

Pre-Mitigation Case

Liability
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Data Sources
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LEGEND

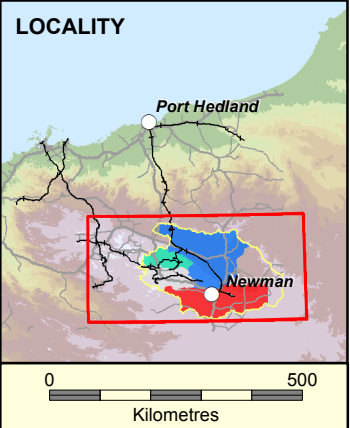
- Ecohydrology Study Boundary
- Karijini National Park
- Ecohydrological Receptors
- Ophthalmia Dam
- Townships
- BHPBIO Mining Areas (current & proposed)
- Third Party Mining Areas (current & proposed)
- BHP Billiton Iron Ore Disturbance 30% Development Scenario
- Third Party Reasonably Foreseeable Disturbance
- Drawdown information not available
- Groundwater Drawdown >1m
- 30% Development Scenario BHP Billiton Iron Ore & Third Party
- BHPBIO Rail Corridor (current & proposed)
- Third Party Rail Corridor (current)
- Great Northern Highway
- Other Roads

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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 Wollie Springs

Third Parties assessment based on:
Davidson Creek (only 10m drawdown contour provided)
Most of Koodaideri, 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



Resource Planning Hydrology
BHP BILLITON IRON ORE

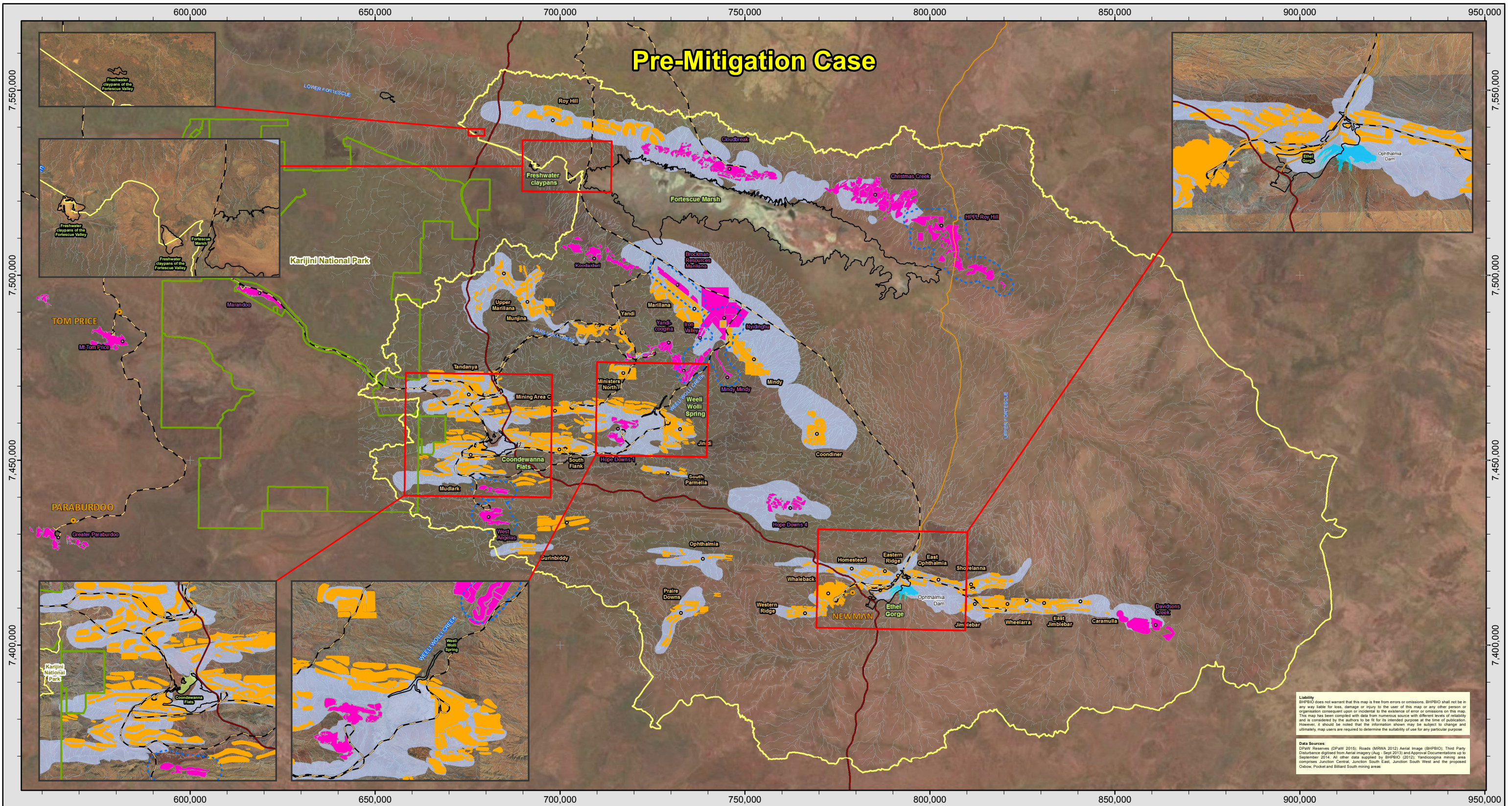
resourcing the future

ECOHYDROLOGICAL CHANGE ASSESSMENT
Groundwater Change
Cumulative - 30% Development Scenario

0 10 20 40 60
Kilometres

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

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev K
Date: 15/04/2015	Checked: J Vermaak	Map: 21
	Reviewed: J Youngs	



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LEGEND

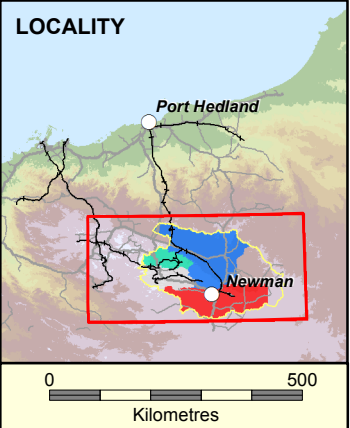
- Ecohydrology Study Boundary
- Karijini National Park
- Ecohydrological Receptors
- Ophthalmia Dam
- Townships
- BHPBIO Mining Areas (current & proposed)
- Third Party Mining Areas (current & proposed)
- BHPBIO Rail Corridor (current & proposed)
- Great Northern Highway
- Other Roads
- BHP Billiton Iron Ore Disturbance Full Development Scenario
- Third Party Reasonably Foreseeable Disturbance
- Drawdown information not available
- Groundwater Drawdown >1m
- Full Development Scenario BHP Billiton Iron Ore & Third Party

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 No groundwater recovery after closure



