Mining Area C – Southern Flank
Public Environmental Review Document
May 2017
Document tracking

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INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on the environmental review for this proposal.

BHP Billiton Iron Ore proposes to develop and operate a new satellite iron ore deposit located immediately south of the existing Mining Area C operation at Southern Flank which will become part of the Mining Area C hub and increase disturbance within the existing Mining Area C operation (the Proposal). In accordance with the Environmental Protection Act 1986 (WA) (EP Act), this Public Environmental Review (PER) has been prepared by BHP Billiton Iron Ore to describe the Proposal and its likely effects on the environment. The PER is available for a public review period of [4] weeks from 8 May 2017, closing on 6 June 2017.

Information on the proposal from the public may assist the EPA to prepare an assessment report in which it will make recommendations on the proposal to the Minister for Environment.

Why write a submission?

The EPA seeks information that will inform the EPA’s consideration of the likely effect of the proposal, if implemented, on the environment. This may include relevant new information that is not in the Public Environmental Review, such as alternative courses of action or approaches.

In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent’s responses and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the Freedom of Information Act 1992.

Why not join a group?

It may be worthwhile joining a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on information in the Public Environmental Review Document.

When making comments on specific elements in the PER document:

- Clearly state your point of view and give reasons for your conclusions.
- Reference the source of your information, where applicable.
- Suggest alternatives to improve the outcomes on the environment.
What to include in your submission

Include the following in your submission to make it easier for the EPA to consider your submission:

Your contact details – name and address.

Date of your submission

Whether you want your contact details to be confidential.

Summary of your submission, if your submission is long.

List points so that issues raised are clear, preferably by environmental factor.

Refer each point to the page, section and if possible, paragraph of the PER.

Attach any reference material, if applicable. Make sure your information is accurate.

The closing date for submissions is Tuesday, 6 June 2017.

The EPA prefers submissions to be made electronically via the EPA’s consultation hub at https://consultation.epa.wa.gov.au

Alternatively, submissions can be:

posted to: Chairman, Environmental Protection Authority, Locked Bag 10, East Perth 6892; or
delivered to the Environmental Protection Authority, Level 8, The Atrium, 168 St Georges Terrace, Perth, Western Australia.

If you have any questions on how to make a submission, please contact the Office of the Environmental Protection Authority (OEPA), on (08) 6145 0800.
EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty. Ltd. (BHP Billiton Iron Ore) proposes to develop and operate a new satellite iron ore deposit, located immediately south of the existing Mining Area C operation, at Southern Flank, which will become part of the Mining Area C hub, and to increase the disturbance at the existing Mining Area C hub (the Proposal). The Proposal is located approximately 100 kilometres (km) northwest of Newman in the Pilbara region of Western Australia.

The Proposal will use existing ore processing facilities located at the Mining Area C hub, including, but not limited to, ore handling plant, stockyard and train load-out facilities coupled with the addition of new ore processing facilities within the current Mining Area C hub. Primary crushing and open-pit mining activities will take place in the Southern Flank locality. This reflects BHP Billiton Iron Ore’s current approach of developing new ore-bodies that are able to use existing infrastructure at established mining hubs. This approach will minimise the amount of disturbance and therefore impacts associated with the Proposal.

The ore resource of the Southern Flank satellite ore body has been estimated at approximately 1,850 million tonnes (Mt). Production from the Southern Flank satellite mine (approximately 80 million tonnes per annum (Mtpa)) will replace declining iron ore supplies, which is currently produced by other BHP Billiton Iron Ore mining operations in the Pilbara and therefore enable BHP Billiton Iron Ore to sustain its current level of iron ore production from its Pilbara mines.

Mining will be undertaken using conventional open-pit iron ore mining activities both above and below the water table and will require mine dewatering ahead of mining to facilitate dry mining conditions. Approximately eight percent of the ore resource at the Southern Flank satellite ore body is estimated to be below the water table. Thus, the Proposal will require in-pit and ex-pit mine dewatering (i.e. groundwater abstraction) ahead of accessing ore resources that are below the water table to facilitate dry mining conditions.

Open pits will be developed using conventional drill and blast techniques. Ore will be transported via an overland conveyor to ore handling facilities at the Mining Area C hub and then transported by rail to Port Hedland for export.

This Public Environmental Review (PER) document provides supporting information to the Environmental Protection Authority (EPA) to enable it to undertake its assessment under s38 of the Environmental Protection Act 1986 (WA) (EP Act). This document provides information about the existing environment, options considered for replacement of iron ore mined from BHP Billiton Iron Ore’s Pilbara mines, an assessment of potential impacts of implementation of the Proposal, any proposed mitigation measures and as assessment of whether the Environmental Protection Authority’s (EPA) objectives will be met. This PER document describes BHP Billiton Iron Ore’s regional management approach to manage potential impacts of the EPA’s environmental factors.

In 1998, the existing Mining Area C mining operation was approved under Part IV of the EP Act as the Multiple Iron Ore Mine Development Mining Area C Northern Flank via Ministerial Statement (MS) 491. A draft Environmental Management Plan (EMP) was attached to the Mining Area C Public Environmental Review, which provided details of the management requirements during construction and operation of the Deposit C and Brockman Detrital deposits. MS 491 provided an ongoing mechanism for the development of the remaining 12 deposits in the Northern Flank of Mining Area C (Proponent Commitment 2), subject to the EMP being reviewed and updated as deposits are developed (Proponent Commitment 3).
In 2016, Revision 6 of the EMP (EMP Revision 6) was accepted by the OEPA as the current version of the EMP. The EMP Revision 6 provided information on the potential environmental impacts as a result of mining of all 14 deposits within the Mining Area C Development Envelope. For the purposes of environmental impact assessments (EIAs) undertaken as part of EMP Revision 6, an impact assessment area of 11,377 hectares (ha) was used. The current MS 491 allows for clearing of up to 5,385 ha anywhere within the 11,377 ha, of which 4,792 ha have been cleared under MS 491 as of 31 December 2016. However, it is noted that the EMP update mechanism does not accommodate a change of the key characteristics for Mining Area C. Therefore, this Proposal includes a request for an additional 5,942 ha of disturbance within the EMP Revision 6 Indicative Impact Assessment Area.

Outcomes from the EIAs previously undertaken to support the development of the EMP Revision 6 are discussed in this document. As the additional clearing may occur anywhere in the 11,377 ha, the EIAs have assessed potential impacts for the entire 11,377 ha, not just the additional clearing.

As Southern Flank and Northern Flank (Mining Area C) operations will be operated as one hub it is proposed that MS 491 be replaced with a new MS. This document therefore provides information on the following:

- **Mining Area C (Northern Flank) Development Envelope**: The area (25,815 ha) currently approved as the development envelope under MS 491.
- **Additional Development Envelope**: The additional area (10,218 ha) that contains the Southern Flank satellite orebodies.
- **Proposed Mining Area C Development Envelope**: This is the proposed development envelope for the full Mining Area C hub. It consists of the Mining Area C (Northern Flank) Development Envelope and the Additional Development Envelope (Southern Flank) and will constitute the boundary of the new MS if approved.
- **Mining Area C Revision 6 EMP Impact Assessment Area**: The area (11,377 ha) that was used for the purposes of impact assessment in line with Condition 7 and commitments 2 and 3 of MS 491 via EMP Revision 6 in January 2016.
- **Indicative Additional Impact Assessment Area**: The indicative spatial area for the development of the Southern Flank ore body, based on the mine plan and design at the time of submission and is used as an assessment tool.

The locations of these areas are shown in Figure ES-1.

