Western Australia Iron Ore

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Eastern Pilbara Water Resource Management Plan

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Contents

Note to Reader:

This document sets out the BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) Eastern Pilbara Water Resource Management Plan (EPWRMP) and summaries the technical considerations, assumptions and risks that underlie the development and implementation of the PWRMS.

The EPWRMP considers the hydrological changes resulting from BHP Billiton Iron Ore mining, the receiving receptors (water resources, environment, social and third-party operations), the potential impacts and the required risk-based adaptive management to mitigate potential impacts to acceptable levels. The plan shall be reviewed and if necessary amended annually following the LOA, 5YR planning process and the Annual Aquifer Review (AAR).

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1. Introduction

This Eastern Pilbara Water Resource Management Plan (EPWRMP) establishes specific water resource and water dependent ecosystem management requirements for the Eastern Pilbara mining area comprising of the Whaleback/Jimblebar water catchments.

The EPWRMP provides a standardised and consistent risk based approach to regional water management for multiple BHP Billiton Iron Ore operations in the Eastern Pilbara. It sets out the overarching approach and incorporates the technical considerations, assumptions and adaptive management that underlie the broader BHP Billiton Iron Ore Pilbara Water Resource Management Strategy (PWRMS).

The EPWRMP directs the consistent development and considerations of the Catchment, Hub and Site Specific Water Resource Management requirements for the Eastern Pilbara.

The EPWRMP considers the hydrological changes resulting from BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) mining, the receiving receptors (water resources, environment, social and third-party operations), external influence and factors, the potential impacts and the required risk-based adaptive management to mitigate potential impacts to acceptable levels.

1.1. EPWRMP Scope

The scope of the EPWRMP, considers the BHP Billiton Iron Ore Eastern Pilbara Hubs including Whaleback Hub, Eastern Ridge Hub and Jimblebar Hub (Whaleback, OB29, OB30, OB35, OB18, Jimblebar, Wheelarra 4, OB23, OB25, OB24 and OB31) operations (current and future) specific water management requirements and the receiving receptors for Eastern Pilbara (Whaleback/Jimblebar Catchment). Long term deposits/mines are at a concept stage only and as such are not consider as part of this plan.

1.2. EPWRMP Objective

The EPWRMP aims to provide a consistent method to identify the hydrological changes (groundwater and surface water quantity, levels and quality) resulting from BHPBIO mining and closure activities, the receiving receptors (water resources, environment, social and third party operations), the potential impacts, and the required risk-based adaptive management to mitigate potential impacts to acceptable levels.

Water Outcome-based Objective:

To manage the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from BHP Billiton Iron Ore Eastern Pilbara Hub operations impacting on receiving receptors to an acceptable level.

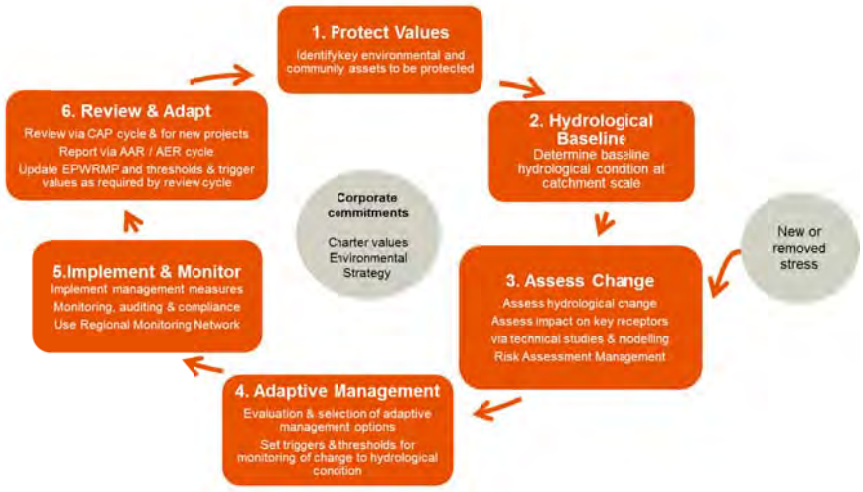
1.3. Water effects assessment and management methodology

The EPWRMP iteratively collates the key findings and knowledge of the eco-hydrogeology technical studies and changes of water affecting activities to inform the required adaptive management to enable achievement of outcome-based objectives. The adaptive management is risk based and is expected to proactively counteract, mitigate or manage potential impacts (both predicted and actual) to an acceptable level. The EPWRMP will be updated at least annually or when significant technical knowledge becomes available, where there is an impact potential change and/or corrective action is required.

As outlined in Figure 1, the EPWRMP considers the following aspects:

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

Figure 1: EPWRMP Adaptive (staged and iterative) management approach



1.4. Operational water management context

Water management associated with mine operations involves the interrelationship between:

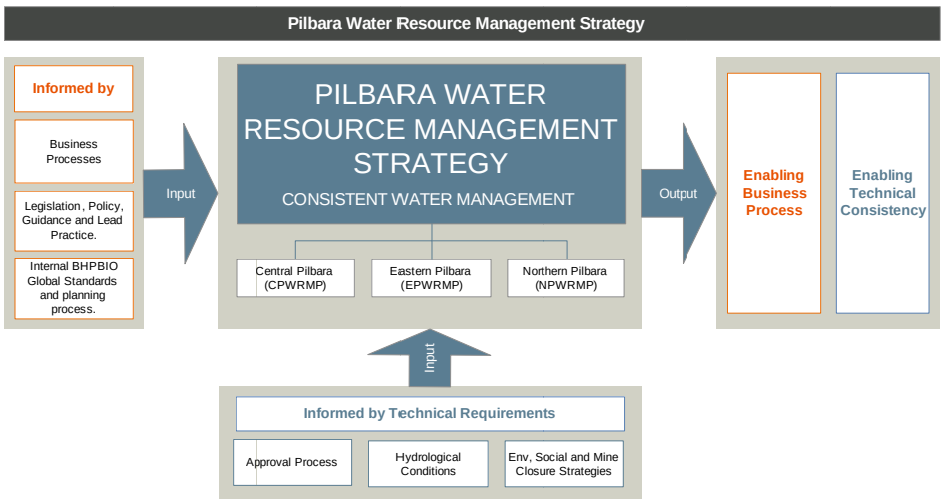
- water supply;
- dewatering (and depressurisation);
- surplus water management;
- wet weather;
- environmental impact (and mine closure) management;
- licence and ministerial conditions; and
- potable water supply.

These considerations cannot be viewed in isolation, together these interrelationships are managed by an Integrated Water Management System (based on the requirements of BHP Billiton Group Level Documents GLDs and ISO 14001 – Environmental Management) and the catchment, hubs and site-specific water balances.

The EPWRMP considers existing management objectives and applies the key findings from the eco-hydrogeological investigations, monitoring and literature to guide the development of outcome-based objectives. The outcome-based objectives are required for the BHP Billiton Iron Ore management of predicted and actual impacts directly resulting from BHP Billiton Iron Ore operations on receiving receptors at a catchment scale. The EPWRMP does not try to manage impacts on receiving receptors that are beyond BHP Billiton Iron Ore's operational impact, control or responsibility, such as impacts resulting from prolonged dry periods, climate variability or third-party operations.

The PWRMS is substantiated by the EPWRMP and will have other catchment scale plans, which provide a consistent approach to water management across the technical and operational groups of the business, as well as providing operational and approval flexibility as shown in Figure 2.

Figure 2: Overview of the Pilbara Water Resource Management Strategy



2. Eastern Pilbara mining operations

This section summarises BHP Billiton Iron Ore's operations within the Eastern Pilbara catchment and the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from BHP Billiton Iron Ore mine operations.

2.1. Overview of the Eastern Pilbara mining hubs

BHP Billiton Iron Ore currently has mining operations within the Eastern Pilbara catchment specifically at the Whaleback Hub, Eastern Ridge Hub and the Jimblebar Hub (Refer In addition to the mining operations, two potable water supply borefields are located within the region, namely the Ophthalmia and Homestead borefields. These two borefields supply Newman town water supply and are managed through the Source Water Protection Plan for Newman.