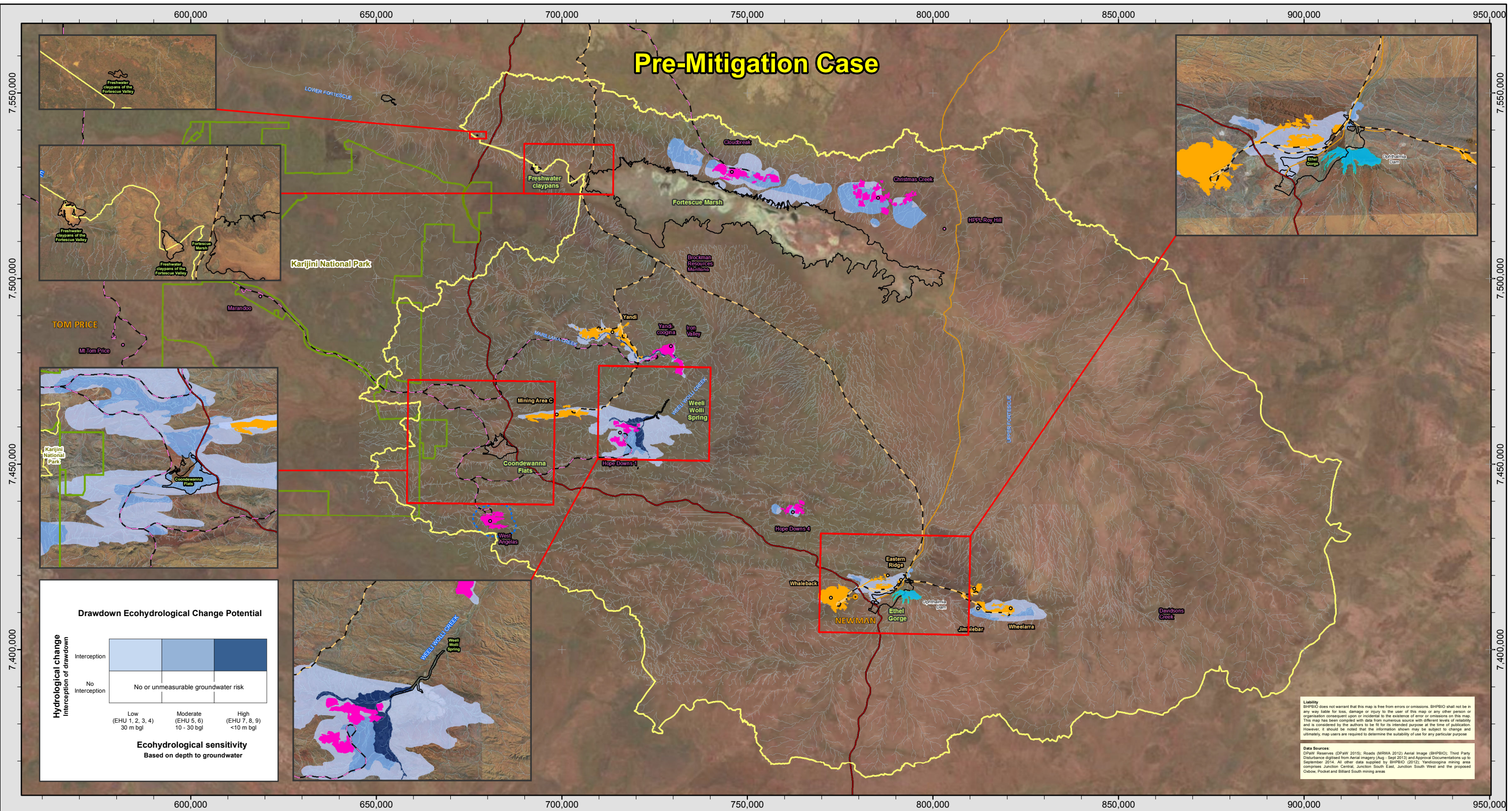
Resource Planning Hydrology
 BHP BILLITON IRON ORE

ECOHYDROLOGICAL CHANGE ASSESSMENT
 Groundwater Change
 Cumulative - Full Development Scenario

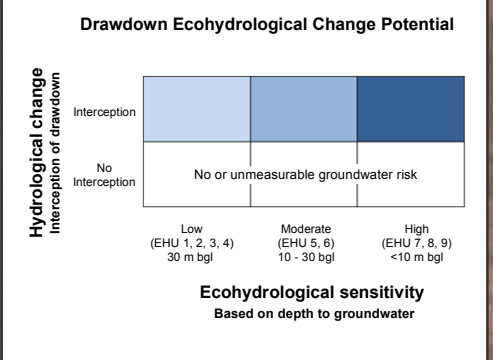
0 10 20 40 60
 Kilometres
 Coordinate System: GDA 1994 MGA Zone 50
 Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev K
Date: 15/04/2015	Checked: J Vermaak	Map: 22
	Reviewed: J Youngs	

GW Change



Pre-Mitigation Case



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LEGEND

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- Ophthalmia Dam
- Ecohydrological Receptors
- Townships
- BHPBIO Mining Areas
- Third Party Mining Areas
- BHPBIO Rail Corridor
- Third Party Rail Corridor
- Great Northern Highway
- Other Roads
- BHP Billiton Iron Ore Existing Disturbance
- Third Party Existing Disturbance
- Drawdown Potential
- 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

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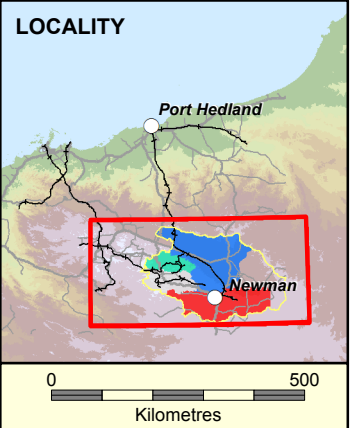
Notes: Pre-mitigation groundwater changes

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

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Irrigation along Weeli Wollie Spring not considered in analysis hence drawdown extent at Weeli Wollie Spring is overestimated