BHP Billiton Iron Ore has developed a regional management approach in consultation with government agencies, including the EPA, over a number of years. The approach is being implemented as part of an increased business focus on simplification to improve the way we do business and to achieve better environmental outcomes in five key areas: water planning; mine closure; biodiversity; noise and air quality. BHP Billiton Iron Ore considers that this Proposal provides an opportunity to further embed this approach.

BHP Billiton Iron Ore and its entities have operated in the Pilbara for over 50 years. BHP Billiton Iron Ore have undertaken numerous studies to support proposals in the Pilbara region, including in the vicinity of this Proposal. BHP Billiton Iron Ore have used its knowledge of the environment, together with an understanding of EIA in the Pilbara region, to undertake an assessment for this Proposal.

The assessment took into consideration the EPA's *Environmental Assessment Guideline 8 for Environmental Factors and Objectives* (EAG 8) (EPA, 2013a), the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2016a) and the OEPA Environmental scoping document (OEPA, 2016) to identify the following as preliminary key environmental factors:
flora and vegetation;
- terrestrial fauna (including short-range endemics);
- subterranean fauna;
- hydrological processes;
- inland waters environmental quality;
- heritage;
- rehabilitation and decommissioning; and
- offsets.

Other environmental factors that were assessed as part of this Proposal are:

- landforms;
- terrestrial environmental quality;
- air quality (including greenhouse gas emissions);
- amenity; and
- human health (noise).

A summary of the potential impacts to the environmental factors considered during the impact assessment process is provided in Table ES-1, which includes the potential impacts associated with additional clearing within the Mining Area C EMP Revision 6 (BHP Billiton Iron Ore, 2015a) impact assessment area, the potential impacts associated with the development of the ore body at Southern Flank and the potential cumulative impacts associated with the Proposed Mining Area C Development Envelope following implementation of the Proposal. The significance of the impact of the implementation of the Proposal on the environmental factors was assessed in line with the EPA’s *EAG 9 for Application of a Significance Framework in the Environmental Impact Assessment Process* (EPA, 2013b). BHP Billiton Iron Ore have concluded that some factors may be considered preliminary key environmental factors as listed above.

Sections 11 and 12 respectively provide a description and evaluation of, the key and other environmental factors listed above. Section 12 details the potential impacts (both inherent and residual following application of the mitigation hierarchy) arising from the Proposal for those factors whose significance was determined to be a preliminary key factor. For those factors that were evaluated to be preliminary key environmental factors in the Environmental Scoping Document phase, Section 11 provides further discussion on what specific management actions BHP Billiton Iron Ore has taken to mitigate the proposed environmental impact of the Proposal in line with the mitigation hierarchy published in the *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014). A figure illustrating the range of actions taken to address the mitigation hierarchy is provided in Figure ES 2. Each discussion includes an evaluation of whether the EPA objective can be met.

Impact assessments undertaken as part of the Proposal for two factors that were considered to be preliminary key factors (Inland Waters Environmental Quality and Heritage) have demonstrated that these factors can meet the EPA objective without the need for application of the mitigation hierarchy or Ministerial Conditions and are therefore not considered likely to have a significant effect on the environment.
BHP Billiton Iron Ore has had due regard for the principles of ecological sustainable development of the EP Act. BHP Billiton Iron Ore has extensive regional data sets, and endorsed current management practises on which the environmental impact assessments were based, offering a high degree of confidence in impact assessments. Where inherent impacts have been assessed as significant the application of the mitigation hierarchy based on a robust scientific methodology has resulted in a reduction of potential impacts to a level BHP Billiton Iron Ore considers reasonable and all EPA objectives are considered to be met.

BHP Billiton Iron Ore considers that the information and assessment presented in this PER adequately identifies and addresses environmental impacts relevant to the Proposal, adequately addresses the environmental scoping document and is suitable to enable the EPA to undertake its assessment of the Proposal.
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Spatial Areas as Discussed in PER Document

Scale A4: 1:150,000
Prepared: S. TRINDER
Project No: A780047 REV B
Date: 12/01/2017
Checked: R. GREGORY
Figure: ES-1
Reviewed: S. WILLIAMSON
Revision: Rev B

Proposed Mining Area C Development Envelope

Approved Mining Area C (Northern Flank) Development Envelope

Additional Development Envelope

Mining Area C EMP Rev 6 Impact Assessment Area

Indicative Additional Impact Assessment Area

Great Northern Highway

BHP Billiton Rail

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

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The Proposal will locate infrastructure at the Mining Area C Hub as opposed to clearing native vegetation for construction of infrastructure (eg ore handling plant and rail) at the Southern Flank satellite ore body.

Re-use of surplus water or return to local groundwater aquifers.

OSA’s moved to reduce amenity impacts to Great Northern Highway

Indicative Additional Impact Assessment Area modified to reduce impact to Ghost Bat and Troglofauna Habitat

Indicative Additional Impact Assessment Area modified to retain Troglofauna habitat

Diversion of surface water around mine to retain flow to natural drainage systems.

The Proposal will locate infrastructure at the Mining Area C Hub as opposed to clearing native vegetation for construction of infrastructure (eg ore handling plant and rail) at the Southern Flank satellite ore body.

Re-use of surplus water or return to local groundwater aquifers.

OSA’s moved to reduce amenity impacts to Great Northern Highway

Indicative Additional Impact Assessment Area modified to reduce impact to Ghost Bat and Troglofauna Habitat

Indicative Additional Impact Assessment Area modified to retain Troglofauna habitat

Diversion of surface water around mine to retain flow to natural drainage systems.
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Table ES-1: Summary of potential impacts, proposed mitigation and outcomes

Note: Factors that are considered to be preliminary key environmental factors are shaded in light green.

<table>
<thead>
<tr>
<th>EPA Objective</th>
<th>Flora and Vegetation</th>
</tr>
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<tbody>
<tr>
<td>To protect flora and vegetation so that biological diversity and ecological integrity are maintained</td>
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### Indicative Additional Impact Assessment Area for Development of Southern Flank (A)
- Indicative Additional Impact Assessment Area contains 11,612 ha of vegetation of which 727 ha is Pristine, 9,016 ha is Excellent, 658 ha is very good, and 312 ha is Good condition vegetation.
- Eight Priority flora taxa recorded. All species are known to exist outside the Proposed Mining Area C Development Envelope, and impacts are considered to be low. Fifteen vegetation associations have been recorded, with low to very low local conservation value.
- No Threatened flora species listed under the WC Act or the EPBC Act has been recorded in the Additional Development Envelope or Indicative Additional Impact Assessment Area.
- Six weeds have been recorded within the Additional Development Envelope, and seven have been recorded within the Indicative Additional Impact Assessment Area. Two of these weed species have not been recorded within the Mining Area C (Northern Flank) Development Envelope.
- It is unlikely that alterations to natural surface water flows will impact on mulga (Acacia aneura).
- There will be no impacts to groundwater-dependent vegetation within the Additional Development Envelope. No significant impacts to the Priority Ecological Communities (PECs) at Weeli Wolli Spring or Coondewanna Flats are likely to occur as a result of groundwater drawdown.
- No expected indirect impacts to the Coondewanna Flats PEC by groundwater moundng to 16 metres below ground level (mbgl) from injection of water at the Juna Downs managed aquifer recharge (MAR) borefield.