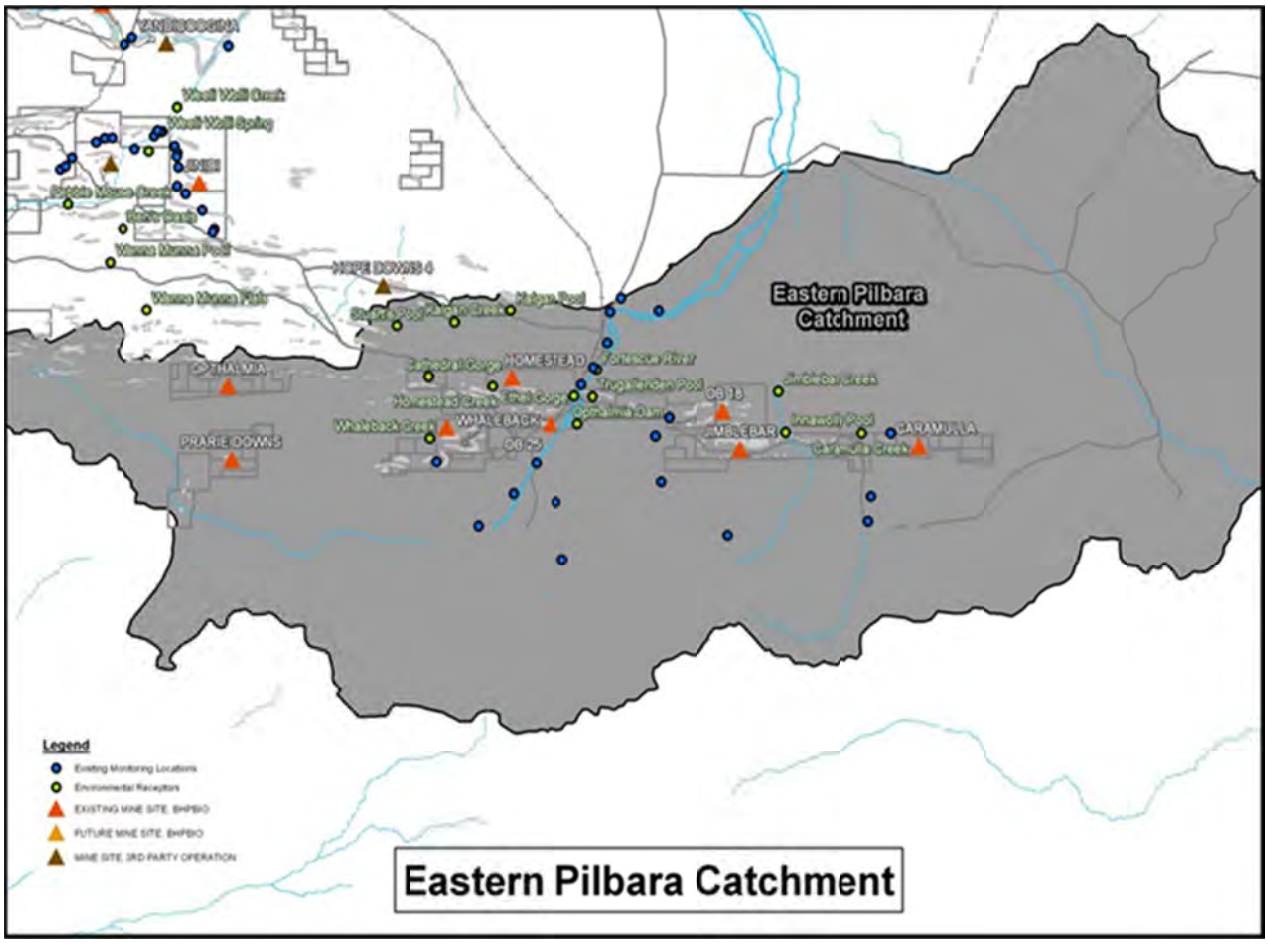
Figure 3). For the purpose of this plan the Eastern Pilbara catchment currently consists of the following grouped deposits/mines:

- Whaleback Hub (current operations - Whaleback, OB29, OB30, OB35).
- Eastern Ridge Hub (current operations OB23, OB24 and OB25).
- Jimblebar Hub (current operations OB18, Jimblebar and Wheelarra 4 and mid-term planned OB31).

A summary of the existing operations which are covered by the EPWRMP is presented in Appendix A.

In addition to the mining operations, two potable water supply borefields are located within the region, namely the Ophthalmia and Homestead borefields. These two borefields supply Newman town water supply and are managed through the Source Water Protection Plan for Newman.

Figure 3: Eastern Pilbara Catchment management area



2.2. Hydrological change and mining operations

Mine dewatering and surface water diversions activities at Eastern Pilbara mines will continue and in some areas increase to support below the water table mining. The dewatering activities are predicted to generate a net surplus water scenario over the next 15 years which will continue to require management on a local and regional scale. A summary of the surplus water management approach is outlined in the Eastern Pilbara Surplus Water Management Plan, 2015.

The potential regional drawdowns and impacts associated with this increase have been simulated by using regional numerical and analytical models calibrated with up to 40 years of data (including 25 years of dewatering), Managed

Aquifer Recharge (via Ophthalmia Dam infiltration) and regional surface and groundwater monitoring results. The models accommodate for technical uncertainty, a range of mine planning option and the various existing and planned Eastern Pilbara Hubs water balance scenarios which consider dewatering activities, and water supply borefields.

3. Protect values – Environmental and community receptors

3.1. Eastern Pilbara Biodiversity key receptors

The Pilbara biodiversity baseline development (consisting of over 6000 biodiversity field studies covering 90% of BHP Billiton Iron Ore tenure) has identified the below Eastern Pilbara catchment receptors for further investigation and assigning values for protection and monitoring.

- Cathedral Gorge
- Caramulla Creek
- Ethel Gorge
- Ethel Gorge Aquifer TEC
- Fortescue River
- Homestead Creek
- Innawally Pool
- Jimblebar Creek
- Kalgan Creek
- Kalgan Pool
- Ophthalmia Dam
- Shovelanna Creek
- Stuarts Pool
- Warrawanda Creek
- Whaleback Creek
- Trugallenden Pool
- Groundwater Resource

The majority of the identified receptors outlined above can be managed through existing Regulatory frameworks and controls, and are not identified as assets of significance which require an adaptive management approach. However, the receptors will be reviewed regularly to determine whether the value or impact potential requires updating based on new understanding (via the adaptive management process).

Ethel Gorge (upper Fortescue River) and Jimblebar Creek are two environmental receptors which have been identified as important assets of value and do have Ministerial Conditions which commit BHP Billiton Iron Ore to existing regulation and management. A description of the important assets of value in the Eastern Pilbara are presented in Appendix B. At this point in time, two assets will form the basis of this plan and adaptive management objectives including preventative and mitigating controls will be set to manage the risk of hydrological change and potential impact. The potential hydrological change, key considerations and adaptive management of these two key receptors are discussed further in Section 6 and 7.

3.2. Eastern Pilbara Community receptors

3.2.1. Eastern Pilbara Indigenous receptors

Community (Indigenous) receiving receptors in the Pilbara Region have been formally identified and their values have been defined and in some instances outlined in individual traditional owner agreements. These receptors are considered via the BHP Billiton Iron Ore Project Environment and Aboriginal Heritage Review (PEAHR) process which is subject to confidential agreements.

Interaction between BHP Billiton Iron Ore and traditional owners continues to expand on the understanding of the values of the social receptors and will continue to be inputs the adaptive management approach required.

3.2.2. Eastern Pilbara Potable drinking water

The Newman Township drinking water is subject to a Department of Water (DoW) Priority 1 classification for drinking water source protection area. The water resources receptors are considered and managed via the BHP Billiton Iron Ore Business Level Document (BLD) Drinking Water Quality Management and reporting and Governance associated with the Newman Drinking Water Source Protection Plan (SPP).