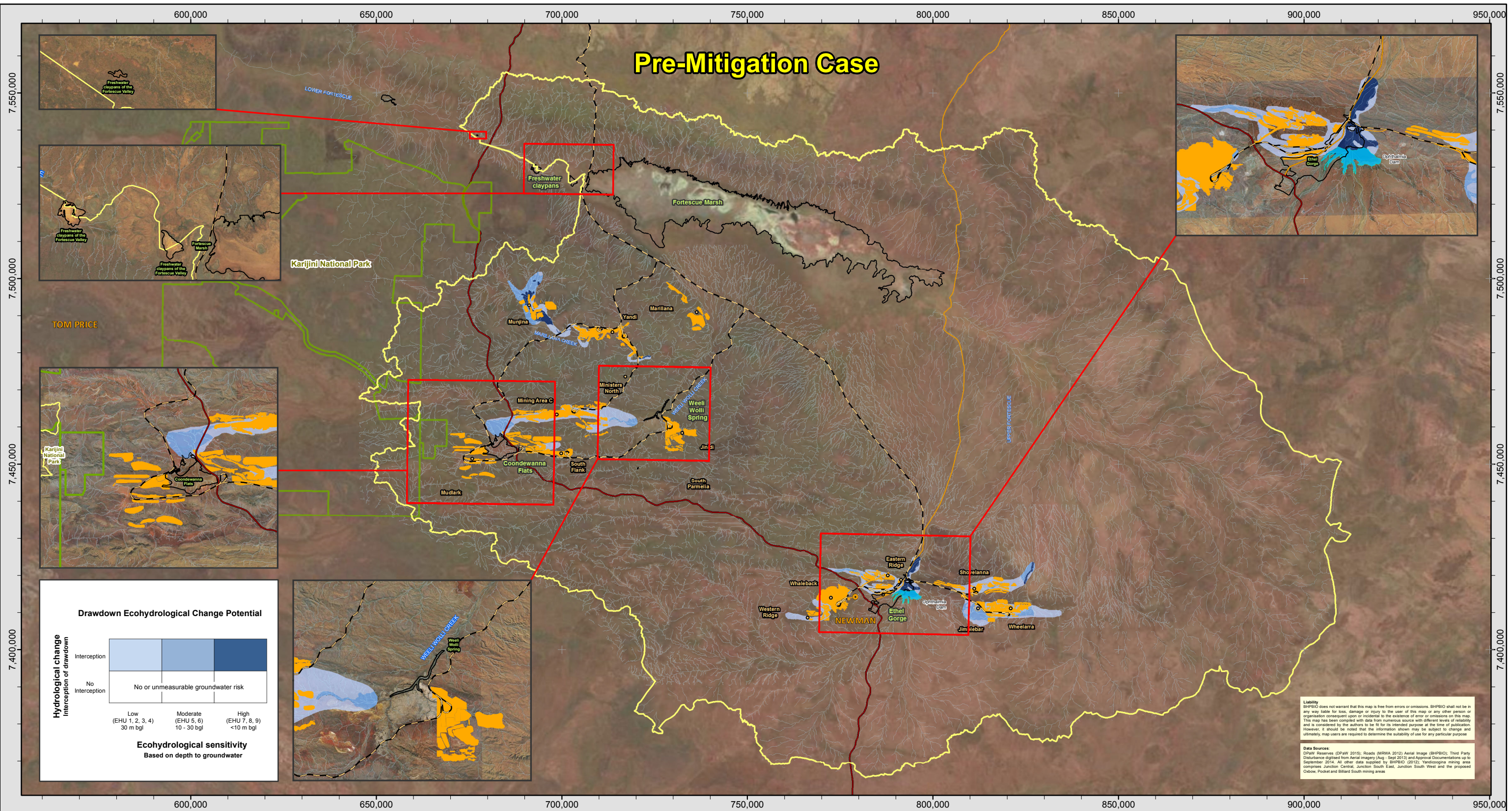
Resource Planning Hydrology
BHP BILLITON IRON ORE

ECOHYDROLOGICAL CHANGE ASSESSMENT
Ecohydrological Change Potential - Groundwater Drawdown Cumulative - Existing Development

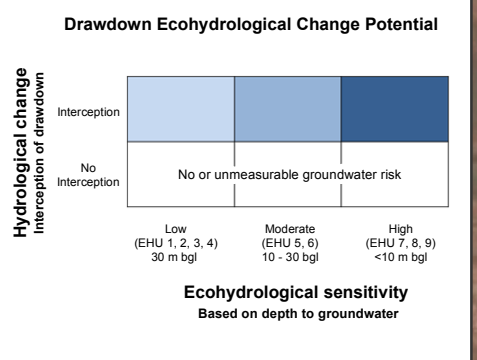
Scale @ A3: 1:1,000,000
Date: 16/04/2015

Prepared: J Botterill
Checked: J Vermaak
Reviewed: J Youngs

Revision: Rev K
Map: 23



Pre-Mitigation Case



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LEGEND

- Ecohydrology Study Boundary
- Karijini National Park
- Ophthalmia Dam
- Ecohydrological Receptors
- Townships
- BHPBIO Mining Areas (current & proposed)
- BHPBIO Rail Corridor (current & proposed)
- Great Northern Highway
- Other Roads
- BHP Billiton Iron Ore Disturbance 30% Development Scenario
- Drawdown Potential
 - 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

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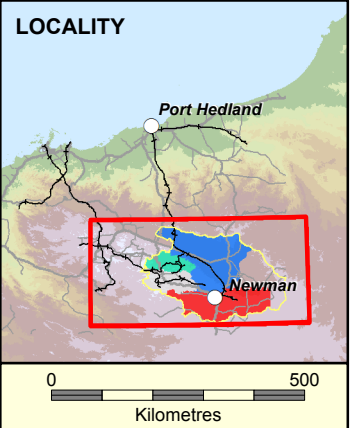
Notes: Pre-mitigation groundwater changes

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

- 1) Groundwater drawdown extent Map#21
- 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 Wollie Spring not considered in analysis hence drawdown extent at Weeli Wollie Spring is overestimated



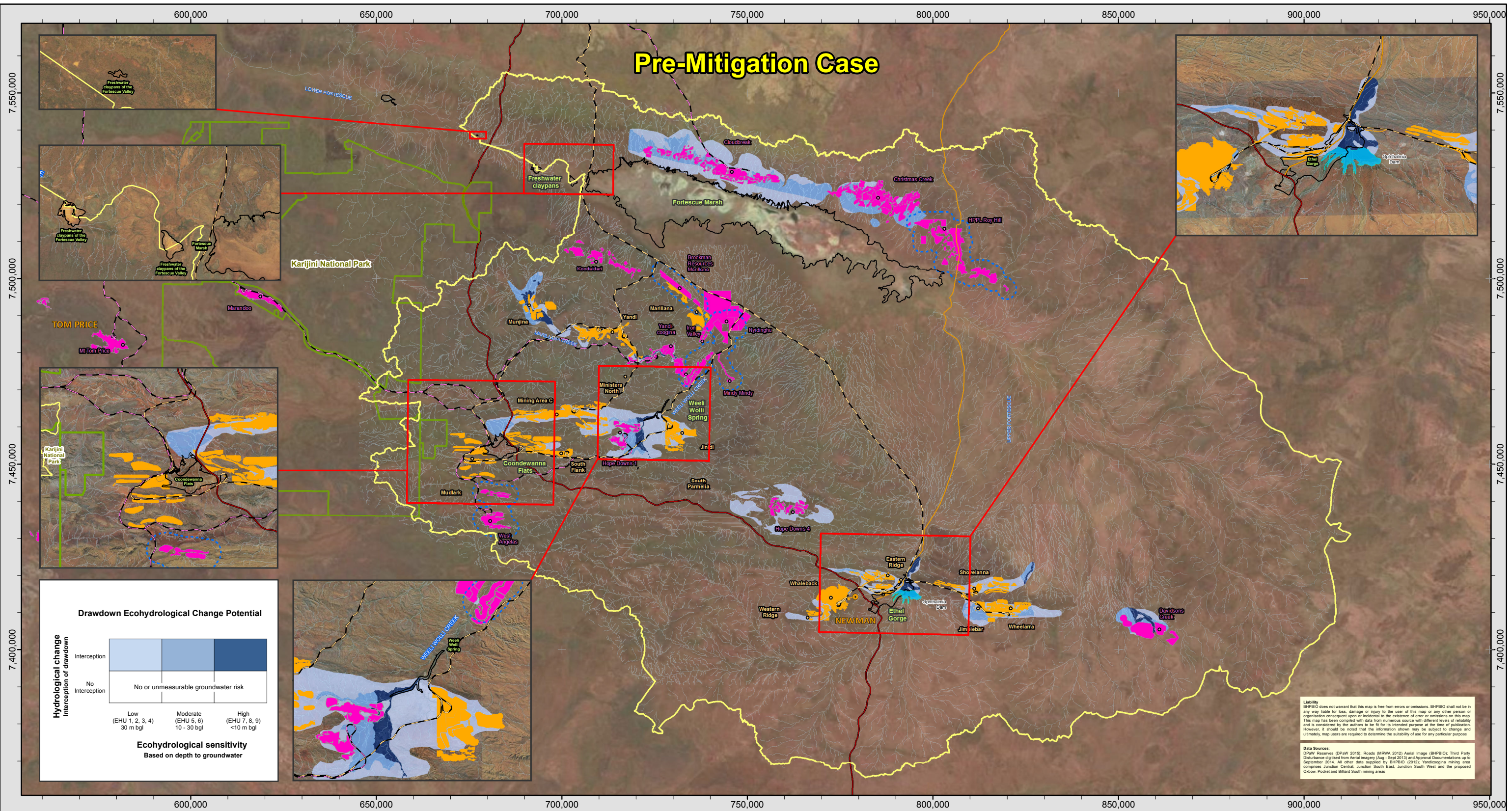
Resource Planning Hydrology
BHP BILLITON IRON ORE