### Mining Area C EMP Rev 6 Impact Assessment (B)
- The Mining Area C EMP Revision 6 Impact Assessment area contains 11,056 ha of vegetation of which none is Pristine, 3,292 ha is Excellent, 3,344 ha is Very Good and 317 ha is Good condition vegetation.
- Six Priority flora species recorded in the Mining Area C EMP Revision 6 Impact Assessment Area (note that this excludes one species that has been delisted since undertaking the environmental impact assessment for the EMP Revision 6). All species are known from records outside of the Mining Area C (Northern Flank) Development Envelope.
- No Threatened flora species listed under the WC Act or the EPBC Act have been recorded in the Mining Area C (Northern Flank) Development Envelope. Thirteen locally significant vegetation associations occur within the Mining Area C (Northern Flank) Development Envelope. Impacts to these are not considered significant.
- Twenty-one weeds have been recorded within the Mining Area C (Northern Flank) Development Envelope. It is unlikely that alterations to natural surface water flows will impact on downstream mulga (Acacia aneura).
- There will be no impacts to groundwater-dependent vegetation within the Mining Area C (Northern Flank) Development Envelope. Two areas surrounding the Mining Area C (Northern Flank) Development Envelope have been identified as supporting groundwater-dependent vegetation:
  - Weeli Wolli Spring Priority Ecological Community (PEC) (10 km east), and
  - Ben's Oasis, a component of the Weeli Wolli PEC (12.5 km southeast).
- No Threatened flora species listed under the WC Act or the EPBC Act have been recorded in the Mining Area C (Northern Flank) Development Envelope. Thirteen locally significant vegetation associations occur within the Mining Area C (Northern Flank) Development Envelope. Impacts to these are not considered significant.
- Twenty-three introduced species have been recorded within the Proposed Mining Area C Development Envelope.

### Cumulative (Proposed Mining Area C Development Envelope) (A + B)
- Total native vegetation clearing if the Proposal is approved will be 28,063.2 ha (of which 19,671.2 ha relates to this Proposal) within the Proposed Mining Area C Development Envelope. A majority of this vegetation is considered to be in Very Good or better condition. Ten Priority flora species have been recorded within the Proposed Mining Area C Development Envelope.
- No Threatened flora, Threatened Ecological Communities (TECs) or PECs relating to have been recorded within the Proposed Mining Area C Development Envelope.
- Thirty-four vegetation associations have been recorded in the Proposed Mining Area C Development Envelope. Four are considered to be an ‘Ecosystem at Risk’, as defined by Kendrick (2001). These, and a further fifteen vegetation associations are located in the Proposed Mining Area C Development Envelope and are considered to have low local conservation significance. All of these communities occur extensively outside the Proposed Mining Area C Development Envelope. Impacts to these communities are considered to be low to very low and do not represent a significant increase to those impacts associated with the approved clearing under MS 491.
- Twenty-three introduced species have been recorded within the Proposed Mining Area C Development Envelope.
- Possible retraction of the silver paperbark (Melaleuca argentea) may occur upstream of Weeli Wolli Springs following closure of Hope Downs 1 and subsequent groundwater recovery. This community has been significantly altered from Hope Downs 1 operations and there is limited information on baseline conditions.
- No expected indirect impacts to the Coondewanna Flats PEC by groundwater moundng to 16 metres below ground level (mbgl) from injection of water at the Juna Downs MAR borefield.

### Mitigation
- Avoid: Where practical BHP Billiton Iron Ore will reduce disturbance to the Modified Indicative Impact Assessment Area. This may potentially avoid up to 4,107 ha of disturbance (of which 1,786 ha is rated to be Very Good or above condition), and may reduce impacts to conservation species Rhagodia sp Hamersley, seven populations may be avoided; and Rostellularia adscendens var. latifolia, one population may be avoided. It may also reduce impacts to two of the three vegetation associations classified as ‘Ecosystems at Risk’.
- Minimise: Reduction in fragmentation of locally significant vegetation associations.
- Rehabilitate: BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope.

### Outcomes
- Residual Impact: Residual loss of vegetation of Good or above condition and loss of populations of conservation significant flora will occur, but regionally the significance of impacts to significant flora and vegetation associations is low.
- Offset: Financial offsets will apply up to 19,671.2 ha of native vegetation clearing. With mitigation it is likely that impacts may not exceed 15,693 ha.

This factor is considered a preliminary key environmental factor. The Proposal meets the EPA objective for this factor; biological integrity and ecological diversity can be maintained.
Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

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<thead>
<tr>
<th>EPA Objective</th>
<th>Terrestrial Fauna</th>
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<tr>
<td></td>
<td>To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.</td>
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<td>Note: Factors that are considered to be preliminary key environmental factors are shaded in light green.</td>
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<td></td>
<td>Note: Factors that are considered to be preliminary key environmental factors are shaded in light green.</td>
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**Indicative Additional Impact Assessment Area for Development of Southern Flank**

- Nine species of conservation significant vertebrate fauna have been recorded within the Additional Development Envelope. Seven of these have been recorded from the Indicative Additional Impact Assessment Area. All are well represented outside of the Additional Development Envelope. Impacts to the ghost bat are considered likely due to the loss of a number of caves that are used as roosts by the species; 33 caves occur within the Indicative Additional Impact Assessment Area. One SRE invertebrate fauna species (Antichiropus ‘DIP007’) has four of five records within the Indicative Additional Impact Assessment Area. Habitat for this species occurs outside the Indicative Additional Impact Assessment Area. No impacts to terrestrial fauna values of the Weeli Wolli Spring PEC are anticipated.

**Mining Area C EMP Rev 6 Impact Assessment Area**

- Nine species of conservation significant vertebrate fauna have been recorded within the Mining Area C (Northern Flank) Development. Six were identified as receptors for the proposed EMP Revision 6 development. The ghost bat (Macroderma gigas; listed as Vulnerable under the WC Act in November 2015 and under the EPBC Act in May 2016) was identified as the only receptor where impacts could result in loss of individuals or reduced breeding success in the locality. Twelve caves (potential ghost bat habitat) have been recorded within the Mining Area C EMP Revision 6 Indicative Impact Assessment Area, and removal of an additional 6 caves were approved under previous revisions of the EMP. Three SRE invertebrate fauna species (Antichiropus ‘DIP006’, Chenistona ‘MYG088’ and Karaops banyjima) have only been recorded within the Mining Area C EMP Revision 6 Indicative Impact Assessment Area. Suitable habitat for Karaops banyjima is known to occur in large continuous extents throughout the Mining Area C (Northern Flank) Development Envelope. Some potential habitat for Antichiropus ‘DIP006’ and Chenistona ‘MYG088’ has been identified outside of the Mining Area C Revision 6 EMP Impact Assessment Area; however it is not continuous.

**Cumulative (Proposed Mining Area C Development Envelope)**

- Eleven species of conservation significant vertebrate fauna have been recorded within the Proposed Mining Area C Development Envelope. All are well represented regionally or nationally. Baseline terrestrial fauna studies indicate that no PECs or TECs relating to terrestrial fauna are located within the Proposed Mining Area C Development Envelope or within 10 km of it. The closest PEC of relevance to terrestrial fauna is the Weeli Wolli Spring PEC, which is located approximately 20 km east of the Proposed Mining Area C Development Envelope. No significant impacts to terrestrial fauna values of the Weeli Wolli Spring PEC are anticipated.

**Mitigation**

- AVOID: BHP Billiton Iron Ore will, where practical, restrict disturbance to within a Modified Indicative Impact Assessment Area, and as a minimum retain 150 m buffer around all ghost bat caves located outside of the Modified Indicative Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area. Following mitigation the number of caves that will be impacted within cumulative impact areas is reduced to 36, with the number retained increasing from 12 to 27. Modification of the Indicative Impact Assessment Area also results in a reduction of impacts to foraging habitat for the ghost bat by 173 ha.