The SPP represents the DoW and BHP Billiton Iron Ore's approach to management and protection of potable water sources in and around the Newman Township and includes the Ophthalmia potable borefield and the Homestead potable borefield. The management of potential impacts to the source water is consistent with the intent of the PWRMP and for the purpose of this document, the potable drinking water source protection objectives can be achieved through the below objectives, thresholds and management triggers for Ethel Gorge.

The Homestead potable borefield will ultimately become a separate and stand alone receptor of value once mining related stresses and threats increase and the risk management requires mitigating or preventative controls over and above the controls outlined in the Newman Drinking Water Source Protection Plan.

4. Regional catchment management approach

The EPWRMP applies an adaptive management approach to manage the range of potential hydrological changes resulting from BHP Billiton Iron Ore operations and potential impacts on a receiving receptor.

This approach can accommodate the uncertainty associated with predicting dewatering volumes and the resulting area of influence whilst maintaining the value of the receiving receptor which may be impacted by changes in hydrological processes or by water quality. This is done through a combination of 1) preventative water management controls, such as surplus water returned to the aquifer, 2) allowing for the application of precautionary principles to be considered as the scientific knowledge evolves through baseline assessments and the monitoring of predicted and actual outcomes and 3) utilising practicable and feasible water mitigation controls to mitigate and offset impacts.

This approach provides a systematic and iterative process for decision-making and establishing management objectives, particularly where uncertainly exists, to achieve the desired outcome as per Figure 1.

4.1. Hydrological change

There are a range of water affecting activities in the Eastern Pilbara catchment which may result in changes to hydrological processes (groundwater levels) and groundwater quality. These include:

1. dewatering of below water table orebodies OB25, OB23, OB29, Jimblebar and OB31 lowering groundwater levels;
2. Ophthalmia Dam discharge and seepage results in an increase to aquifer salinity;
3. pumping from the Ethel Gorge aquifer (Ophthalmia Borefield) lowers water levels and increases salinity; and
4. dewatering water is discharged through infiltration ponds increasing water levels and lowering water quality.

The expected response to the range of water-affecting activities is presented in the OB31 Hydrogeological Impact Assessment, BHP Billiton Iron Ore, 2015.

4.2. Key considerations

The framework requires outcome-based objectives to be established for receiving receptors, which are shown to be potentially impacted by BHP Billiton Iron Ore operations through the impact assessment process.

Preliminary modelling undertaken during the impact assessment phase and any existing monitoring data is used to:

1. identify environmental and social receptors potentially impacted by existing and new operations;
2. assess the potential impact to baseline hydrological processes from new developments and their potential impact on environmental and social receptors;
3. establish threshold values and early warning trigger values, these are then validated through the operational phase and adjusted via the adaptive management review and monitoring process; then
4. informs establishing appropriate management and mitigation measures, including corrective actions.

4.3. Setting thresholds for significant impact

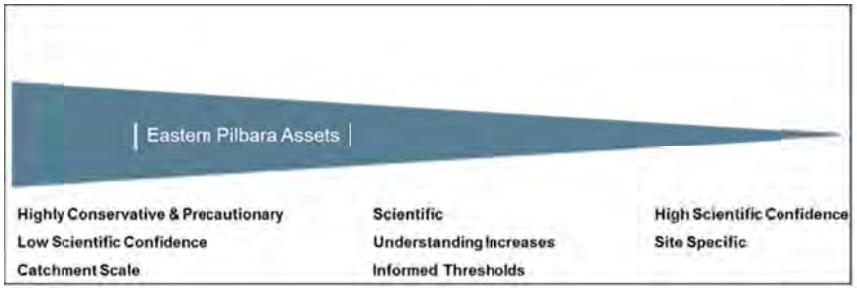
These objectives are supported by thresholds to monitor whether a hydrological change that can result in an impact to a receiving receptor has occurred as a result of BHP Billiton Iron Ore operations. Two receptors have been identified as having the potential to be impacted by changes in hydrological processes associated with the implementation of additional discharge or abstraction volumes, these being the Ethel Gorge TEC and Jimblebar Creek. A description of the receptors of value are presented in Appendix A.

Early warning triggers are also defined to provide the point at which water management options must be considered and implemented to avoid potential impact to a receiving receptor; the trigger is intended to operate sufficiently early to allow water management options to be put in place well before the threshold value for the receiving receptor is reached.

4.4. Early warning triggers and thresholds

To achieve the outcome-based objectives, early warning triggers and thresholds will be developed within the area of influence, receptor location and surrounding pathways (laterally and vertically through the aquifers) to monitor predicted and actual BHP Billiton Iron Ore impacts, isolate and characterise natural variance an influences from 3rd parties and to enable receiving receptor protection. Initially, early warning triggers and thresholds will reflect existing scientific knowledge to deal with the risks of uncertainty and the need to interpolate catchment-wide data and a range of mine water balance scenarios. In the absence of technical knowledge and a mine planning process which introduces variability, plus the requirement for impact assessment conclusions to be validated in the field, conservative and precautionary thresholds will be enacted. As the scientific understanding evolves and transitions from catchment-wide to site-specific interpretative investigations, the level of uncertainty and the amount of interpolation will decrease and thresholds will be iteratively refined, as shown in Figure 4. The approach accommodates the persistence of hydrological and ecological uncertainty during operations and ultimately post closure. However, the approach also recognises that the persistence of uncertainty associated with variations to mine plans and mine development rates may always exist to provide operational flexibility.

Figure 4: Iteratively refined thresholds to reflect scientific knowledge for the Eastern Pilbara Receptors



To identify appropriate thresholds and any subsequent water management options, the outcome-based objectives for receiving receptor values must explicitly define the scope of BHP Billiton Iron Ore's responsibilities with respect to the hydrological change to which they contribute and the potential impact to receiving receptors.

4.5. Water management options

The water management options outlined in Figure 5 consider feasible options and controls (preventative and mitigating) to counteract hydrological changes resulting from BHP Billiton Iron Ore operations and the potential impacts to receiving receptors during BHP Billiton Iron Ore operations and closure. This enables an innovative flexibility with regards to water management and takes into account optimising of mine dewatering, storage and use. This approach is consistent with the DoW guidance (Water and Mining Guidelines, 2013) and considers prioritisation of transferring water for reuse, minimising the dewatering drawdown footprint, and offsetting the impacts to receiving receptors to an acceptable level.

Figure 5: Feasible water management options to minimise potential impacts to receiving receptors resulting from BHP Billiton Iron Ore operations

WATER RESOURCE	TRANSFER	STORAGE	TREATMENT	DISCHARGE	OTHER
Proactive Dewatering	**Short term pipeline**	**Tanks, Turkey Nests, Ponds**	**Desalination/RO**	**Managed Aquifer Recharge (MAR)**	**Community project**
Aquifer Abstraction	**Long pipeline**	**Managed Aquifer Recharge (MAR)**	**Sediment Basins**	**Infiltration Ponds**	**3rd Party Supply**
Desalination/RO		**Infiltration Dam and Ponds**		**Irrigation of Trees**	Agriculture
Surface water capture		In-pit Storage		Creek Discharge	
				In-pit Storage Short term	

Note: Options shown in bold are confirmed and currently in place. Options shown in regular are currently under evaluation or a future possible alternative under suitable water balance and sustainability scenarios.

4.6. Cumulative effects

Hydrological conditions can be impacted by more than one mining operation, depending on the surface water and groundwater hydrological interconnectivity at the catchment scale.

The Eastern Pilbara is a unique environment as BHP Billiton Iron Ore is the only mining operation mining in the catchment. As such, BHP Billiton Iron Ore has data in the catchment and can undertake cumulative impact assessments for its operations as new developments come online.

Regional Monitoring Network and catchment scale eco-hydrological studies are being undertaken to provide baseline assessments and predictive models, which will be updated iteratively to inform cumulative impact assessments and require adaptive management.