ECOHYDROLOGICAL CHANGE ASSESSMENT
Ecohydrological Change Potential - Groundwater Drawdown
BHP Billiton Iron Ore - 30% Development Scenario

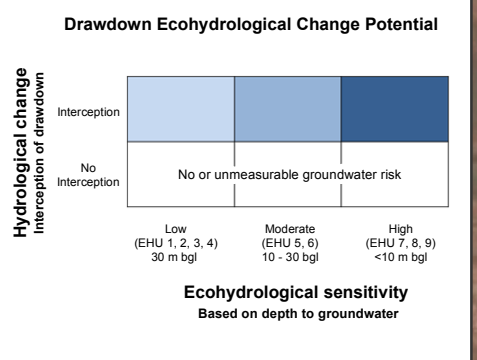
Scale @ A3: 1:1,000,000
Date: 15/04/2015

Prepared: J Botterill
Checked: J Vermaak
Reviewed: J Youngs

Revision: Rev K
Map: 24



Pre-Mitigation Case



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- ### LEGEND
- Ecohydrology Study Boundary
 - Karijini National Park
 - Ophthalmia Dam
 - Ecohydrological Receptors
 - Townships
 - Third Party Mining Areas
 - BHPBIO Mining Areas
 - BHPBIO Rail Corridor (current & proposed)
 - Third Party Rail Corridor (current)
 - Great Northern Highway
 - Other Roads
 - BHP Billiton Iron Ore Disturbance 30% Development Scenario
 - Third Party Reasonably Foreseeable Disturbance
 - Drawdown information not available

- ### Drawdown Potential
- 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

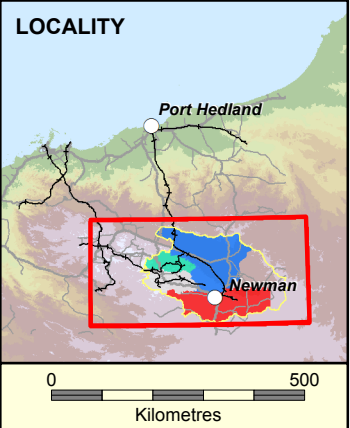
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- 2) Ecohydrological sensitivity to groundwater change Map#10

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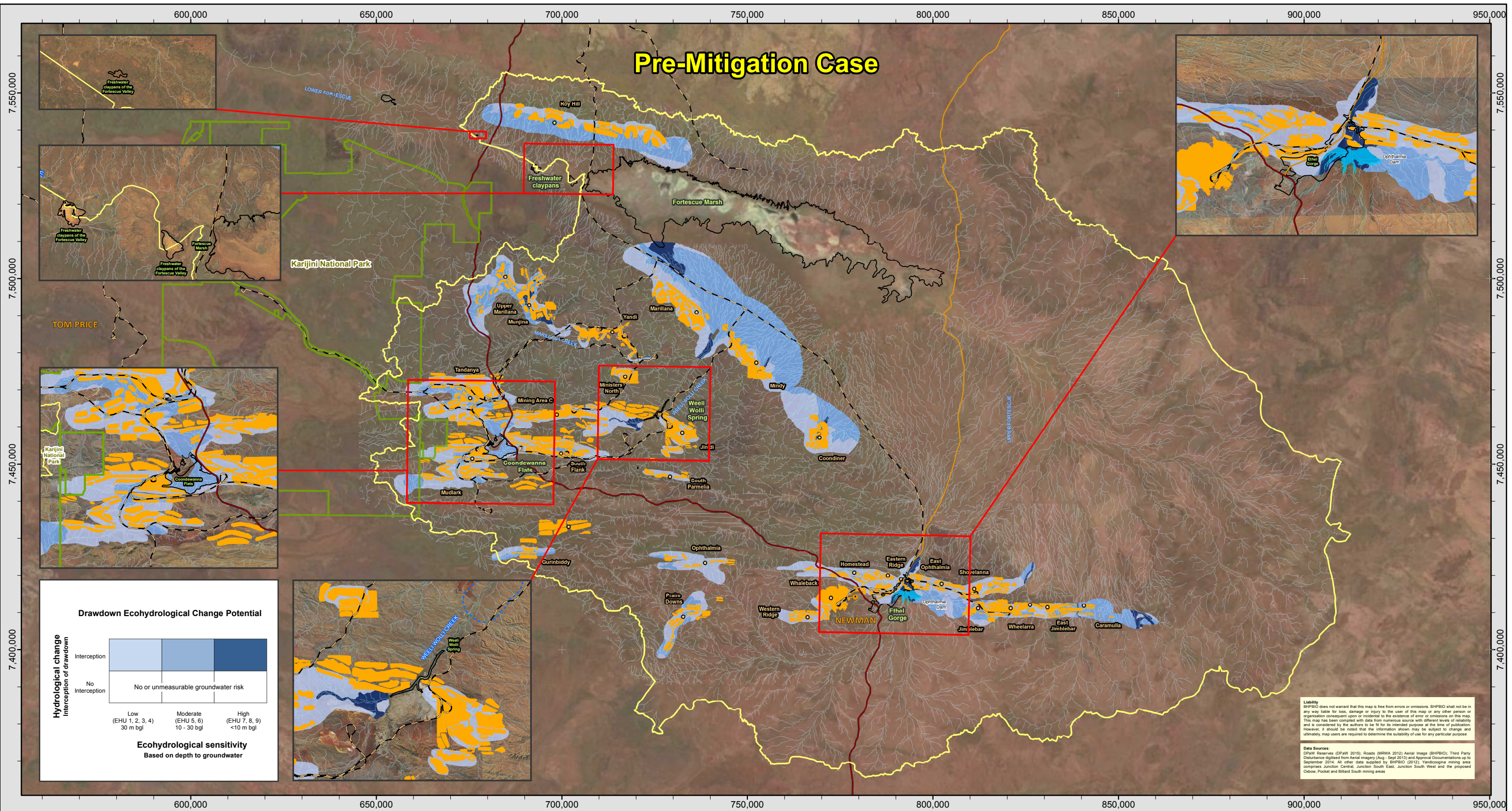
Resource Planning Hydrology
BHP BILLITON IRON ORE

