the Annual Environment Report to the DWER by 1 October each year.

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 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. • BHP may implement additional response actions depending on the particular circumstances. <p>Threshold contingency actions:</p> <p>Response actions to threshold criteria exceedances include any or all of the following, but are not limited to:</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 (geotechnical safety assessment undertaken as part of Level 2 threshold response actions) (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, 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>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>



BHP Spatial Data - Studies Planning & Access
BHP IRON ORE

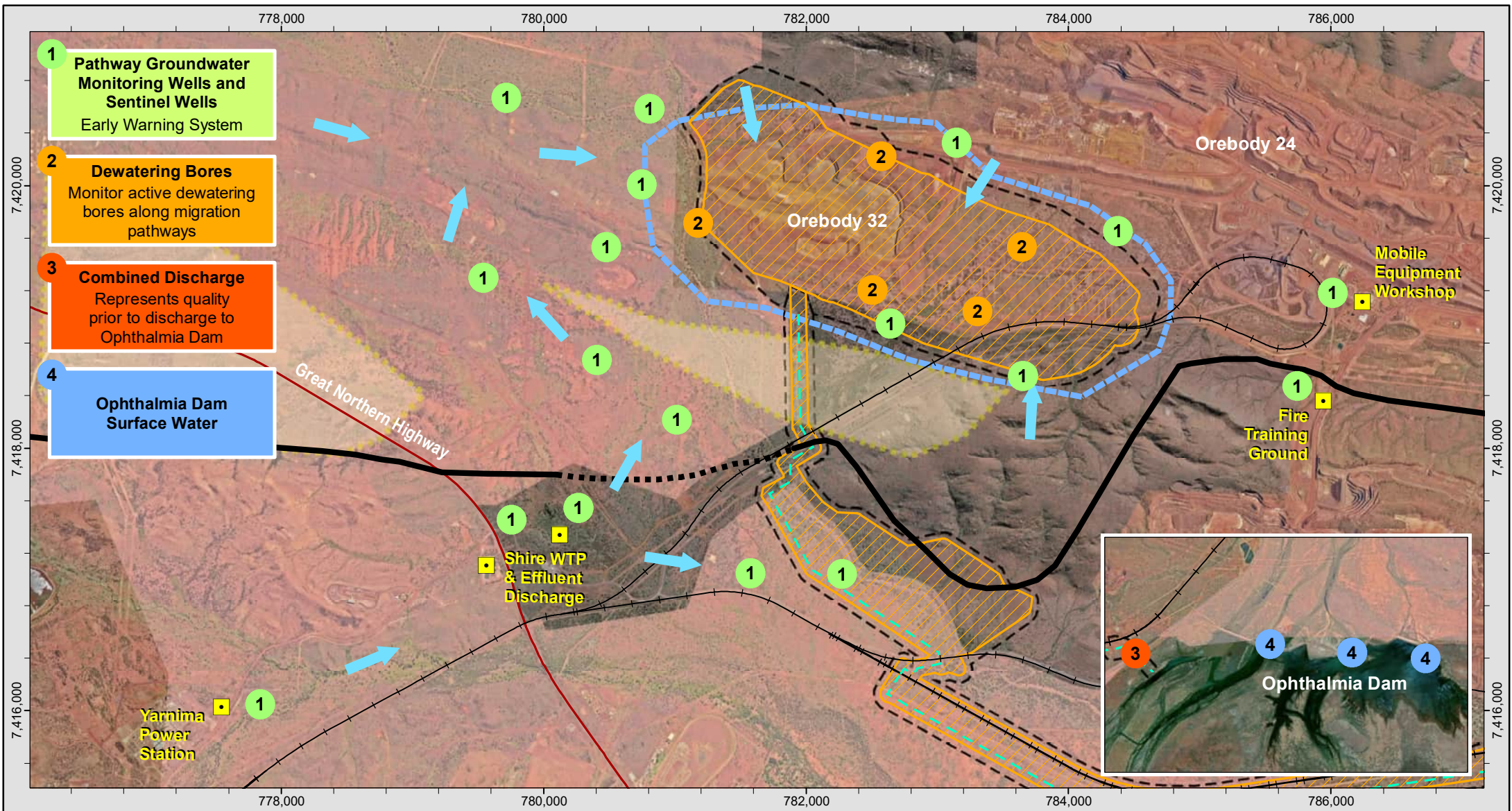
OB32 PFAS WATER MANAGEMENT PLAN
Indicative Level 1 groundwater monitoring locations

Coordinate System: GDA 1984 MGA Zone 50 Projection: Transverse Mercator, Datum: GDA 1984, Units: Meter

Date: 24/10/2022	Project No: A1084/003A	Figure: 5
Prepared: M. English	Checked: ENV Approvals	

LEGEND

- +— BHP rail
- Highways
- Groundwater monitoring locations
- — — Inferred Fault
- ▨ Jeerinah low permeability flow barrier
- — — Proposed surplus water pipeline alignment
- Potential PFAS sources
- ▭ Proposed Development Envelope
- ▨ Indicative Footprint
- ➡ Pre-dewatering Groundwater Flow Direction
- ➡ Inferred dewatering induced Groundwater Flow Direction