5. Monitor, review and take corrective action

The specific monitoring and corrective actions for the key Eastern Pilbara receptor are detailed in Section 6 for Ethel Gorge and in Section 7 for Jimblebar Creek, if necessary. This plan outlines the specific monitoring requirements, triggers and preventative and corrective actions.

Below is a summary of the monitoring and corrective action process.

5.1. Monitor and review

5.1.1. Monitoring and management zones

Monitoring facilities will characterise groundwater, soil water, surface water and where necessary ecological health and abundance. Monitoring zones or points will be established which represents the risk, the receptor location and surrounding pathways (laterally and vertically through the aquifers) to allow the predicted and actual BHP Billiton Iron Ore impacts to be monitored, Early warning monitoring points or facilities will be highlighted. The monitoring frequency and parameters will depend upon the risk characteristic, the location of the monitoring facility and extent of technical uncertainty.

Management zones or facilities will allow preventative and mitigating controls to be implemented. Details are provided for receptor-specific management approaches in Section 6 and 7.

5.1.2. Review of the plan and triggers

The EPWRMP is underpinned by current scientific understanding. The early warning triggers, thresholds and outcome-based objectives also reflect current scientific understanding and will require iterative updating as uncertainty is addressed and actual results are compared against observed results.

The predicted footprint of water effecting activities and the regional water balance is based on a midterm mine plan (5 yr plan) and it is recognised that the extent of dewatering and surface water interception may change with further mine development planning. Mine Planning and hydrological modelling will also be iteratively updated to reflect predicted and actual changes.

The plan shall be reviewed and if necessary amended annually following the BHP Billiton Iron Ore internal planning process which is completed annually and reported externally through the Annual Aquifer Review (AAR) and the Groundwater Operating Strategy (GWOS).The EPWRMP shall also be reviewed as part of the assessment process for any new projects for which Hydrological Processes or Inland Waters Environmental Quality are potential key environmental factors.

Triggers and Thresholds will be reviewed when either:

- a new project for which Hydrological Processes or Inland Waters Environmental Quality is a key environmental factor;
- the level of scientific knowledge relating to a key environmental or social receptor produces results which justify a change in the current triggers and thresholds; or
- when monitoring results justify a change in the current triggers and thresholds.

Reviewing results on an iterative basis will lead to an increased scientific understanding of the ecological resilience, adaptability and hydrological dependency, and also the hydrological environment and change resulting from BHP Billiton Iron Ore's Eastern Pilbara Hub dewatering operations.

5.2. Reporting

Reporting of monitoring results shall be provided to Office of the Environmental Protection Authority (OEPA) and the DoW via the Annual Environment Report and the Annual Aquifer Review, respectively on an annual basis.

6. Ethel Gorge Threatened Ecological Community

6.1. Outcome-baseline environmental objective

The water management objectives have been set as monitoring thresholds and corrective action triggers for the Ethel Gorge TEC based on changes in water levels and water quality as salinity. Both hydrological and ecological thresholds have been established to manage the potential impacts.

1. The primary hydrological thresholds have been established to manage the potential impacts to the Stygofauna community habitat and are set to maintain hydrological conditions (nominally water levels and salinity) in the Ethel Gorge aquifer within acceptable historical ranges. The hydrological thresholds based on historical ranges for the primary Ethel gorge aquifer are as per Table 1 below. Over and above these thresholds, site specific criteria basedon ANZECC (2000) have been established for a range of water quality parameters in Ethel Gorge aquifer. These criteria reside in the Ophthalmia Borefield Groundwater Operating Strategy to support the 5C abstraction licence and are reported annually through the annual aquifer review process.

2. A secondary ecological threshold has been established to manage the potential impacts to the riparian tree health as a result of rising groundwater level in Ethel Gorge aquifer and the perminant inundation of the rooting zone. The inundation may introduce impacts to the riparian tree health. The threshold is set as an averaged annual upper water level. The lower water level threshold for the riparian tree health is set as the above hydrological threshold. The ecological water level threshold is outlined in **Error! Not a valid bookmark self-reference.**below.

Table 1: Historical and acceptable ranges from the primary Ethel Gorge aquifer

Threshold	Measure	Acceptable range
Hydrological	GWL annual allocation	+/- 6 m[1.]
	Historical variance in water quality (as TDS)	<2,500 mg/L
Ecohydrological	Upper water level as meters below surface	>1m

Notes: [1.] Interpreted as the Ethel Gorge statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat (Monitoring Zone 1 – Figure 6). It is recognised that a localised water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses will not bias the overall thresholds.

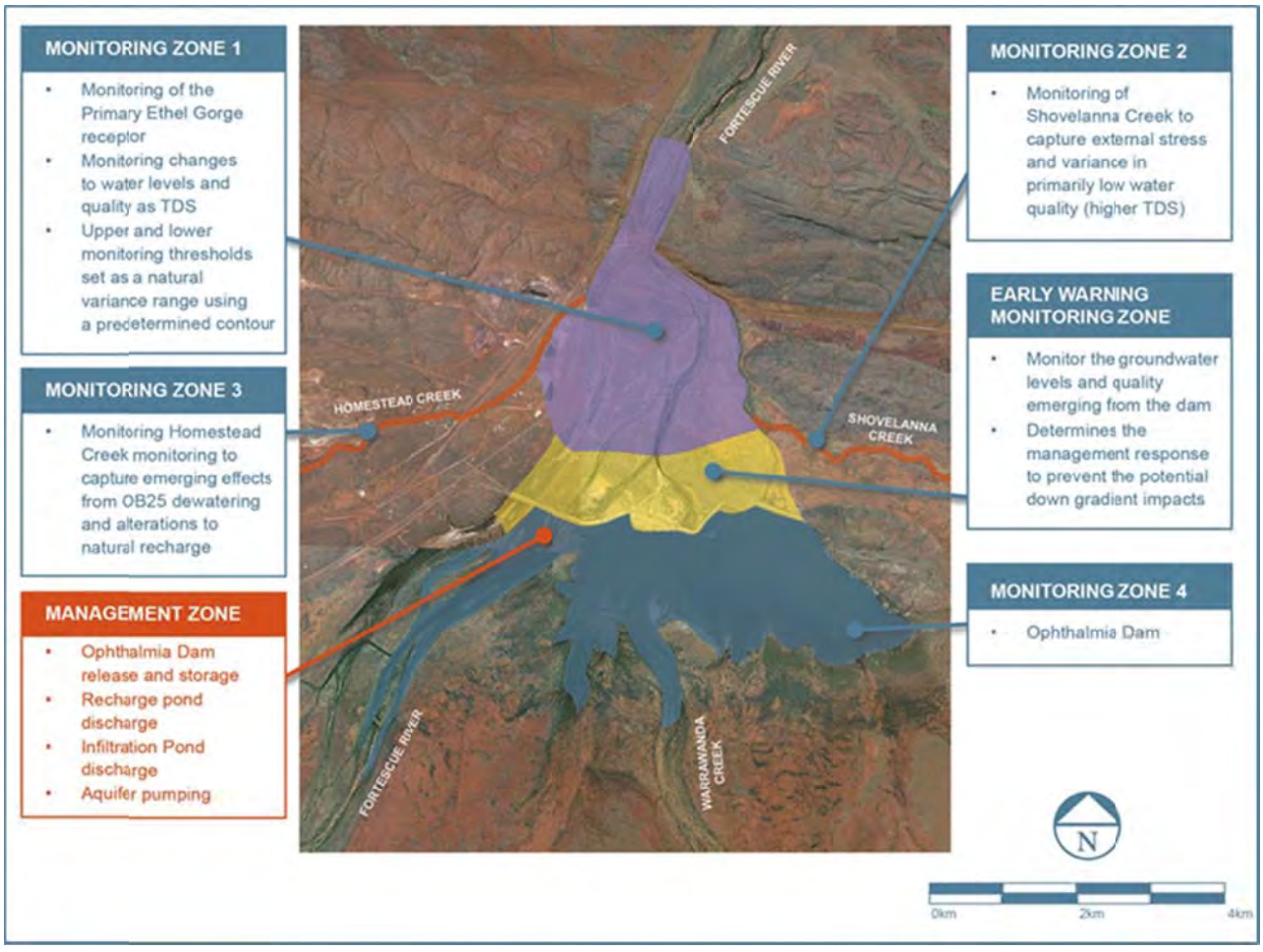
These triggers and thresholds are considered precautionary and will seek to transition during subsequent iterations of the EPWMP towards ecological thresholds which may represent the aquifer thickness and variability, and stygofauna abundance, resilience and adaptability.