ECOHYDROLOGICAL CHANGE ASSESSMENT
Ecohydrological Change Potential - Groundwater Drawdown
Cumulative - 30% Development Scenario

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

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev K
Date: 15/04/2015	Checked: J Vermaak	Map: 25
	Reviewed: J Youngs	

GW Drawdown Change Potential



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LEGEND

- Ecohydrology Study Boundary
- Karijini National Park
- Ophthalmia Dam
- Ecohydrological Receptors
- Townships
- BHPBIO Mining Areas (current & proposed)
- BHPBIO Rail Corridor (current & proposed)
- Great Northern Highway
- Other Roads
- BHP Billiton Iron Ore Disturbance Full Development Scenario
- Drawdown Potential**
- Low: No change to the natural ecological receptor condition
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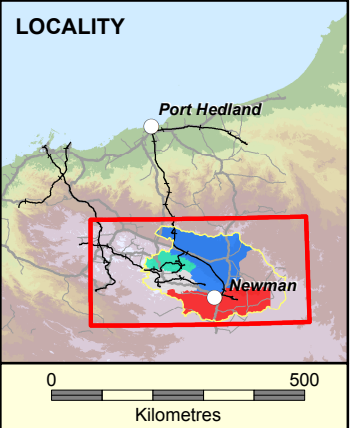
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- 1) Groundwater drawdown extent Map#22
- 2) Ecohydrological sensitivity to groundwater change Map#09

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Irrigation along Weeli Wollie Spring not considered in analysis hence drawdown extent at Weeli Wollie Spring is overestimated



Resource Planning Hydrology
BHP BILLITON IRON ORE

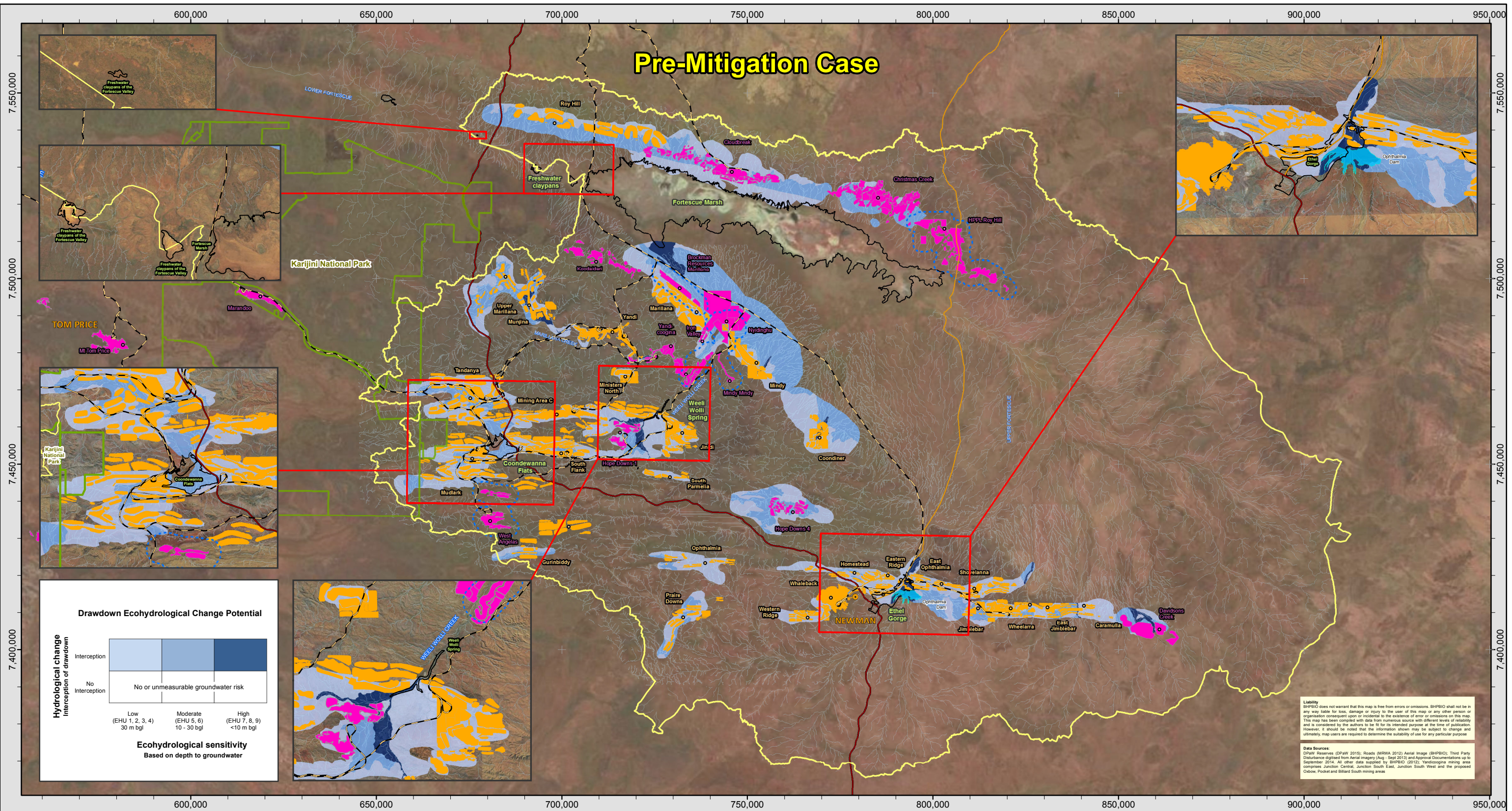
bhpbilliton
resourcing the future

ECOHYDROLOGICAL CHANGE ASSESSMENT
Ecohydrological Change Potential - Groundwater Drawdown
BHP Billiton Iron Ore - Full Development Scenario

0 10 20 40 60 Kilometres

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

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev K
Date: 7/05/2015	Checked: J Vermaak	Map: 26
	Reviewed: J Youngs	



LEGEND

- Ecohydrology Study Boundary
- Karijini National Park
- Ophthalmia Dam
- Ecohydrological Receptors
- Townships
- Third Party Mining Areas
- BHPBIO Mining Areas
- BHPBIO Rail Corridor (current & proposed)
- Great Northern Highway
- Other Roads
- BHP Billiton Iron Ore Disturbance Full Development Scenario
- Third Party Reasonably Foreseeable Disturbance
- Drawdown information not available

