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Notes: Pre-mitigation groundwater changes

BHP Billiton Iron Ore assessment based on:
- Analytical assessment
- No recharge
- No groundwater recovery after closure, pits remain open after closure
- No infiltration from Ophthalmia Dam
- No irrigation at Weeli Wolli Springs

Third Parties assessment based on:
- Davidson Creek (only 10m drawdown contour provided)
- Most of Loosewater, Iron Valley and Lamb Creek are above the water table
- Drawdown extents for third parties obtained from public documents
- The drawdown extent at Hope Downs 1 was based on the Central Pilbara Groundwater Study (Johnson and Wright, 2001)
- No groundwater recovery after closure

Data Sources:
- DPaw Reserves (DPaw 2015); Roads (MRWA 2012)
- Aerial Image (BHP Billiton); Third Party Disturbance digitised from Aerial imagery (Aug - Sept 2013) and Approval Documentations up to September 2014.
- All other data supplied by BHP Billiton (2012); Yandicoogina mining area comprises Junction Central, Junction South East, Junction South West and the proposed Oxbow, Pocket and Billiard South mining areas

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Pre-Mitigation Case

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Data Sources:
- DPaW Reserves (DPaW 2015)
- Roads (MRWA 2012) Aerial Image (BHPBIO)
- Third Party Disturbance digitised from Aerial imagery (Aug - Sept 2013) and Approval Documentations up to September 2014
- All other data supplied by BHPBIO (2012)
- Yandicoogina mining area comprises Junction Central, Junction South East, Junction South West and the proposed Oxbow, Pocket and Billiard South mining areas

Notes:
- Pre-mitigation groundwater changes
- The map shows the potential for ecohydrological change based on two datasets
  1. Groundwater drawdown extent Map#20
  2. Ecohydrological sensitivity to groundwater change Map#09
- Infiltration from Ophthalmia Dam not considered in analysis hence drawdown extent at Ethel Gorge is overestimated
- Irrigation along Weeli Wolli Spring not considered in analysis hence drawdown extent at Weeli Wolli Spring is overestimated

Ecohydrological change assessment

Ecohydrological Change Potential - Groundwater Drawdown Cumulative - Existing Development

Legend:
- Ecohydrology Study Boundary
- BHPBIO Mining Areas
- BHP Billiton Iron Ore Existing Disturbance
- Third Party Mining Areas
- Third Party Existing Disturbance
- Ophthalmia Dam
- Third Party Rail Corridor
- Drawdown Potential
- Ecological Receptors
- Great Northern Highway
- Moderate: Small potential for change to the ecological receptor condition
- Townships
- High: Potential for change to the ecological receptor condition
- Other Roads

Drawdown Ecohydrological Change Potential

- No or unmeasurable groundwater risk
- Based on depth to groundwater
- Interception
- No
- Low: 0 - 30 m bgl
- Moderate: 30 - 100 m bgl
- High: > 100 m bgl
**Pre-Mitigation Case**

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**Ecohydrological Change Assessment**

**Ecohydrological Change Potential - Groundwater Drawdown**

BHP Billiton Iron Ore - 30% Development Scenario

Notes:

The map shows the potential for ecohydrological change based on two datasets:

1. Groundwater drawdown extent Map21
2. Ecohydrological sensitivity to groundwater change Map29

Infiltration from Ophthalmia Dam not considered in analysis, hence drawdown extent at Ethel Gorge is overestimated.

Irrigation along Weeli Wolli Spring not considered in analysis, hence drawdown extent at Weeli Wolli Spring is overestimated.

**Data Sources:**

- DPaw Reserves (DPaw 2015)
- Roads (MRWA 2012)
- Aerial Image (BHPBIO)
- Third Party Disturbance digitised from Aerial imagery (Aug - Sept 2013) and Approval Documentations up to September 2014
- All other data supplied by BHPBIO (2012)

Yandicoogina mining area comprises Junction Central, Junction South East, Junction South West and the proposed Oxbow, Pocket and Billiard South mining areas.