6.2. Adaptive management – Monitoring and management zones

The following Figure depicts BHP Billiton Iron Ore's approach to management and monitoring zones within the Ethel Gorge TEC area. The monitoring and management facilities have been in operation for up to 40 years and have proven suitable to characterise hydrological conditions and allow for effective adaptive management.

The adaptive management monitoring zones for Ethel Gorge are detailed below in Figure 6. Five monitoring zones within and surrounding the primary Ethel Gorge receptor, including an early warning zone, have been established. The management zone overlies the monitoring zones and considers Ophthalmia Dam and the adjoining infiltration ponds and basins are appropriate for managing impact on the Ethel Gorge TEC.

Figure 6: Adaptive management monitoring zones for Ethel Gorge



More specifically the monitoring and management zones include:

1. An **early warning monitoring zone** located immediately in front of Ophthalmia Dam to identify a measurable change in water levels and quality above predetermined acceptable ranges within the groundwater system resulting from infiltration through Ophthalmia Dam.

1. **Three groundwater monitoring zones** to reflect the primary Ethel Gorge habitat and supporting aquifer, plus two neighbouring groundwater systems which converge into the Ethel Gorge System, namely Homestead Creek and Shovelanna Creek aquifers. The neighbouring monitoring zones identify and characterise natural variance in salinity originating to the east and the hydrological stresses and pathway located between Ethel Gorge and the neighbouring operations.

2. **Ophthalmia Dam monitoring zone** which measures water level, outflow and water quality, and

3. The Ophthalmia Dam and infiltration and recharge ponds as **active management zones** located within the Ethel Gorge receptor and early warning management zone.

6.2.1. Adaptive management – Monitoring zone thresholds

Adaptive management thresholds are based on historical hydrological conditions in the Ethel Gorge aquifer being 1) water level and salinity ranges and 2) the rate of water level change.

Adaptive management for Ethel Gorge allows for three stages of response, including an investigation, action and mitigation stage. The approach ensures that any change and/or response observed is characterised and understood prior to implementing corrective action.

Three stages are described under the following hierarchy:

1. **Investigation Stage -** evaluate and characterise the change identified. The investigation results may establish a revised investigation, action threshold or timeline for action and mitigation.

2. **Action Stage –** prepares for mitigating activity. The Action values are considered to be precautionary and conservative to ensure there is sufficient time available to prevent impact. If an assessment showed that there was a potential for the unpredicted trend to impose a negative impact on the environment, adaptive management options would be prepared.

3. **Mitigation Stage –** response or corrective action is immediately required to prevent impact or reverse the trends.

Thresholds for the primary receptor zone are presented in Table 2.

Table 2: Investigate, Action and Mitigate thresholds established for the Ethel Gorge aquifer which supports the stygobiont community and riparian tree habitat

Receptor	Threshold Basis	Monitoring and Management Threshold		
		Investigate	Action	Mitigate
Ethel Gorge Primary Receptor monitoring zone	Water Quality	>2500 mg/L.	3000 mg/L or to be determined by investigation Stage	4000 mg/L of to be determined by Action stage
	Lower Water Level	Aquifer water levels fall 5m1. or at a rate <4m/year.	Water levels fall >6m1. or at a rate >4m/year.	Determined by investigation trigger.
	Upper Water Level	Water levels are below 1m2. from land surface.	Water levels are at 1m below surface.	Determined by investigation trigger.

Notes - [1]. Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat (Monitoring Zone 1 – Figure 6). Water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses shall not bias the overall thresholds. 2. Interpreted as the depth to groundwater below ground surface in the vicinity of the riparian creek zone.

Operational triggers have also been established to support the management of the broader hydrological system and the range of potential changes to hydrological conditions in the primary Ethel Gorge receptor. These triggers are not formal Ethel Gorge management thresholds but are set as operational response triggers to aid in the outcome objectives.

Table 3: Investigate, Action and Mitigate thresholds established for the Ethel Gorge monitoring and management zones

Monitoring and Management Zone	Location	Monitoring and Management Stage		
		Investigate	Action	Mitigate
Monitoring Zone – Shovelanna Creek	Shovelanna Creek Aquifer	**Water Quality** - TDS statistically significant increase of 20% from long term seasonal average.	-	-
Monitoring Zone – Homestead Creek	Homestead Creek Aquifer	**Water Levels** – change +/- 6m1. or at a rate of >4m per year.	-	-
		Water Quality – TDS statistically significant increase of 20% from an interpreted seasonal baseline.	-	-
Monitoring Zone – Ophthalmia Dam	Ophthalmia Dam and outflow values	**Water Quality** - Dam water TDS exceeds 4000 mg/L.	Dam water TDS exceeds 5000 mg/L	-
Monitoring Zone – Early Warning	Management Zone – north of Dam	**Water Quality** - TDS statistically significant increase by 20% from the interpreted seasonal baseline.	TDS statistically significant increases by 50% from interpreted seasonal baseline.	-
		Upper Water Level - Water levels are below 1m2.	Water levels are at 1m below surface	Determined by investigation trigger

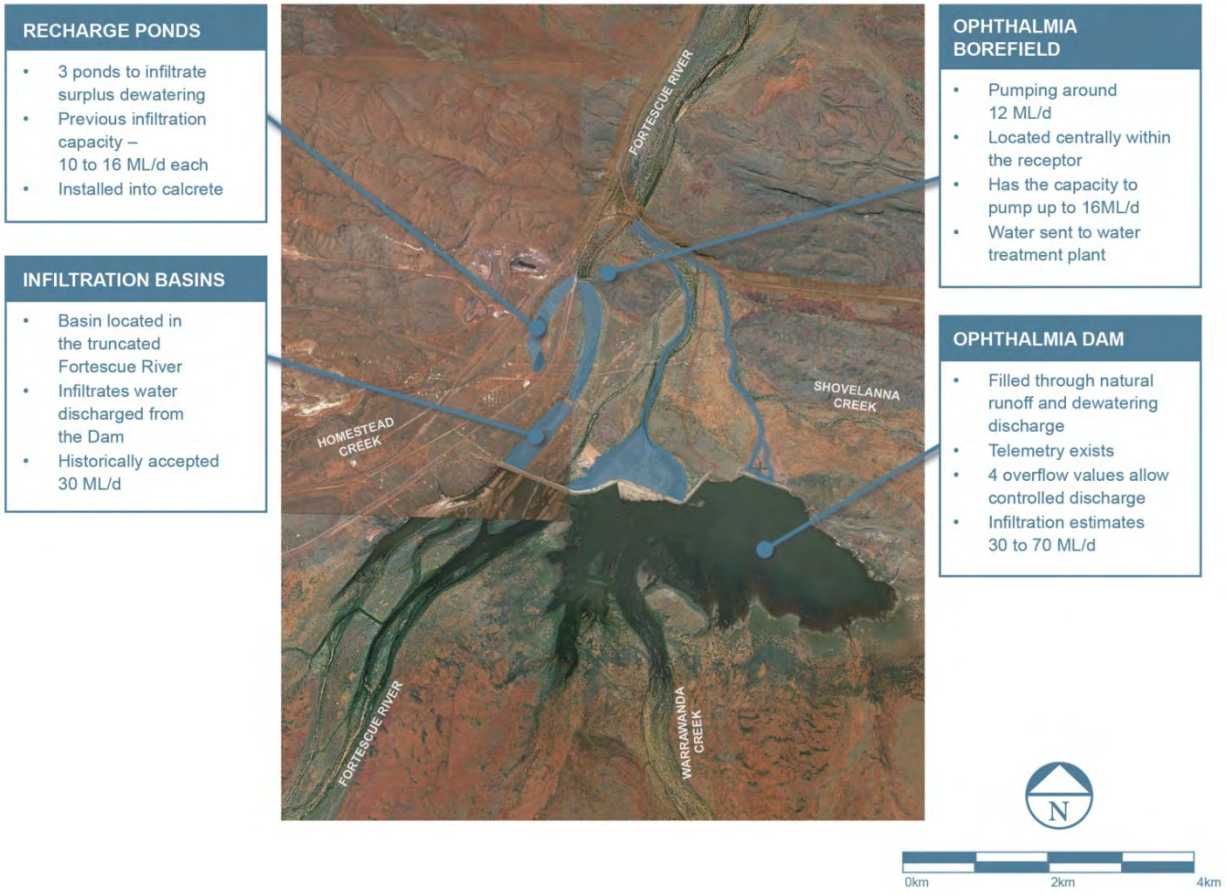
Notes - [1.] Interpreted as the statistically significant aquifer response and change to water level in the Ethel Gorge primary habitat (Monitoring Zone 1 – Figure 6). It is recognised that a localised water level responses greater than the above thresholds may result from localised bore abstraction and these localised responses will not bias the overall thresholds. [2.] Interpreted as the depth to groundwater below ground surface in the vicinity of the riparian creek zone.