Drawdown Potential

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LOCALITY

0 500
Kilometres

Resource Planning Hydrology
BHP BILLITON IRON ORE

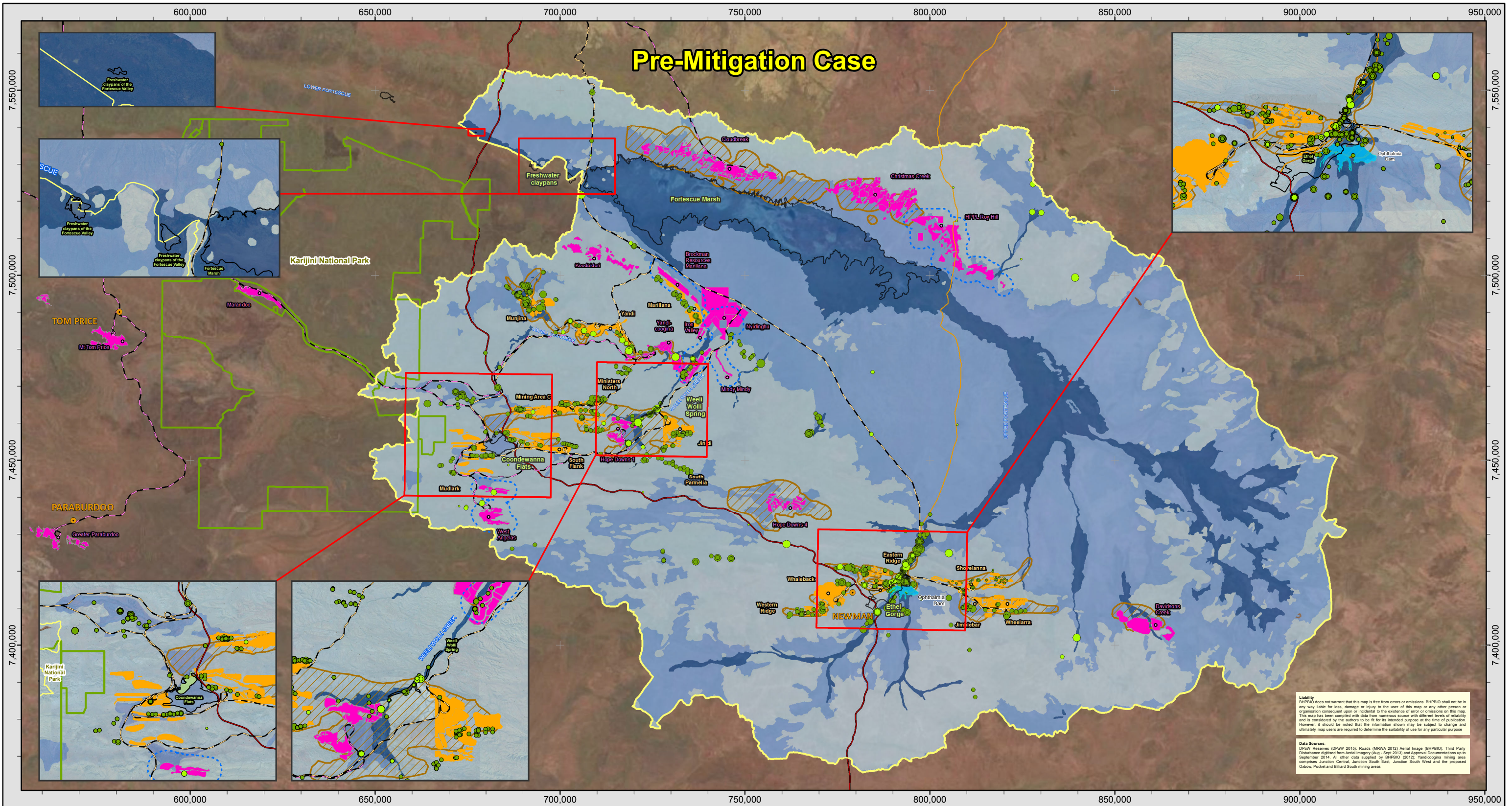
ECOHYDROLOGICAL CHANGE ASSESSMENT

Ecohydrological Change Potential - Groundwater Drawdown Cumulative - Full Development Scenario

0 10 20 40 60
Kilometres

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

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev K
Date: 16/04/2015	Checked: J Vermaak	Map: 27
	Reviewed: J Youngs	



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 - Third Party Mining Areas (current & proposed)
 - BHPBIO Rail Corridor
 - Third Party Rail Corridor

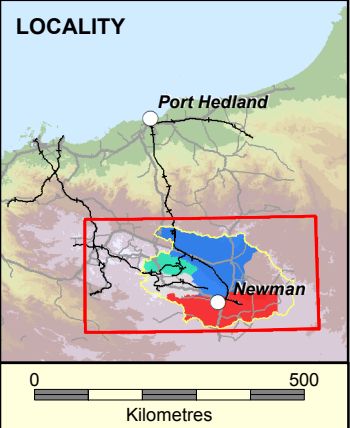
- Stygofauna Abundance: Pilbara Bio-diversity Survey**
- 0 (15)
 - 1 - 20 (21)
 - 21 - 65 (16)
 - 66 - 500 (10)
- Source: Halse et al, 2014
- Stygofauna Abundance: BHPBIO Survey**
- 0 (53)
 - 1 to 25 (2,999)
 - 26 to 50 (127)
 - 51 to 500 (126)
 - 501 to >1000 (10)
- Stygofauna Habitat Change Potential**
- Light blue: low stygofauna abundance
 - Moderate blue: moderate stygofauna abundance
 - Dark blue: high stygofauna abundance
- Disturbance Scenarios**
- Great Northern Highway
 - Other Roads
 - BHP Billiton Iron Ore Disturbance 30% Development Scenario
 - Third Party Reasonably Foreseeable Disturbance
 - Drawdown information not available
 - Potential Stygofauna Habitat affected by Groundwater Drawdown 30% Development Scenario BHP Billiton Iron Ore & Third Party

Notes: Pre-mitigation groundwater changes:

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 (between 10 and 30 m associated with EHUs 5 and 6) is assumed to have a moderate stygofauna abundance.

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.

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.