- MINIMISE: Clearing only within the Modified Indicative Impact Assessment Area results in a reduction in clearing of medium and high value fauna habitats. Rehabilitation: BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope, and will include the use of Corymbia hammeri which is considered key habitat for Antichiropus ‘DIP007’.

**Outcomes**

- Residual Impact: The loss of caves within the Indicative Additional Impact Assessment Area and Mining Area C Revision 6 EMP Impact Assessment Area suitable to support ghost bat may result in a reduction of the Hamersley population by approximately 50 individuals. Modification of the Indicative Additional Impact Assessment Area has increased ghost bat caves retained from 12 to 27 (11 high value), and the removal of foraging habitat has been reduced by 173 ha. With mitigation it is predicted that ghost bats will persist in the Proposed Mining Area C Development Envelope following closure and rehabilitation. Even with mitigation, it is likely that the population size will be reduced but that at closure the species will persist in the area. Retained mitigation strategies including construction of artificial roosts and management of foraging habitat will be considered as part of a management plan for the species.

- Offset: The level of residual impacts to the ghost bat warrants an offset commitment. Therefore, continued study of the ecology of the ghost bat in the Pilbara will be undertaken to provide information to assist in identifying key habitats (roosting and foraging) for the species. This work will be published so that it is available to third-party operators in the Pilbara and will be considered during future mining developments undertaken by BHP Billiton Iron Ore.

This factor is considered a preliminary key environmental factor. The Proposal meets the EPA objective for this factor with the implementation of mitigation and management measures biological integrity and ecological diversity can be maintained.
### Table E5-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

#### EPA Objective
To protect subterranean fauna so that biological diversity and ecological integrity are maintained

#### Potential Impacts

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<tr>
<th>Mining Area C EMP Rev 6 Impact Assessment Area [A]</th>
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<tr>
<td><strong>Indicative Additional Impact Assessment Area for Development of Southern Flank</strong></td>
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<td><strong>Stygofauna</strong></td>
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<tr>
<td>Six species are only known from the Groundwater Assessment Area. Four of these species occur within the vicinity of the Weeli Wolli Spring PEC and are considered likely to occur along Weeli Wolli Creek outside the area of impact. The fifth species, <em>Notobathyrella</em> sp. is also considered likely to occur outside the area of impact. The sixth species, <em>Paramelitidae</em> sp. 054 (BR South) has been recorded from 21 samples over a range of 11 km. There is strong evidence that the distribution of this species extends outside the Groundwater Assessment Area, and hence the conservation threat to this species is considered low.</td>
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<tr>
<td>Troglofauna</td>
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| Eighteen species are known only from the proposed pit areas within the Indicative Additional Impact Assessment Area (plus three species are only known from within it and the Mining Area C EMP Revision 6 Impact Assessment Area).
Current habitat data suggest that four species may be restricted to habitats that occur only within the Indicative Additional Impact Assessment Area, and for one of its status is uncertain due to insufficient information on species ecology. It is noted that all of these species are known only from a single record (4 of the 5 are singletons) or drill hole, and therefore there is little information from which to infer likely ranges or habitats. |

| Cumulative (Proposed Mining Area C Development Envelope) [A + B] |
|---|---|
| **Stygofauna** |
| Fifty three stygofauna species have been recorded from the cumulative area of groundwater drawdown associated with Proposal. Of these twenty species have not been recorded outside proposed areas of impact. Of these twenty species, three may be impacted by cumulative mining within the sub-catchments: *nr Actophothanes* sp. B01, *Dussartcyclops* sp. B10, *Bathyrella* sp. 2 and *nr Notobathyrella* sp. S01) are known only from Mining Area C EMP Revision 6 Groundwater Assessment Area. The ranges of *nr Actophothanes* sp. B01, *Bathyrella* sp. 2 and *Dussartcyclops* sp. B10 are unclear, and the potential threat to these species is uncertain because of their occurrence in single drill holes. *nr Notobathyrella* sp. S01 occurs only 77 m from the edge of the Mining Area C EMP Revision 6 Groundwater Assessment Area, and given the proximity of this record to areas of minimal groundwater drawdown it is considered likely that its range extends into areas that are classified as undisturbed. Consequently, the level of threat to *nr Notobathyrella* sp. S01 is likely to be low. |
| Troglofauna |
| Twenty species are known only from the proposed pit areas within the Mining Area C EMP Revision 6 Impact Assessment Area. Based on a detailed habitat assessment, the inferred ranges of 17 of the 20 species are considered likely to extend beyond the proposed pit areas. The status of the three remaining species (*Hanseniella* sp. B08, *Symphyella* sp. B03, and *Parapappidae* sp. S05) is uncertain because there is currently little information from which to infer likely ranges of these species. |

| Cumulative (Proposed Mining Area C Development Envelope) [A + B] |
|---|---|
| **Stygofauna** |
| Four species (nr *Epactophalinae* sp. B01, *Dussartcyclops* sp. B10, *Bathyrella* sp. 2 and *nr Notobathyrella* sp. S01) are known only from Mining Area C EMP Revision 6 Groundwater Assessment Area. |
| Troglofauna |
| Four species (nr *Epactophalinae* sp. B01, *Dussartcyclops* sp. B10, *Bathyrella* sp. 2 and *nr Notobathyrella* sp. S01) are known only from Mining Area C EMP Revision 6 Groundwater Assessment Area. The ranges of *nr Actophothanes* sp. B01, *Bathyrella* sp. 2 and *Dussartcyclops* sp. B10 are unclear, and the potential threat to these species is uncertain because of their occurrence in single drill holes. *nr Notobathyrella* sp. S01 occurs only 77 m from the edge of the Mining Area C EMP Revision 6 Groundwater Assessment Area, and given the proximity of this record to areas of minimal groundwater drawdown it is considered likely that its range extends into areas that are classified as undisturbed. Consequently, the level of threat to *nr Notobathyrella* sp. S01 is likely to be low. |
| Troglofauna |
| Twenty species are known only from the proposed pit areas within the Mining Area C EMP Revision 6 Impact Assessment Area. Based on a detailed habitat assessment, the inferred ranges of 17 of the 20 species are considered likely to extend beyond the proposed pit areas. The status of the three remaining species (*Hanseniella* sp. B08, *Symphyella* sp. B03, and *Parapappidae* sp. S05) is uncertain because there is currently little information from which to infer likely ranges of these species. |

#### Mitigation

**Avoid:** Where practical, BHP Billiton Iron Ore will restrict disturbance to the Modified Indicative Impact Assessment Area. With respect to subterranean fauna this restriction will:
- reduce the number of potentially restricted species by seven to none;
- one species of uncertain status has been removed from potential disturbance areas taking it to nine uncertain status species (six troglofauna and three stygofauna);
- three species added to the Modified Indicative Additional Impact Assessment Area, but all are considered unlikely to be restricted to habitats within it.

**Rehabilitate:** BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope. Habitat assessments and a review based on species’ ecology suggests that all but eight of these species are likely to occur outside the indicative impact assessment areas. All but one of these species are currently only known from a single record or drill hole, and therefore there is currently little information from which to infer likely ranges or habitats.

**Offset:** BHP Billiton will continue to undertake research into troglofauna habitats and taxonomy.

#### Outcomes

**Residual Impact:** Implementation of the Proposal will result in a net loss of subterranean fauna habitat. Extensive troglofauna surveys, including the use of leading technology such as optical televiewer and a 3D habitat model, have been undertaken in conjunction with a habitat assessment that has suggested that all but eight species either occur or have habitat available outside of the cumulative impact assessment area. It is noted that all but one of these species are known only from a single record (seven of the eight are singletons) or drill hole, and therefore there is little information from which to infer likely ranges or habitats.