6.3. Preventative management and corrective action controls

The range of specific water management options which are currently being used as the primary controls for mitigating water impacts in the Eastern Pilbara are outlined in Figure 7.

- **Ophthalmia Dam Storage and infiltration -** Surplus dewater is discharged and stored into Ophthalmia Dam. Ophthalmia Dam is designed to retard the flow of some surface water from the Fortescue River and enable passive infiltration into the shallow alluvial aquifer which supports Ethel Gorge Stygofauna and the Newman drinking water supply. The controlled release of the dam water via three outlets directs water into the Fortescue River and the down gradient infiltration basins, returning water back into the environment when required and as a preventative control to mitigate the effects of increased salinity or inundation of the rail line.
- **Recharge ponds -** The ponds located within Ethel Gorge receive discharge water from OB25 mine dewatering and enable passive but relatively quick infiltration into the underlying alluvial aquifer through the shallow and permeable calcrete formations. The facility mitigates impacts from changes to water level in Ethel Gorge from mining below the water at OB23 and OB25.
- **Infiltration Basins –** Controlled release of Ophthalmia Dam water into the infiltration basins located immediately in front of the dam. The ponds induce vertical leakage and support water levels and water quality (low salinity) in the Ethel Gorge alluvial aquifer. The basins have historically been effective as a “fast response” tool to increase water levels and lower salinity.
- **Ophthalmia Borefield –** Ophthalmia borefield located within Ethel gorge supports some of the Newman water supply. Controlled abstraction from this facility can control the water levels within the primary Ethel Gorge aquifer. The option of using the borefield enables the mitigating control on elevated water levels in the Ethel Gorge aquifer whilst delivering a protected drinking water supply.
- **Fortescue sesaonal release** – Ophthalmia Dam has been designed to allow for the controlled release of water into the upper Fortescue tributaries, including Shovelanna creek via the eastern dam wall valve. The temporary release of dam water immediately following a wet season (typically December through March) would allow for additional storage capacity during the dry period, particularly when dewatering volumes are predicted to be greater than outflows. Three months of controlled release into the upper Fortescue following the wet season is considered appropriate and unlikely to develop permenent or ponding water downstream in the Fortescue River immediately following a wet season. The seasonal release is unlikely to have an impact on riparian vegetation.

Figure 7: Ethel Gorge preventative management and corrective controls



The application of the management measures and controls are shown in Table 4. These water management options will be used as both operational water management techniques and as preventative or mitigating controls which are carried out as part of adaptive management or mitigation techniques to prevent impact. The application, timeframes and success factors of the control will be determined following investigations and action trigger stages are reviewed.

Table 4: Ethel Gorge Management measures and controls

Method	Process Objective	Application
Capture and release of higher salinity water in Ophthalmia Dam during rain events.	Store surplus dewatering discharge in Ophthalmia Dam during dry seasons (April to November) and practice controlled release of higher salinity water into Fortescue River during the wet seasons – (November to March).	• Requires a rain event which overtops the Dam. • Requires a buffer in Dam for fresh runoff to sufficiently dilute the Dam surplus prior to discharge.
Capture and infiltrate fresh water through the Dam floor to mitigate increased aquifer salinity down gradient.	Capture fresh rainfall runoff into Ophthalmia Dam during wet seasons and periodically release into the infiltration ponds*.	• Requires dewatering surplus to be discharge elsewhere.
Discharge dewatering water into the Dam and mix with captured fresh runoff to dilute before controlled release.	Dilute dewatering surplus water in the dam with fresh runoff. Followed by either passive infiltration or controlled release downstream into the River or infiltration ponds.	• Requires a buffer in Dam for fresh runoff to sufficiently dilute the Dam surplus prior to discharge.
Store and infiltrate dewatering water into the aquifer directly through recharge ponds.	Infiltrate surplus dewatering water through the 3 recharge ponds into the Ethel Gorge aquifer.	• Requires dewatering water salinity to be below Ethel Gorge aquifer threshold salinity.
Maintain sufficient buffer in the Ethel Gorge aquifer to accommodate the infiltration of fresh runoff.	Control upper water levels through the operation of Ophthalmia Borefield to lower levels and encourage fresh (low salinity) infiltration during rain events.	• Abstraction rates limited by potable infrastructure and demand.

7. Jimblebar Creek – Adaptive management

Baseline surveys & hydrological trial are being completed to inform this section.

8. Terminology

adaptive management *n.* planning, organising, leading and controlling an operation in a manner that changes iteratively as new knowledge comes to light.

Baseline Conditions *n.* the hydrological conditions that prevailed before BHP Billiton Iron Ore mining operations commenced, including natural variation.

cumulative impacts *n.* detrimental effects on a receiving receptor from more than one source; for example, two or more BHPBIO mining operations within one water catchment or a combination of BHP Billiton Iron Ore and third-party operations within one water catchment.

Current Conditions *n.* the hydrological conditions that prevail now that BHP Billiton Iron Ore has begun mining operations, including natural variation.

early warning trigger *n.* the point at which water management options must be considered and implemented to avoid potential impact to a receiving receptor; the trigger should operate sufficiently early to allow water management options to be put in place well before the threshold value for the receiving receptor is reached.

Future Conditions *n.* the hydrological conditions that prevail post BHP Billiton Iron Ore operations including transitioning towards mine closure, mine closure final land form and relinquishment.

hub area (hub) *n.* a geographical location within which more than one BHP Billiton Iron Ore mine is operating in sufficient proximity to other BHP Billiton Iron Ore mines to, for example, allow sharing of resources or potentially increase detrimental effects. Hubs are based on tenements rather than on water catchments.

hydrological dependencies *n.* the numerous factors, such as scale, time, interconnectivity, recharge sources, topography and land use, that determine the hydrological characteristics and receiving receptors dependencies on surface water and groundwater.

outcome-based objectives *n.* a covenant setting out the result that will be met to ensure potential impacts on receiving receptors have been mitigated to acceptable levels.

receiving receptors *n.* the water resources, environmental, social and third-party operations that scientific study has shown have the potential to be detrimentally affected by a BHP Billiton Iron Ore mining operation. Environmental receiving receptors potentially include such things as flora and fauna, biodiversity. Social receiving receptors potentially include Indigenous cultural heritage sites and domestic or industrial water bore users. Third-party operations potentially include other mining operations in the vicinity of the BHP Billiton Iron Ore mining operation.

significant hydrological impact *n.* a detrimental change in hydrological condition causing an effect on a receiving receptor that inhibits its ability to continue to function, such as a lowering of the groundwater level outside the natural variation of Baseline Conditions.

third party *n.* a party other than BHP Billiton Iron Ore living or doing business within the area of interest.

third-party operations *n.* mining activities other than those of BHP Billiton Iron Ore occurring within the area of interest.

threshold *n.* a scientifically informed limit, informed by baseline studies, to the amount of hydrological change that a receiving receptor can accommodate before reaching the point at which impact will occur.

transparency *n.* operating with openness, communication, and accountability in such a way that it is easy for others to see what actions are performed and for all observers to have the ability to see what is wrong, to see what the problems are, or to see potential trouble.

water management area *n.* a geographical extent within which all surface water drains to the same point, such as a river, or at which the drained surface water percolates into the groundwater. Water management areas are based on water catchments and are divided one from the other by a ridge, hill or mountain.

water management option *n.* a mitigation activity that is tested and practicable (i.e., known to produce the desired outcome and feasible both technically and economically).