Resource Planning Hydrology
 BHP BILLITON IRON ORE

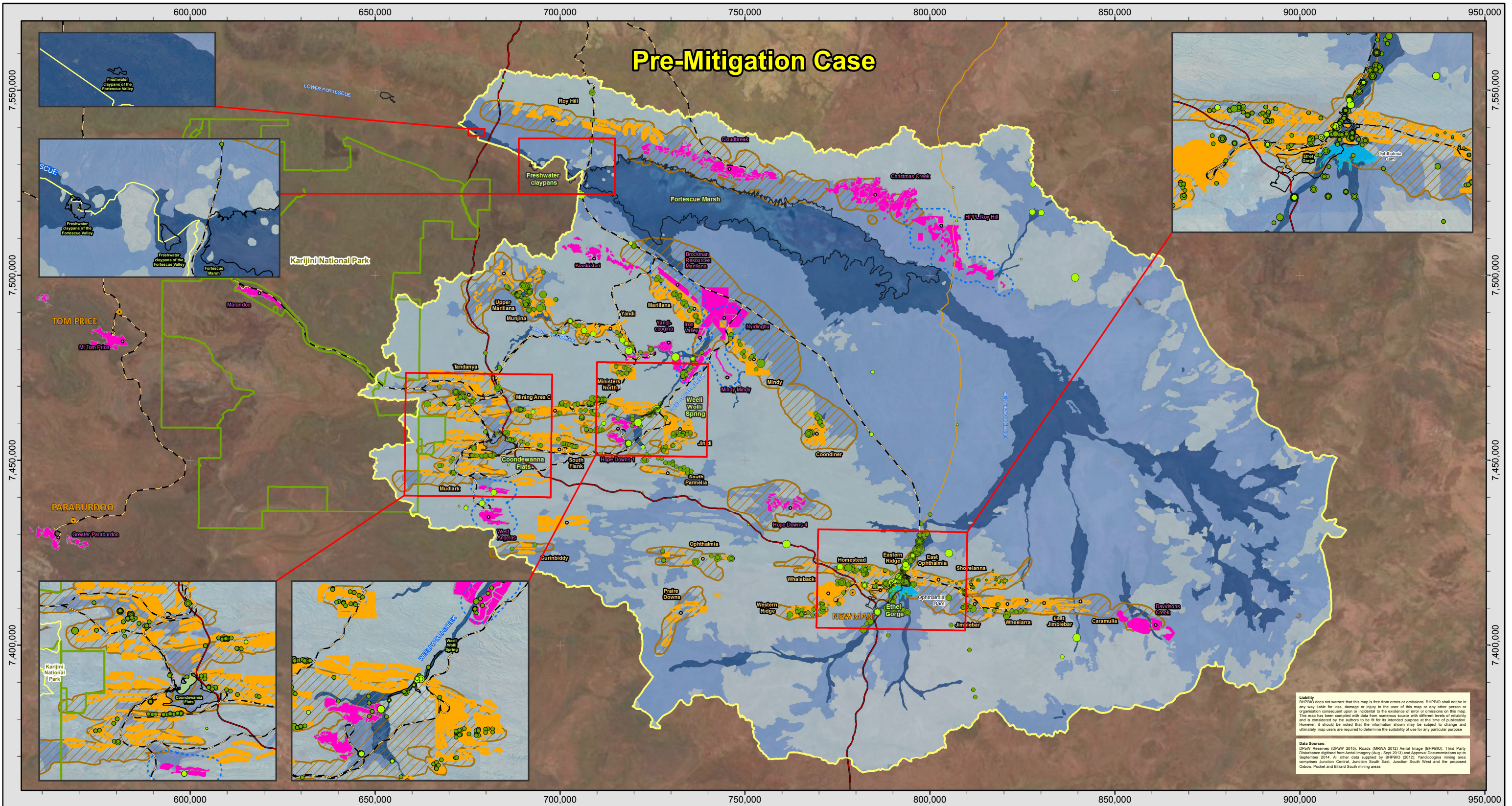
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 Stygofauna Habitat Change Potential
 Cumulative - 30% Development Scenario

0 10 20 40 60
 Kilometres

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Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev J
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Stygofauna



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 - BHPBIO Rail Corridor

- Stygofauna Abundance: Pilbara Bio-diversity Survey**
- 0 (15)
 - 1 - 20 (21)
 - 21 - 65 (16)
 - 66 - 500 (10)
- Source: Halse et al, 2014
- Stygofauna Abundance: BHPBIO Survey**
- 0 (53)
 - 1 to 25 (2,999)
 - 26 to 50 (127)
 - 51 to 500 (126)
 - 501 to >1000 (10)

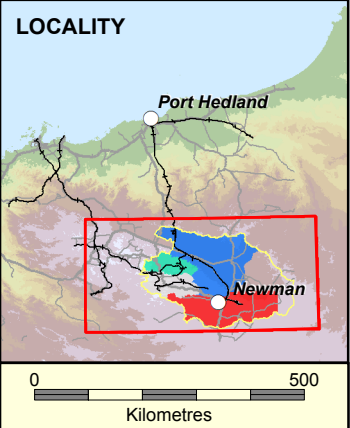
- Great Northern Highway
 - Other Roads
 - BHP Billiton Iron Ore Disturbance Full Development Scenario
 - Third Party Reasonably Foreseeable Disturbance
 - Drawdown information not available
 - Potential Stygofauna Habitat affected by Groundwater Drawdown >1m Full Development Scenario BHP Billiton Iron Ore & Third Party
- Stygofauna Habitat Change Potential**
- Light blue: low stygofauna abundance
 - Moderate blue: moderate stygofauna abundance
 - Dark blue: high stygofauna abundance

Notes: Pre-mitigation groundwater changes:

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 EHU's 7, 8 and 9) and lower in areas with deep groundwater levels (>30m associated with EHU's 1, 2, 3 and 4). Areas with a medium depth to groundwater levels (between 10 and 30 m associated with EHU's 5 and 6) is 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.