**Stygofauna** species may be impacted by cumulative mining within the Coondewanna and Weeli Wolli sub-catchments. Two of these taxa are only known from a single location and therefore it is difficult to infer species range. The third species has been recorded in bores of another stygofauna species that occurs outside the cumulative area of drawdown, and therefore it is considered likely that it occurs over a similar range.

**Offset:** The level of residual impacts to troglofauna warrant an offset commitment. Therefore, continued study of habitats and distribution of troglofauna within Pilbara will be undertaken to provide information to assist in impact assessment and conservation of this faunal group. This work will be published so that it is available to third-party operators in the Pilbara and will be considered for future mining developments undertaken by BHP Billiton Iron Ore.

This factor is considered a preliminary key environmental factor. The Proposal meets the EPA objective for this factor with the implementation of mitigation and management measures.
### Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

**Note:** Factors that are considered to be preliminary key environmental factors are shaded in light green.

#### Hydrological Processes

**EPA Objective**

To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

<table>
<thead>
<tr>
<th>Potential Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mining Area C EMP Rev 6 Impact Assessment Area [B]</strong></td>
</tr>
<tr>
<td>The modelling and hydrological impact assessment was inclusive of mining of all 14 deposits within the current Mining Area C (Northern Flank) Development Envelope (BHP Billiton Iron Ore, 2015a) (based on the 2014 mine plan). The assessment predicted the following:</td>
</tr>
<tr>
<td>- The maximum dewatering rate may be up to 42,000 kL/d (15.3 GL/a).</td>
</tr>
<tr>
<td>- The maximum cumulative groundwater drawdown (including third-party operations at Hamersley Hope Downs 1 Mine Project) at:</td>
</tr>
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</tr>
<tr>
<td>- Post-closure, the recovery of the groundwater system is likely to take hundreds of years at Coondewanna Flats and Ben’s Oasis, but tens of years at Weeli Wolli Spring.</td>
</tr>
<tr>
<td>- The scenario of leaving open voids at A and E Deposits post-closure is predicted to result in a reduction in the final recovery of groundwater levels, particularly at Coondewanna Flats. All 14 pits at Mining Area C will be backfilled above the historic water table to mitigate this impact at Mining Area C.</td>
</tr>
<tr>
<td>- The surface water system is located within the Fortescue Marsh Catchment Area, within this areas the potential impact of mining 14 deposits within the Mining Area C (Northern Flank) Development Envelope equates to 0.18% of the whole catchment area.</td>
</tr>
</tbody>
</table>

| Cumulative (Proposed Mining Area C Development Envelope) [A + B] |
| Potential impacts, inclusive of potential impacts from the Proposal and existing operations at Mining Area C and those from third party operations in the area (Hope Downs 1) were assessed. The maximum cumulative groundwater drawdown (including third-party operations at Hamersley Hope Downs 1 Mine Project) at: |
| Coondewanna Flats is predicted to be between 8 and 22 m, however, the impact is considered minor as the vegetation has been established to not be groundwater-dependent and surface water impacts are minimal. |
| Ben’s Oasis is likely to be less than approximately 1 m. |
| Weeli Wolli Spring is likely to be between 1 and 2.5 m (after the period of proposed mitigation by Rio Tinto Iron Ore). |
| The impact of the Proposal area is located in the Fortescue Marsh Catchment Area and this impact is predicted to impact less than 1% of the Fortescue Marsh Catchment Area. Ongoing monitoring and adaptive management in line with the objectives outlined in the Central Pilbara Water Resource Management Plan (CPWRMP), will ensure that appropriate mitigation measures (such as managed aquifer recharge and pit backfill) are applied to prevent significant impact to the key ecohydrological receptors. Appropriate mitigation techniques have been tested and are available for implementation. |

#### Mitigation

**Minimal:**

- Surplus dewatering volumes will continue to be used as a process supply to minimise requirement for additional water supply bores within the catchment.
- Consistent with the Department of Water (DoW) Mine Water in Mining Guideline (DoW, 2013b), and where practicable and feasible, surplus groundwater will continue to be preferentially returned to the aquifer through MAR, if volumes are higher than required for process supply. MAR systems will be located in dolomite and alluvial aquifers, effectively storing water for future use by the mine and reducing potential extent of drawdown at Coondewanna Flats.
- Surface water will continue to be diverted around the mining footprint to the extent practicable to minimise the loss of surface water flow in the natural drainage systems.
- Backfilling of below the water table mine voids will be used as required to mitigate potential impacts to ecohydrological receptors.

**Rehabilitate:** BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope.

#### Outcomes

**Residual Impact:** BHP Billiton Iron Ore currently has a plan that incorporates a hierarchy of management options (e.g. monitoring, aquifer recharge) in line with the DoW guidelines for the management of water in the Pilbara region (DoW, 2013a). It is proposed that this plan will be incorporated into the CPWRMP and continue to be used to manage and minimise the residual impacts to hydrological processes for the Mining Area C hub. Approvals issued under Part V of the EP Act and Rights in Water and Irrigation Act 1914 (RIWI Act) SC licence will support the management plan. The residual impact following application of management options and minimisation activities is not considered significant. Implementation of the plan is proposed to be managed via a ministerial condition.

This factor is considered a preliminary key environmental factor. The Proposal meets the EPA objective for this factor; hydrological regimes can be maintained so that environmental values are protected.
### Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

**Inland Waters Environmental Quality**

<table>
<thead>
<tr>
<th>EPA Objective</th>
<th>To maintain the quality of groundwater and surface water so that environmental values are protected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential Impacts</td>
<td></td>
</tr>
<tr>
<td>Indicative Additional Impact Assessment Area for Development of Southern Flank [A]</td>
<td>Proposed surface water modifications (e.g., diversion of natural surface water flows around pit areas) within the Southern Flank ore body development will not materially impact water quality in the surface water catchment. The Proposal will potentially mobilise additional sediment to the natural drainage systems arising from the overburden storage areas (OSAs), ore stockpiles and native vegetation clearing in general. Rainfall and surface water runoff from mining areas has the potential to increase sediment-laden water transmitted to the environment and natural drainage systems. However, the potential for increases in surface water sediment loading will be minimal overall, following the design and implementation of sediment basin interceptors. Groundwater in the Southern Flank deposits is of high quality and as such is suitable for return to groundwater via injection with a low risk to the receiving aquifer water quality. The potential risk for acid and metaliferous drainage (AMD) impacts on groundwater and surface water is considered negligible based on the fact that the waste characterisation shows AMD potential is low to negligible.</td>
</tr>
<tr>
<td>Mining Area C EMP Revision 6 Impact Assessment Area [B]</td>
<td>Proposed pit and OSAs within the additional disturbance have the potential to impact surface water resources by changing local surface water flow patterns, by affecting surface water runoff volumes and quality, by increasing the risk of erosion and sedimentation or by contamination from chemicals or hydrocarbons. Potential impacts on natural surface water quality resulting from the extra disturbance within the Mining Area C EMP Revision 6 Impact Assessment Area are negligible. The impact assessment undertaken concluded that the potential for AMD is low due to the oxidised nature of the ore. Impacts to surface water due to chemical or hydrocarbon spills potentially occur but this is not expected to be an issue due to the installation of appropriate fuel, hydrocarbon and chemical containment and storage facilities.</td>
</tr>
<tr>
<td>Cumulative (Proposed Mining Area C Development Envelope) [A + B]</td>
<td>Proposed surface water modifications will not materially impact water quality in the surface water catchment. Groundwater in the catchments is of high quality and as such is suitable for return to groundwater via injection with a low risk to receiving aquifer water quality. The potential risk for AMD impacts on groundwater and surface water is considered negligible across the Proposed Mining Area C Development Envelope.</td>
</tr>
<tr>
<td>Mitigation</td>
<td>Avoid: Diversion of surface water around operational mining area to maintain natural surface water flows downstream. Minimise: Implementation of sedimentation basin to reduce sediment in surface water. Rehabilitate: BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Residual impact: Preliminary AMD analysis and risk assessment have shown that the risk of AMD impacts to water quality as low to negligible. This coupled with the business preference to back fill below water table (BWT) pit voids to manage water quality within the local water catchments means that it is not anticipated that water quality will be significantly affected as a result of implementation of the Proposal. The Proposal meets the EPA’s objective for this factor. Following impact assessment this factor is not considered likely to have a significant impact. BHP Billiton Iron Ore therefore considers that Inland Waters Environmental Quality is not a key environmental factor and can be addressed under Part V of the EP Act and the RIWI Act licencing.</td>
</tr>
</tbody>
</table>