Appendix A Summary of existing operations

Whaleback Hub

The Whaleback operations have historically fluctuated between a water surplus and deficit. Currently Whaleback water supplies are sourced from Eastern Ridge surplus water from dewatering operations (OB25). In the near future OB29 will commence dewatering and the Whaleback Hub will once again become a water balance positive hub whereby excess water will be used onsite for dust suppression and processing, and the remaining surplus will then be transferred to Ophthalmia Dam for storage and infiltration.

The main Whaleback pit is 315m below water table and active dewatering is achieved through in pit pumping bores.

Mining of Orebodies 29, 30 and 35 below water table will commence in FY2015. Approval from the EPA has been granted for the below water table mining of these Orebodies and for disposal of surplus dewater into Ophthalmia Dam.

Operations / Activity	Pathway	Receptor	Threat	Controls
Mining below water table	Drawdown (local)	Homestead potable borefield Priority 1 - Newman Drinking Water Source Protection Area	Potential threat to Eastern Pilbara Potable Drinking Water	• Abstraction rates controlled via 5C Licence, Groundwater Operating Strategy. • Drinking Water Quality Management Plan • Source Protection Plans • PEAHR
Mining below water table	Drawdown (regional)	Ethel Gorge	Modelling shows that mining operations at Whaleback Hub do not extend to the Ethel Gorge TEC buffer (Ref, 2013).	N/a
Mining below water table	Water Discharge		Potential threat to the receiving environment of Ophthalmia Dam	• Ministerial Statement 963 allows discharge of up to 8GL/year to Ophthalmia Dam from OB29/30/35 BWT mining. • Discharge locations, volumes and quality are controlled under DER Licence 4503/1975/14.
Surface water management / diversion	Water Discharge - Quality	Whaleback Creek	Quality of water from Whaleback Hub operations impacts the environment of Whaleback Creek.	• Water of low pH is directed to the on-site ARD Facility. • Discharge locations, volumes and quality are controlled under DER Licence 4503/1975/14. • Monitoring of creek water quality is required. • No further action required.

Eastern Ridge Hub

BHP Billiton Iron Ore Eastern Ridge and Whaleback water management and supply activities are connected. BHP Billiton Iron Ore operates three deposits as part of the Eastern Ridge Hub, OB23, OB25 and OB24. Of these, OB23 is approaching closure and is not actively being mined. OB25 pit 1 and pit 3 is being actively mined below water table. OB24 is being actively mined above water table and is planned to mine below water table within the next 5 years.

Eastern Ridge mines are net water positive owing largely to OB25 pit 3 dewatering requirements. Surplus water from Eastern Ridge Hub operations is either directed to Whaleback, for use in processing, or discharged to Ophthalmia Dam and the surrounding infiltration ponds. BHP Billiton Iron Ore has a Licence to Operate which approves discharge of surplus dewatering water into Ophthalmia Dam. Importantly, the Dam and surrounding ponds serve as both a discharge point for surplus water management and also as a mitigating control on impact by increasing recharge to the underlying aquifer and Ethel Gorge which support the Stygobionts.

The ER operations are directly adjacent to the Ethel Gorge TEC and are located within the TEC buffer. Approvals applications address the potential for impact to the Ethel Gorge TEC.

Operations / Activity	Pathway	Receptor	Threat	Assessment	Controls
Mining below water table (OB23 and OB25)	Drawdown (local)	Ethel Gorge	Local groundwater drawdown impacts health of Ethel Gorge TEC.		• Abstraction rates controlled via 5C Licence, Groundwater Operating Licence. • Ministerial Statement 712 – requiring monitoring of the Ethel Gorge TEC. Note: Water levels of Ethel Gorge have been maintained via Ophthalmia Dam acting as an MAR scheme, which supports groundwater levels.
		Homestead Creek	Local groundwater drawdown impacts tree health quality of groundwater dependant vegetation.		• Ministerial Statement 712. Monitoring required. Remedial action plan in place should a decline in tree health be observed.
Mining below water table (OB23 & OB25)	Drawdown (regional)	Ethel Gorge	Regional groundwater drawdown impacts health of Ethel Gorge TEC.	Monitoring and modelling shows that mining operations at Eastern Ridge Hub have not resulted in impact to groundwater levels within the area of the Ethel Gorge TEC (Ophthalmia TAR, 2014).	As for local drawdown.
Mining below water table (OB25)	Surplus Water Discharge		Potential threat to the receiving environment of Ophthalmia Dam		• Ministerial Statement 712 allows discharge of up to 13.87GL/year to Ophthalmia Dam from Eastern Ridge (OB25) mining operations. • Discharge locations, volumes and quality are controlled under DER Licence 6942/1997/12.
Surface water management	Water Discharge	Homestead Creek	Quality of water from Eastern Ridge Hub operations has the potential to impact the environment of Homestead Creek.		• Discharge locations, volumes and quality are controlled under DER Licence 6942/1997/12. Monitoring of creek water quality is required. No further action required.

Jimblebar Hub

The Wheelarra Hill (Jimblebar) Mine Site involves open pit mining of iron ore from the Wheelarra Hill and Hashimoto deposits and the South Jimblebar deposits. Mine dewatering associated with below watertable mining at the following pits:

- Wheelarra Hill (W1/2, W3 East, W5/6 pit extensions);
- South Jimblebar (JS West, JS Central, JS East); and
- Hashimoto (H1 West, H1 East; H2; H3; and H4).

Active dewatering and pumping is only occurring in the vicinity of the South Jimblebar operations. Abstracted groundwater is used for mining operational activities and camp and potable supplies. A hydrodynamic trial has been operating for 2 years to understand the groundwater system and surplus water management options locally and furthermore test multiple water management concepts which meet sustainability objectives and which may be applicable and transferable elsewhere in the Pilbara. As part of the hydrodynamic trial, surplus water is discharged to Jimblebar and Copper Creeks. This was undertaken to investigate the potential impacts of groundwater discharge to the creek. Discharge is controlled to prevent the wetting front from extending to within 500 m of Innawally Pool.

Orebody 18

BHP Billiton Iron Ore is currently planning the development of additional pits, being Orebody 17 and Orebody 31, to the east of the existing operations.

The water balance for the OB18 area is currently water balance negative and process water is sourced from standalone water supply production bores. In the midterm from 2018 onwards, dewatering from the proposed OB31 mine is likely to generate a period of surplus water and some sub regional groundwater drawdown.