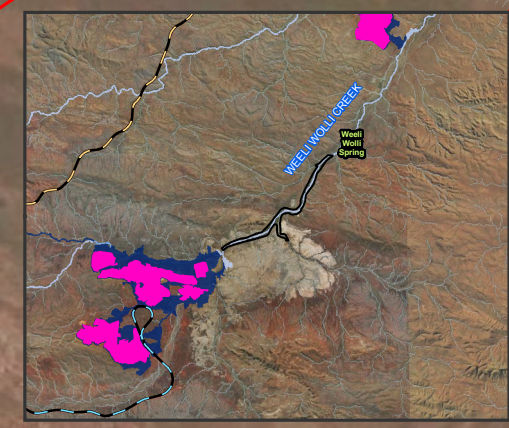
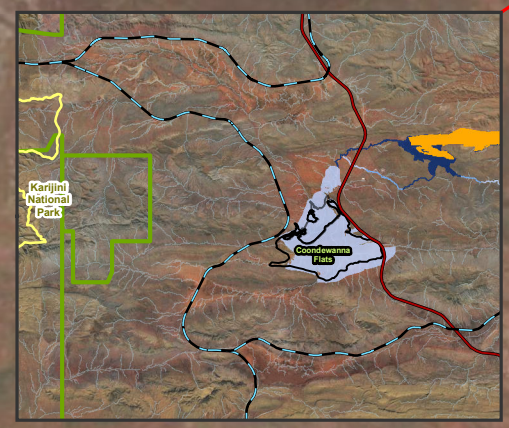
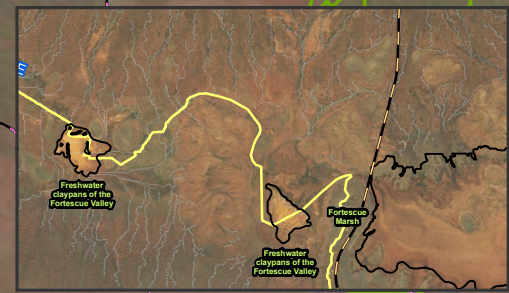
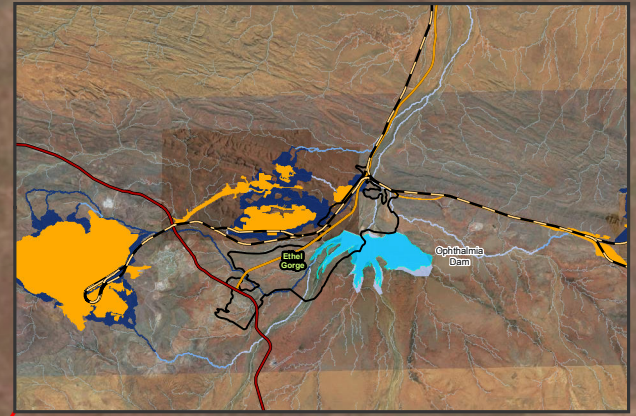
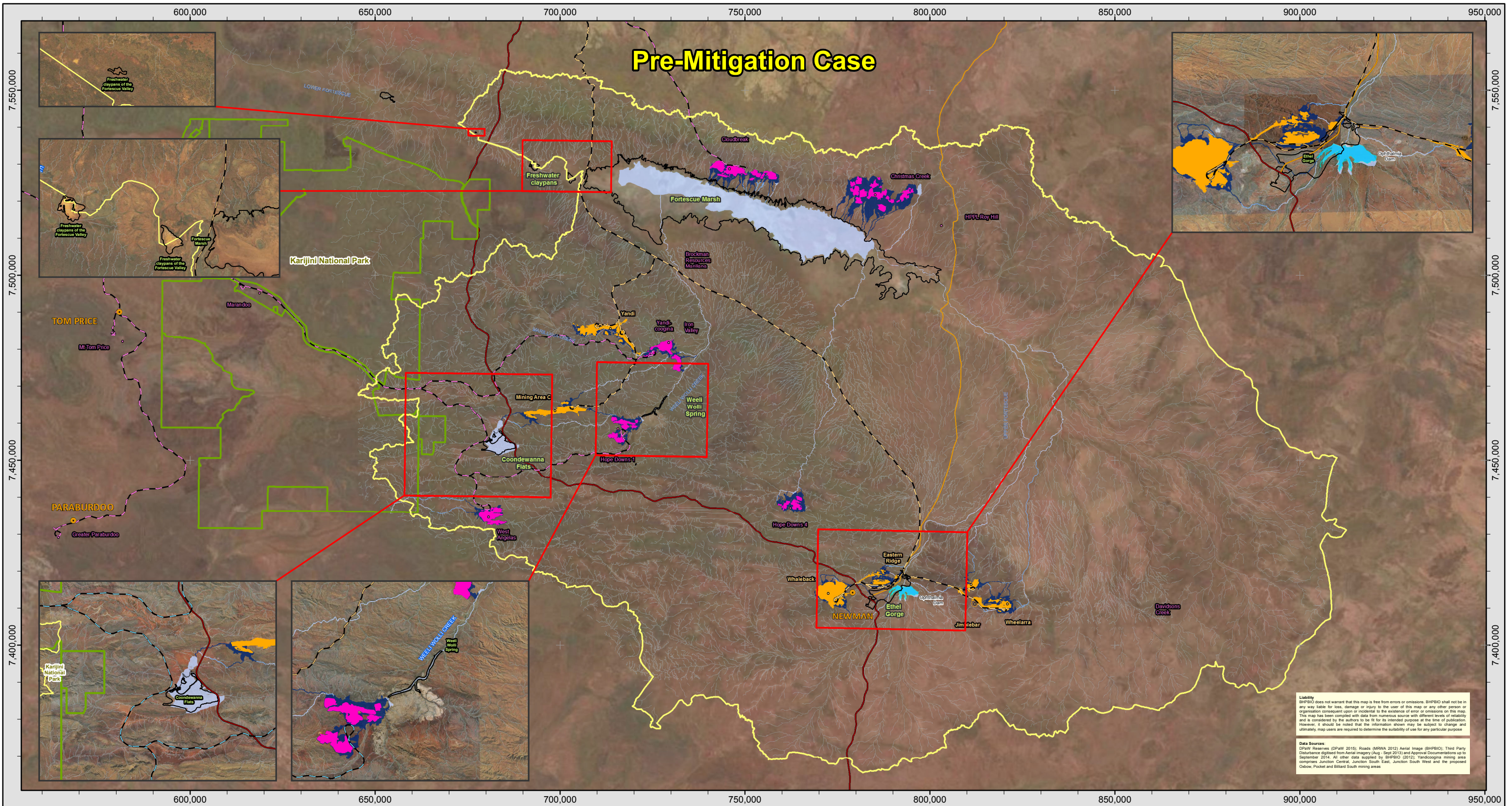
Resource Planning Hydrology
BHP BILLITON IRON ORE

ECOHYDROLOGICAL CHANGE ASSESSMENT
Stygofauna Habitat Change Potential
Cumulative - Full Development Scenario

0 10 20 40 60
Kilometres

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

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev J
Date: 15/04/2015	Checked: J Vermaak	Map: 29
	Reviewed: J Youngs	



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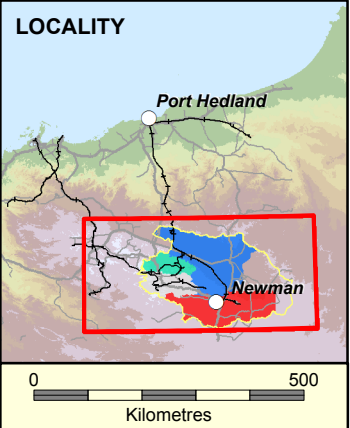
Data Sources
DPAW Reserves (DPAW 2015); Roads (MRWA 2012); Aerial Image (BHPBIO); Third Party Disturbance digitised from Aerial Imagery (Aug - Sept 2013) and Approval Documentations up to September 2014. All other data supplied by BHPBIO (2012). Yandi/Coonga mining area comprises Junction Central, Junction South East, Junction South West and the proposed Oatley, Picket and Billard South mining areas.

LEGEND	
Ecohydrology Study Boundary	Third Party Mining Areas
Karijini National Park	BHP Billiton Iron Ore Existing Disturbance
Ecohydrological Receptors	Third Party Existing Disturbance
Ophthalmia Dam	Surface Water Reduction
Townships	No or unmeasurable < 5% loss of catchment
BHPBIO Mining Areas	Low 5-20% reduction
BHPBIO Rail Corridor	High >20% loss of catchment
Third Party Rail Corridor	
Great Northern Highway	
Other Roads	
Drainage Lines 5-30m DEM	

Notes: Pre-mitigation surface water changes

The map shows the change in surface water availability caused by the mining disturbance areas. The assessment was carried out using terrain analysis and is based on:

No runoff occurs from mining disturbance areas
The change of surface water availability is directly proportional to the change in catchment area
Runoff from the upstream catchments are diverted around the disturbance areas and flow to the downstream catchments, 1km downstream of the disturbance areas



Resource Planning Hydrology
BHP BILLITON IRON ORE

ECOHYDROLOGICAL CHANGE ASSESSMENT
Surface Water Change
Cumulative - Existing Development

0 10 20 40 60
Kilometres

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

Scale @ A3: 1:1,000,000	Prepared: J Botterill	Revision: Rev J
Date: 15/04/2015	Checked: J Vermaak	Map: 30
	Reviewed: J Youngs	

SW Change