**Locality:**

- Karijini National Park
- Ophthalmia Dam
- Great Northern Highway
- Other Roads
- Townships
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The context of this map is conceptual only, of a general nature and does not purport to contain all information relevant to future project development associated with the Project. This map has been prepared solely for the purposes of informing environmental impact assessment pursuant to the Environmental Protection Act 1986 (WA) and Environment Protection and Biodiversity Conservation Act 1999 and is not intended for use for any other purpose. No representation or warranty is given that project development associated with any or all of the data sources indicated on this map will actually proceed. As project development is dependent upon future events, the outcome of which is uncertain and cannot be assured, actual development may vary materially from this conceptual map.
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Pre-Mitigation Case

The map shows the potential for ecohydrological change based on two datasets:
1. Groundwater drawdown extent Map#22
2. Ecohydrological sensitivity to groundwater change Map#09

Infiltration from Ophthalmia Dam not considered in analysis hence drawdown extent at Ethel Gorge is overestimated.
Irrigation along Weeli Wolli Spring not considered in analysis hence drawdown extent at Weeli Wolli Spring is overestimated.

Notes:
- Pre-mitigation groundwater changes
- The map shows the potential for ecohydrological change based on two datasets
- Groundwater drawdown extent Map#22
- Ecohydrological sensitivity to groundwater change Map#09
- Infiltration from Ophthalmia Dam not considered in analysis hence drawdown extent at Ethel Gorge is overestimated
- Irrigation along Weeli Wolli Spring not considered in analysis hence drawdown extent at Weeli Wolli Spring is overestimated.

No or unmeasurable groundwater risk
Interception
Low: No change to the natural ecological receptor condition
Moderate: Small potential for change to the ecological receptor condition
High: Potential for change to the ecological receptor condition

Data Sources:
- DPaW Reserves (DPaW 2015)
- Roads (MRWA 2012)
- Aerial Image (BHPBIO)
- Third Party Disturbance digitised from Aerial imagery (Aug - Sept 2013) and Approval Documentations up to September 2014
- All other data supplied by BHPBIO (2012)
- Yandicoogina mining area comprises Junction Central, Junction South East, Junction South West and the proposed Oxbow, Pocket and Billiard South mining areas.
The content of this map is conceptual only, of a general nature and does not purport to contain all information relevant to future project development associated with the Project. This map has been compiled solely for the purposes of informing environmental impact assessment pursuant to the Environmental Protection Act 1986 (WA) and Environment Protection and Biodiversity Conservation Act 1999 and is not intended for use for any other purpose. No representation or warranty is given that Project development associated with any or all of the disturbance indicated on this map will actually proceed. As Project development is dependent upon future events, the outcome of which is uncertain and cannot be assured, actual development may vary materially from this conceptual map.

Notes:
1. Pre-mitigation groundwater changes
   - The map shows the potential for ecohydrological change based on two datasets
     1) Groundwater drawdown extent MapK22
     2) Ecohydrological sensitivity to groundwater change MapK9

   Infiltration from Ophthalmia Dam not considered in analysis hence drawdown extent at Ethel Gorge is overestimated
   Irrigation along Weeli Wolli Spring not considered in analysis hence drawdown extent at Weeli Wolli Spring is overestimated

Data Sources:
- DPW Reserves (DPW 2015)
- Roads (MRWA 2012) Aerial Image (BHPBIO)
- Third Party Disturbance digitised from Aerial imagery (Aug - Sept 2013) and Approval Documentations up to September 2014
- All other data supplied by BHPBIO (2012)
- Yandicoogina mining area comprises Junction Central, Junction South East, Junction South West and the proposed Oxbow, Pocket and Billiard South mining areas
The map shows the potential stygofauna habitat and the portion of the habitat that might be subjected to groundwater drawdown. Stygofauna abundance is higher in areas with a shallow depth to groundwater (<10m associated with EHUs 7, 8 and 9) and lower in areas with deep groundwater levels (>30m associated with EHUs 1, 2, 3 and 4). Areas with a medium depth to groundwater levels (10-30m associated with EHUs 5 and 6) are assumed to have a moderate stygofauna abundance. The potential stygofauna habitat that might be subjected to >1m groundwater drawdown are shown as hashed brown areas. Stygofauna communities are resilient to changes in groundwater levels and the affected stygofauna habitat is therefore considered conservative.