Proposed Orebody 31

Operations / Activity	Pathway	Receptor	Threat	Assessment	Controls
Mining below water table (OB31)	Drawdown (local)	GDV	Local groundwater drawdown impact tree health quality of groundwater dependant vegetation.	No GDVs have been mapped within the groundwater drawdown zone, as such no impact is expected to GDV health.	N/a
Mining below water table (OB31)	Drawdown (regional)	Ethel Gorge		Predicted modelling (conservative) shows that drawdown resulting from mining operations at OB18 Hub, including OB31, will extend slightly into the Ethel Gorge TEC buffer, with drawdown predicted to be less than 2m at this location. Assessments have determined this is unlikely to have any impact on the conservation value of the TEC (Bennelongia 2014b).	N/a
Mining below water table (OB31)	Surplus Water Discharge	Ophthalmia Dam	Potential threat to the receiving environment of Ophthalmia Dam		• Ministerial Statement XXX (TBA) allows discharge of up to XGL/year (TBA) to Ophthalmia Dam from OB31 mining operations. • Discharge locations, volumes and quality are controlled under DER Licence XXX (TBA).
		Jimblebar Creek	Potential threat to the receiving environment of Jimblebar Creek.		• Ministerial Statement XXX (TBA) allows discharge of up to XGL/year (TBA) to Jimblebar Creek from OB31 mining operations. • Discharge locations, volumes and quality are controlled under DER Licence XXX (TBA).
			Quality of water from OB31 operations impacts the environment of Jimblebar Creek or its tributaries.		• Discharge locations, volumes and quality are controlled under DER Licence XXX. Monitoring of creek water quality is required.

Appendix B A description of the Receptors of importance

Ethel Gorge Threatened Ecological Community

Hydrological baseline conditions

Based on hydrological investigations it is known that the Groundwater Baseline Condition at Ethel Gorge ranges from 0 to 10mbgl, depending on both the local topography and seasonal factors. This range is reflective of the significant recharge events following relatively wet periods during the summer months. Further data supporting these statements is provided in OB31 Hydrogeological Impact Assessment, BHP Billiton Iron Ore, 2015.

Moreover, such a range in water levels maintains a substantial saturated thickness in the upper alluvial aquifer (including the Calcretes) and provides a consistent habitat for stygofauna (OB18 Hydrogeological Impact Assessment, January 2015). The area of the Ethel Gorge TEC coincides with both areas of shallow groundwater and the deposit of subsurface Calcretes.

Ethel Gorge is an important feature of the Eastern Pilbara hydrological system, as the surface and groundwater flows from the entire upstream catchment area, is general directed into Ethel Gorge. From a landscape context, the Ethel Gorge area can be characterised as a receiving environment, comprising channels, flood plains and calcretes of the river and calcrete land systems. Typical of receiving landscapes, the Ethel Gorge area is characterised by groundwater levels of less than 10m below ground level (mbgl) which gives rise to potential interactions between the groundwater and terrestrial environments (through surface water connection and vegetation).

Ophthalmia Dam, some 5km upstream of Ethel Gorge, acts as a MAR and has an important influence on the resulting hydrological condition.

Based on the hydrological assessment it is known that hydrological changes at Ophthalmia Dam could result in changes at Ethel Gorge.

Significant receptor values

Ecological understanding

The Ethel Gorge Aquifer Stygobiont Community (53 species of stygofauna including Chydaekata amphidops) has been identified by Department of Environment and Conservation (DEC) now Department of Parks and Wildlife (DPaW) as a Threatened Ecological Community (TEC) due to high biodiversity values and conservation significance. The stygofauna include locally endemic and undescribed species (EPA, 1998). The Ethel Gorge TEC has a high species richness and diversity of stygofauna communities. The Ethel Gorge TEC hosts five stygofauna species declared as Specially Protected (Threatened) fauna under the *Wildlife Conservation Act 1950* (EPA, 1998).

The Ethel Gorge TEC is hosted in shallow alluvial aquifers (notably calcrete) and their habitat is maintained by saturation of these aquifers.

Hydrological Dependency

The Ethel Gorge TEC has a strong groundwater hydrological dependency that provides saturated pore spaces in which stygofauna live. The calcrete provides a primary habit for stygofauna (OB31 Hydrogeological Impact Assessment, BHP Billiton Iron Ore, 2015).

Assessment of potential impacts

Potential impacts

The BHP Billiton Iron Ore mining activities which have the potential to change the hydrological condition of the Ethel Gorge TEC environment have been identified as: mine dewatering, groundwater extraction, mine pit salinisation and surplus water discharge.

Within 10km of Ethel Gorge are BHP Billiton Iron Ore mining operations Orebody 23, 24 and 25. The mineralized Band Iron Formation (BIF) aquifer is dewatered at these mines to provide access to the ore. Operational dewatering results in localised water table drawdown and reduced through-flow in the Ethel Gorge Aquifer south east of pits (Groundwater levels in some monitoring bores fall at 5m per year, although recover to pre-mining levels following cyclones.

More specifically threats from current operations include:

Aspect	Site/s	Operations / Activities	Threat	Control
Drawdown (local)	Eastern Ridge Operations (Orebody 23 and 25)	Mining below water table close to Ethel Gorge TEC	Orebody 25 is mining below water table, dewatering is required to undertake these operations, which may result in some localised groundwater drawdown.	Managed under Ministerial Statement 478 (Eastern Ridge) Abstraction rates are controlled via 5C Licences (OB25 Pit 1) GWL158381(5), (OB25 Pit 3) GWL160437(5), (OB23) GWL74556(9)
Water Discharge - Volume	Eastern Ridge operations (Orebody 23,24 & 25) Orebody 29, 30 & 35 operations Not yet commenced: Jimblebar operations (to Ophthalmia), Proposed Orebody 31 operations	The total volume of approved discharges in accordance with Ministerial Statements. Currently, limited surplus water is being discharged into Ophthalmia Dam, as the majority of Eastern Ridge surplus water is directed to Mount Whaleback for operational use and below water table mining / dewatering at Orebodies 29/30/35 and Jimblebar discharge to Ophthalmia Dam has not yet commenced.	Increased dewatering volumes have the potential to raise groundwater levels in Ethel Gorge aquifer resulting in the inundation of the vegetation rooting zone in the Fortescue River system.	As above for Ministerial Statements.
Water Discharge - Quality			There is the potential that disposal of surplus water into Ophthalmia Dam will increase the TDS of the Dam and aquifer which is the habitat of the Ethel Gorge stygobiont community.	Eastern Ridge operations are managed under DER Licences: L6942/1997/12 Orebody 29/30/35. Orebody 31 Project has not yet been approved for commencement.

No significant physical changes to the environment of the Ethel Gorge TEC are proposed at this stage.

As noted above, there are currently controls in place under existing approvals to managed the potential impacts to Ethel Gorge from BHP Billiton Iron Ore existing operations.

Relevant 5C licences and DER Licence will be sought for new projects.

Assessment of potential impacts on the Ethel Gorge TEC

The potential impacts to ecological communities in the vicinity of the Ethel Gorge TEC resulting from BHP Billiton Iron Ore Eastern Pilbara Hubs are predicted to be insignificant owing to:

- Drawdown is localised and most of the aquifer is unaffected.
- To date, potential significant environmental impacts have been counteracted as a result of the Ophthalmia Dam MAR, which has artificially sustained the hydrological baseline conditions.
- Intermittent recharge events during cyclones and rainfall.

Based on the hydrological assessment it is known that hydrological changes at Ophthalmia Dam could result in changes at Ethel Gorge. To date, potential significant environmental impacts have been counteracted as a result of the Ophthalmia Dam MAR, which has artificially sustained the hydrological baseline condition at Ethel Gorge.

Jimblebar Creek – Adaptive management

Hydrological baseline conditions

Baseline surveys and hydrological trial is underway and this section will be updated at a later stage once information is available.

Protect values – Ecological values of the Jimblebar Creek

Ecological understanding

No formal protection.

Baseline surveys underway to inform this section.

Hydrological dependency

No formal protection.

Baseline surveys and hydrological trial underway to inform this section.

Hydrological change

Hydrological trial underway to inform this section

Key considerations

Potential impacts

The BHP Billiton Iron Ore mining activities which have the potential to change the hydrological condition of the Jimblebar Creek environment (north of Innawally Pool) have been identified as surplus water discharge.

More specifically, threats from discharge of surplus water include:

- Baseline surveys and hydrological trial underway to inform this section.

Assessment of potential impacts on the Jimblebar Creek

Baseline surveys and hydrological trial underway to inform this section.