*Note: Factors that are considered to be preliminary key environmental factors are shaded in light green.*
### Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

<table>
<thead>
<tr>
<th>EPA Objective</th>
<th>Heritage</th>
</tr>
</thead>
<tbody>
<tr>
<td>To ensure that historical and cultural associations are not adversely affected.</td>
<td></td>
</tr>
<tr>
<td>(Note: this factor now forms part of Social Surroundings factor whose objective is To protect social surroundings from significant harm)</td>
<td></td>
</tr>
</tbody>
</table>

#### Potential Impacts

<table>
<thead>
<tr>
<th>Cumulative (Proposed Mining Area C Development Envelope)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Proposed Mining Area C Development Envelope lies mostly within the Banjima Native Title claim, with the southeast corner lying within the Nyiyaparli Native Title claim. BHP Billiton Iron Ore is committed to working cooperatively with the Banjima and Nyiyaparli people and has formalised this commitment through comprehensive Indigenous Land Use Agreements (ILUAs) executed with the Nyiyaparli people in 2012 and the Banjima people in October 2015. The ongoing dialogue and consultation established via the ILUAs will continue. To date, up to 200 archaeological and ethnographical surveys have been conducted in the Proposed Mining Area C Development Envelope in consultation with the Banjima and Nyiyaparli people. Over 1,500 potential heritage places have been identified within this development envelope, of which 75% occur within the indicative impact assessment areas. All places are classed as ‘other place’s or as ‘site’s as per Section 5 of the Aboriginal Heritage Act 1972 (AH Act). No places located within the Proposed Development Envelope are classed as government protected, exclusion zones or managed areas. All section 5 classed sites are managed in compliance with the ILUAs and the AH Act. The Proposal will impact 17 archaeological sites and partially impact (~30%) one ethnographic site in addition to those already impacted within the Mining Area C EMP Revision 6 Impact Assessment Area. Although more intensive surveys have been undertaken within the Development Envelope than elsewhere within the Banjima claim area, resulting in an overestimation of impacts regionally, the estimated impact regionally to heritage places based on current data represents approximately 25% of the places within the claim area.</td>
</tr>
</tbody>
</table>

#### Mitigation

**Avoid:**
- The Proposed Mining Area Development Envelope specifically avoided the Mount Robinson exclusion area.
- The mine plan and design was modified to avoid, where practical, heritage places. This resulted in approximately 15% of heritage places being avoided

**Minimise:**
- Heritage places have been recorded to a detailed level to mitigate against their loss. The detailed recording is considered a mitigation as it preserves the information contained in the site.
- An extensive excavation project has been undertaken in partnership with the relevant Traditional Owners to better understand the cultural landscape and the sequence of early occupation of the area to ensure any impacts to the landscape are minimised.

**Rehabilitate:** BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope.

#### Outcomes

**Residual Impact:** The impacts predicted from implementation of the Proposal do not present a significant impact to biophysical features of heritage significance.

**Offset:** The significance of impact does not warrant application of offsets.

The Proposal meets the EPA’s objective for this factor. Following impact assessment, this factor is not considered likely to have a significant impact, therefore it is not considered a key environmental factor by BHP Billiton Iron Ore. BHP Billiton Iron Ore considers that this factor can be managed under the AH Act.
### Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

**Note:** Factors that are considered to be preliminary key environmental factors are shaded in light green.

<table>
<thead>
<tr>
<th>EPA Objective</th>
<th>To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State</th>
</tr>
</thead>
</table>
| Potential Impacts | **Indicative Additional Impact Assessment Area for Development of Southern Flank [A]**  
The proposed mine closure strategy will take an adaptive management approach for the Proposed Mining Area C Development Envelope. Key focus areas will be:  
- erodibility of final OSA (landform) design, including ongoing assessment of waste material;  
- management and or mitigation of potential groundwater impacts as a results of BWT pit voids or lakes; and  
- validation of the low acid and metalliferous drainage (AMD) risk.  
Ongoing monitoring of groundwater drawdown and any impacts on ecohydrological receptors (for example, Weeli Wolli Spring), will be the main adaptive management closure drivers at Southern Flank.  
This outcome-oriented strategy will, where required, mitigate impacts on receptors by BWT pit voids in the Additional Development Envelope to above the water table with inert waste material, minimise legacy issues associated with empty pits post-mining and reduce final OSA landform area for rehabilitation through operations dumping waste material in-pit, as much as practicable.  
No tailings storage facilities are planned as part of the Proposal. |
|                 | **Mining Area C EMP Revision 6 Impact Assessment Area [B]**  
The current approved Mine Closure Plan is to continue backfilling depleted pits within the Mining Area C (Northern Flank) Development Envelope with waste material in accordance with the mine plan and where practicable to minimise legacy issues associated with voids post-mining and impact on final landforms.  
This is reflected in the updated Mining Area C Mine Closure Plan. |
|                 | **Cumulative (Proposed Mining Area C Development Envelope) [A + B]**  
Alterations of landforms, management of AMD, OSA rehabilitation, backfill of BWT pits to above the water table, and landform engineering (abandonment bunds) remain key closure aspects in the updated Mining Area C Mine Closure Plan. |

| Mitigation | **Avoid:** Ensure pit abandonment bunds adequately control unauthorised pit access post-closure for pits adjacent the Great Northern Highway. If required, removing open-pit edges by backfilling material to buttress pit walls may be necessary.  
**Minimise:**  
- Augmentation of aquifer recovery should aquifer recovery time lag post-closure prove unacceptable.  
- Ongoing monitoring of groundwater drawdown.  
**Rehabilitate:**  
- BHP Billiton Iron Ore will undertake progressive rehabilitation within the Proposed Mining Area C Development Envelope.  
- Armouring component of OSA rehabilitation based on using local competent material and adaptive management to achieve erosionally stable final OSA slope angles.  
- Final landform revegetation - topsoil material placed on the outer surface of landforms with consideration of growth media characteristics and depth required for suitable plant growth for establishing the target vegetation community and supporting agreed final land use.  
- Backfilling of below the water table pit voids to above the pre-mining water table, as required, based on impacts to key ecohydrological receptors. |
| Outcomes | **Residual Impact:** BHP Billiton Iron Ore considers that potential residual impacts are low and propose that impacts can be managed via implementation of the Mine Closure Plan. Implementation of the plan is proposed to be managed via a Ministerial condition.  
This factor is considered a preliminary key environmental factor. The Proposal meets the EPA objective for this factor. |
**Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)**