The high stygofauna abundance rating for saline groundwater systems (e.g. aquifers underneath the Fortescue Valley) has been retained in accordance to the precautionary principle because of a lack of knowledge of stygofauna communities in saline groundwater environments. The high stygofauna abundance rating for saline groundwater systems is considered by the authors to be fit for its intended purpose at the time of publication.

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Pre-Mitigation Case

LEGEND

- Ecological Study Boundary
- Kajiri National Park
- Ecological Receptions
- Ophthalmia Dam
- Townships
- BHPBIO Mining Areas
  - (current & proposed)
- Third Party Mining Areas
  - (current & proposed)
- BHPBIO Rail Corridor
- Third Party Rail Corridor
- Projects
- WEELI WOLLI CREEK
- Fortescue Valley claypans of the Freshwater
- WEELI WOLLI зимок

Stygofauna Abundance: BHPBIO Survey
- 0 (15)
- 10 to 50 (209)
- 66 to 500 (10)
- 21 to 65 (16)
- 1 to 20 (4)
- 26 to 50 (26)
- 0 (1)

Stygofauna Abundance: Pilbara Bio-diversity Survey
- 0 (15)
- 10 to 50 (209)
- 66 to 500 (10)
- 21 to 65 (16)
- 1 to 20 (4)
- 26 to 50 (26)
- 0 (1)

Note: Pre-mitigation groundwater changes:

The potential stygofauna habitat that might be subjected to groundwater drawdown are shown as hashed brown areas. Stygofauna communities are resilient to changes in groundwater levels and the potential stygofauna habitat is therefore considered conservative.

Source:
Halse et al., 2014

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The map shows the potential stygofauna habitat and the portion of the habitat that might be subjected to groundwater drawdown. Stygofauna abundance is higher in areas with a shallow depth to groundwater (<1m associated with EHUs 7, 8 and 9) and lower in areas with deep groundwater levels (>30m associated with EHUs 1, 2, 3 and 4). Areas with a medium depth to groundwater levels (10m associated with EHUs 1, 2, 3 and 4) are assumed to have a moderate stygofauna abundance. The map shows the potential stygofauna habitat that might be subjected to >1m groundwater drawdown are shown as hashed brown areas. Stygofauna communities are resilient to changes in groundwater levels and the potential stygofauna habitat that might be subjected to >1m groundwater drawdown are shown as hashed brown areas. Stygofauna communities are resilient to changes in groundwater levels and the affected stygofauna habitat is therefore considered conservative.

Notes: Pre-mitigation groundwater changes:

- Pre-Mitigation Case
- Full Development Scenario BHP Billiton Iron Ore & Third Party
- Potential Stygofauna Habitat affected by Groundwater Drawdown >1m
- Drawdown information not available
- Third Party Reasonability Foreseeable Disturbance
- Stygofauna Habitat Change Potential

LEGEND

- Great Northern Highway
- Clever Roads
- BHP Billiton Iron Ore Disturbance Full Development Scenario
- Full Development Scenario BHP Billiton Iron Ore & Third Party Stygofauna Habitat Change Potential
- Potential Stygofauna Habitat affected by Groundwater Drawdown >1m
- Light blue: low stygofauna abundance
- Moderate blue: moderate stygofauna abundance
- Dark blue: high stygofauna abundance
- Stygofauna Abundance: BHPBIO Survey
- Stygofauna Abundance: Pilbara
- Stygofauna Abundance: Pilbara (current & proposed)

The high stygofauna abundance rating for saline groundwater systems (e.g. aquifers underneath the Fortescue Valley) has been retained in accordance to the precautionary principle because of a lack of knowledge of stygofauna communities in saline groundwater environments. The potential stygofauna habitat that might be subjected to <1m groundwater drawdown are shown as hatched brown areas. Stygofauna communities are resilient to changes in groundwater levels and the affected stygofauna habitat is therefore considered conservative.

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