1 Pathway Groundwater Monitoring Wells and Sentinel Wells
Early Warning System

2 Dewatering Bores
Monitor active dewatering bores along migration pathways

3 Combined Discharge
Represents quality prior to discharge to Ophthalmia Dam

4 Ophthalmia Dam Surface Water

Orebody 24

Orebody 32

Mobile Equipment Workshop

Fire Training Ground

Shire WTP & Effluent Discharge

Yarnima Power Station

Great Northern Highway

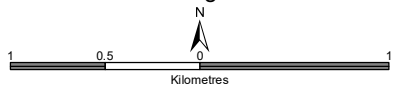


Ophthalmia Dam



Spatial Data - Studies Planning & Access
BHP IRON ORE

OB32 PFAS WATER MANAGEMENT PLAN
Indicative and conceptual illustration of monitoring locations



Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Date:	25/10/2022	Project No:	A1084/004A	Figure:	6
Prepared:	M. English	Checked:	ENV. APPROVALS		

LEGEND

- +— BHP rail
- Highways
- Inferred Fault
- Conceptual Groundwater Capture Zone
- Jeerinah low permeability flow barrier
- Proposed surplus water pipeline alignment
- Potential PFAS sources
- Proposed Development Envelope
- Indicative Footprint
- Indicative Groundwater Flow Direction

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 7.

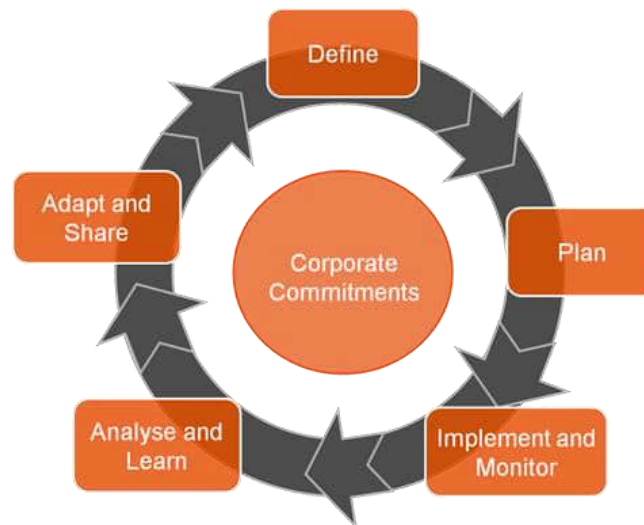


Figure 7: BHP's adaptive management approach

Where the WMP is a requirement of a 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 DWER.

3.2 Review and revision of this EMP

BHP will review this EMP (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 EMP 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 EMP may arise from the following:

- BHP reviews the EMP 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 EMP 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 EMP 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

Engagement regarding PFAS, including PFAS sampling results, the development of the multi-level control system, and the development of the first draft Newman Hub PFAS WMP (for Western Ridge) in 2021 and 2022 is summarised in the *Newman Hub (Orebody 32 Below Water Table) Derived Proposal Request Ministerial Statement 1105* document (BHP 2022). BHP provided the Western Ridge WMP (which is the basis of the OB32 BWT WMP) to DWER (EPA Services) in February 2022, and the draft OB32 BWT WMP to Niyaparli Traditional Owners in May 2022 as a supporting document to the draft derived proposal document. BHP has not received any feedback on either WMP to date.

BHP will continue to consult with government agencies (including decision-making authorities) and Niyaparli Traditional Owners through targeted consultation and via administration of the Comprehensive Agreement, where relevant, in relation to the finalisation, implementation and revision of this WMP. Consultation specifically undertaken for this WMP is summarised in Table 5.

Table 5: Summary of stakeholder consultation

Stakeholder	Date	Topics/issues raised
KNAC Implementation Committee	20 October 2022	BHP presented the OB32 BWT Proposal to Niyaparli representatives and KNAC at the Implementation Committee, including an overview of this WMP.
EPA Chair and EPA Services	2 August 2022	BHP presented on the Proposal including key factors, potential impacts and proposed management, including a site visit to the existing OB32 AWT mine, proposed Development Envelope-Pipeline and discharge point at Ophthalmia Dam.
KNAC Implementation Committee	13 and 14 July 2022	BHP presented the OB32 BWT Proposal to Niyaparli representatives and KNAC at the Implementation Committee, including an overview of this WMP.
KNAC and Preston Consulting	May 2022	OB32 BWT WMP (Rev 0) was provided to KNAC for review, prior to referral to the EPA. Feedback from KNAC requested figure update, and update do Table 5 Stakeholder Consultation.

5 Changes to an EMP

This WMP (v1) is the draft version to be provided in the referral package as a supporting document to the OB32 BWT Derived Proposal document.

6 References

BHP (2022) *Newman Hub (Orebody 32 Below Water Table) Derived Proposal Request Ministerial Statement 1105*. (In preparation).

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.

Environmental Protection Authority (EPA) (2021) *How to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans: Instructions*, EPA, Western Australia. Version 2.0. Published 29 October 2021.

Golder WSP (2022) *OB32 dewatering and per- and polyfluoroalkyl substances mixing assessment*. 25 July 2022.

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

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

Tetra Tech Coffey (2021b) *Eastern Ridge Mine Site: Limited Site Investigation for Per- and Polyfluoroalkyl Substances*. Report prepared for BHP. September 2021.