**Offsets**

<table>
<thead>
<tr>
<th>EPA Objective</th>
<th>To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th><strong>Offsets</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicative Additional Impact Assessment Area for Development of Southern Flank</strong></td>
<td>Clearing of an additional 13,858 ha of Very Good to Excellent condition vegetation will be required to implement the development of the Southern Flank ore body. Where significant residual impacts are identified following rehabilitation of up 13,858 ha, BHP Billiton Iron Ore will provide environmental offsets via the Pilbara Conservation Fund, or alternatively, delivered consistent with contemporary offset guidance. Approximately 4,239 ha of High suitability SRE habitat occurs in the Indicative Additional Impact Assessment Area (a majority of this is habitat for <em>Antichiropus ‘DIP007’</em>). It is considered that removal of this habitat will likely have a moderate to high impact on SRE fauna.</td>
</tr>
<tr>
<td><strong>Mining Area C EMP Rev 6 Impact Assessment Area</strong></td>
<td>Clearing of an additional 5,942 ha of Very Good to Excellent condition vegetation within the 11,377 ha Mining Area C EMP Revision 6 Impact Assessment Area will be required to facilitate the development of the Southern Flank ore body. Where significant residual impacts are identified following rehabilitation of up 5,942 ha, BHP Billiton Iron Ore will provide environmental offsets via the Pilbara Conservation Fund, or alternatively, delivered consistent with contemporary offset guidance. Approximately 612 ha of High suitability SRE habitat occurs in the Mining Area C EMP Revision 6 Impact Assessment Area. It is considered that removal of this habitat will likely have a moderate to high impact on SRE fauna.</td>
</tr>
<tr>
<td><strong>Cumulative (Proposed Mining Area C Development Envelope)</strong></td>
<td>Total native vegetation clearing if the Proposal is approved will be 25,185 ha (of which 19,671.2 ha relates to this Proposal) within the Proposed Mining Area C Development Envelope. The majority of this vegetation is considered to be in Very Good or better condition. Rehabilitation of up to 19,671.2 ha is proposed as part of the Southern Flank Mine Closure Plan.</td>
</tr>
</tbody>
</table>

| Mitigation | Modification of the Indicative Additional Impact Assessment Area has increased the number of ghost bat caves retained from 12 to 27 (11 high value), and the removal of foraging habitat has been reduced by 173 ha. BHP Billiton Iron Ore will commit to retaining a 150 m buffer around all ghost bats roosts that occur outside the Mining Area C Revision 6 EMP Impact Assessment Area and the Modified Indicative Additional Impact Assessment Area. Modification of the Indicative Additional Impact Assessment Area has reduced clearing of Medium and High value fauna habitats as follows:  
- Gorge/Gully – clearing reduced from 465 ha to 383 ha.  
- Crest/Slope – clearing reduced from 6,427 ha to 6,414 ha.  
- Major Drainage Line – clearing reduced from 21 ha to 0 ha.  
- Mulga – clearing reduced from 874 ha to 496 ha.  
- Sand Plain – clearing reduced from 429 ha to 135 ha.  
Rehabilitation of SRE habitat areas with *Corymbia hamersleyana*. |

| Outcomes | Where significant residual impacts are identified following rehabilitation, BHP Billiton Iron Ore will provide environmental offsets via the Pilbara Conservation Fund, or alternatively, delivered consistent with contemporary offset guidance. With the application of mitigation measures, it is likely that the total vegetation clearing can be reduced to 15,693 ha, however a conservative offset amount of 19,671.2 ha is proposed. BHP Billiton Iron Ore further proposes:  
- Continued study of the ecology of the ghost bat in the Pilbara will be undertaken to contribute to the current understanding of this species.  
- Funding additional studies on troglofauna habitats and taxonomy to further understand of species and their distribution in the Pilbara. This could include environmental DNA studies and taxonomic study of Diplurans.  
This factor is considered a preliminary key environmental factor. The Proposal meets the EPA objective for this factor; residual environmental impacts and/or uncertainty have been addressed through the application of offsets. |
Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)  

**EPA Objective**  
To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.

<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>Landforms</th>
</tr>
</thead>
</table>
| **Indicative Additional Impact Assessment Area for Development of Southern Flank (A)** | The following land systems are located within the Additional Development Envelope:  
- Newman;  
- Boolgeeda;  
- Platform; and  
- Wannamunna.  
The following SMUs have been recorded within the Additional Development Envelope:  
- ridgelines;  
- scree slopes;  
- undulating stony plains;  
- drainage lines; and  
- hardpan wash plains.  
The soils and landforms in the Indicative Additional Impact Assessment Area are not considered rare or important in the Pilbara region and they are not of scientific interest or play an integral role in maintaining existing ecological or physical processes in the region. |
| **Mining Area C EMP Revision 6 Impact Assessment Area (B)** | The following land systems are located within the Approved Mining Area C Development Envelope:  
- Newman;  
- Boolgeeda;  
- Platform; and  
- Wannamunna.  
The following SMUs have been recorded within the Approved Mining Area C Development Envelope:  
- ridgelines;  
- scree slopes;  
- undulating stony plains; and  
- drainage lines.  
The soils and landforms in the Mining Area C EMP Revision 6 Impact Assessment Area are not considered rare or important in the Pilbara region and they are not of scientific interest or play an integral role in maintaining existing ecological or physical processes in the region. |
| **Cumulative (Proposed Mining Area C Development Envelope) (A + B)** | Overall, the following land systems are located within the Proposed Mining Area C Development Envelope:  
- Newman;  
- Boolgeeda;  
- Platform; and  
- Wannamunna.  
The following SMUs have been recorded within the Proposed Mining Area C Development Envelope:  
- ridgelines;  
- scree slopes;  
- undulating stony plains;  
- drainage lines; and  
- hardpan wash plains.  
Landforms within the Proposed Mining Area C Development Envelope are not considered rare, of scientific interest or of ecological importance. The variety and integrity of the landforms in the region will not be significantly altered in the region as a result of the Proposal. |

**Mitigation**  
As the impacts are not significant, no application of the mitigation hierarchy is required. This factor can be adequately managed via the updated Mine Closure Plan.

**Outcomes**  
Landforms within the Proposed Mining Area C Development Envelope are not considered rare, of scientific interest or of ecological importance. The variety and integrity of the landforms in the region will not be significantly altered in the region as a result of the Proposal.  
Following impact assessment, BHP Billiton Iron Ore considers that the Proposal meets the EPA’s objective for this factor. Landforms is therefore not considered a key environmental factor for this Proposal and can be addressed under Part V of the EP Act.
### Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

#### Terrestrial Environmental Quality

<table>
<thead>
<tr>
<th>EPA Objective</th>
<th>To maintain the quality of land and soils so that environmental values are protected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicative Additional Impact Assessment Area for Development of Southern Flank (A)</td>
<td>A preliminary AMD Risk Assessment (BHP Billiton Iron Ore, 2016b) has been carried out for the Southern Flank Development. This study assessed AMD potential as low to very low. Within the resource and mining model, no blocks of fresh rock with acid-forming potential, classified as AMD 1 (NAPP greater than or equal to 3), and were identified. Minor amounts of weathered and detrital material (less than 3.5% overall), designated AMD 2 and 3, respectively, is present; however, sulphur in this material is likely oxidised and unlikely to have acid-generating capacity. Ongoing geochemical assessment will be undertaken to validate risks assessed for AMD 2 and 3 material.</td>
</tr>
</tbody>
</table>
| Mining Area C EMP Revision 6 Impact Assessment Area (B) | Potential sources of impacts include mining of potentially acid-forming (PAF) material during operations, generation of waste materials, and storage and handling of dangerous goods. Potential sources of AMD during operations are:  
- mine waste and by association OSAs;  
- pits (pit wall, wall rock).  
Mining Area C is a low-sulphur system, with material classified as PAF characterised by a low net acid production potential (NAPP) of an average less than 5 to 6 kg H2SO4/t (sulfuric acid per tonne) and thus not likely to generate elevated acidity. Potential impacts from contamination are considered low for Mining Area C operations. Existing waste disposal procedures and practices are considered to be effective and PAF and AMD are managed through the Mine Closure Plan. |
<p>| Cumulative (Proposed Mining Area C Development Envelope) (A + B) | Overall, potential impacts from contamination are low for the Proposal. Existing waste disposal procedures and practices are considered effective. |
| Mitigation | Precautions will be taken for materials that have been found to have minor amounts of weathered and detrital materials by placing them more than 10 m from the final OSA rehabilitation surfaces. Approvals under Part V of the EP Act and under the Dangerous Goods Safety Act 2004 (WA) will be sought for the handling and storage of dangerous goods and the construction and operation of landfills. |
| Outcomes | The potential impact to Terrestrial Environmental Quality as a result of the Proposal are considered not significant and the EPA objective can be met. Following impact assessment, BHP Billiton Iron Ore considers that the Proposal meets the EPA’s objective for this factor. Terrestrial Environmental Quality is therefore not considered a key environmental factor for this Proposal and can be addressed under Part V of the EP Act. |</p>
<table>
<thead>
<tr>
<th>Potential Impacts</th>
<th>EPA Objective</th>
<th>Note: Factors that are considered to be preliminary key environmental factors are shaded in light green.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Quality</strong></td>
<td>To maintain air quality and minimise emissions so that environmental values are protected.</td>
<td></td>
</tr>
<tr>
<td><strong>EPA Objective</strong></td>
<td>The BHP Billiton Iron Ore licence for Newman was used as guidance to assess the significance of impacts from the Southern Flank Development. Air quality modelling undertaken for the prediction of potential impacts was carried out under worst-case meteorological and mining configuration (i.e. mining activity nearest the receptors and at maximum volume). While the maximum predicted particulate concentrations at the accommodation camps is slightly above the guidance, ongoing monitoring of background air quality shows that this is typical of the Pilbara region. It is expected that, with the use of fixed plant engineered controls, proactive operational controls and changes already implemented in mine design, these impacts can be minimised and the EPA objective can be met.</td>
<td></td>
</tr>
<tr>
<td><strong>Indicative Additional Impact Assessment Area for Development of Southern Flank</strong></td>
<td>The BHP Billiton Iron Ore licence for Newman was used as guidance to assess the significance of impacts from the Southern Flank Development. Air quality modelling undertaken for the prediction of potential impacts was carried out under worst-case meteorological and mining configuration (i.e. mining activity nearest the receptors and at maximum volume). While the maximum predicted particulate concentrations at the accommodation camps is slightly above the guidance, ongoing monitoring of background air quality shows that this is typical of the Pilbara region. It is expected that, with the use of fixed plant engineered controls, proactive operational controls and changes already implemented in mine design, these impacts can be minimised and the EPA objective can be met.</td>
<td></td>
</tr>
<tr>
<td><strong>Mining Area C EMP Revision 6 Impact Assessment Area</strong></td>
<td><strong>Mining Area C EMP Revision 6 Impact Assessment Area</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cumulative (Proposed Mining Area C Development Envelope)</strong></td>
<td>Within the Approved Mining Area C Development Envelope there are two owned and managed accommodation camps: Packsaddle and Mulla Mulla. Air quality monitoring undertaken for the prediction of potential impacts was carried out under worst case meteorological and mining configuration (i.e. mining activity nearest the receptors and at maximum volume). The 95th percentile prediction of PM(_{10}) ground level concentrations are 59 µg/m(^3) at the Packsaddle accommodation village and 44 µg/m(^3) at the Mulla accommodation village with standard controls included. Based on these predictions, it can be concluded that implementation of the Proposal will not result in air quality impacts that could be considered significant as they are typical of the Pilbara region, as natural background levels have been measured as similar to these predictions.</td>
<td></td>
</tr>
<tr>
<td><strong>Mitigation</strong></td>
<td>BHP Billiton Iron Ore designs and implements a series of fixed pant and mobile plant dust abatement controls. These include but are not limited to foggers, water canyons, surfactants, belt washes. These controls will minimise potential impacts to air quality.</td>
<td></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Following impact assessment, BHP Billiton Iron Ore considers that the Proposal meets the EPA’s objective for this factor. Air quality is therefore not considered a key environmental factor for this Proposal.</td>
<td></td>
</tr>
<tr>
<td>Amenity</td>
<td>EPA Objective</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Amenity</td>
<td>To ensure that impacts to amenity are reduced as low as reasonably practicable.</td>
<td></td>
</tr>
<tr>
<td>Potential Impacts</td>
<td>Indicative Additional Impact Assessment Area for Development of Southern Flank (A)</td>
<td>Six key viewpoint sites were identified and analysed for potential visual impacts. Visibility risk to the Great Northern Highway as a result of particulate emissions was assessed. The visual impact of the Proposal along the Great Northern Highway adjacent to the Proposal is predicted to be moderate. It is predicted that for approximately 30% of the year there is a medium risk (visibility of 2 km or less) to visibility along the highway when mining is occurring in the near vicinity of the highway with detrimental wind conditions.</td>
</tr>
<tr>
<td>Potential Impacts</td>
<td>Mining Area C EMP Revision 6 Impact Assessment Area (B)</td>
<td>Nine potential key viewpoint sites were identified and analysed for potential impacts to view sheds. The highest potential impact to a view shed is along the Great Northern Highway located immediately east of the Approved Mining Area C Development Envelope.</td>
</tr>
<tr>
<td>Potential Impacts</td>
<td>Cumulative (Proposed Mining Area C Development Envelope)</td>
<td>[A + B]</td>
</tr>
<tr>
<td>Mitigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitigation</td>
<td>The mine design has been modified to relocate OSAs further from the Great Northern Highway to reduce visibility and amenity impacts to highway users. BHP Billiton Iron Ore will, where practical, restrict vegetation clearing and undertake progressive rehabilitation of OSAs and associated mining infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcomes</td>
<td>Following impact assessment, BHP Billiton Iron Ore considers that the Proposal meets the EPA’s objective for this factor. Amenity is therefore not considered a key environmental factor for this Proposal and can be addressed under Part V of the EP Act.</td>
<td></td>
</tr>
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Table ES-1: Summary of potential impacts, proposed mitigation and outcomes (continued)

<table>
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<tr>
<th>Human Health (Noise)</th>
<th>Note: Factors that are considered to be preliminary key environmental factors are shaded in light green.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EPA Objective</strong></td>
<td>To protect human health from significant harm.</td>
</tr>
<tr>
<td><strong>Indicative Additional Impact Assessment Area for Development of Southern Flank [A]</strong></td>
<td>Under worst-case meteorological conditions and worst-case mining locations (fleet located at the surface and closest to the camps), received noise levels at the Packsaddle Accommodation Village are below assigned night time noise regulations (less than 35 dB (A)). At the Mulla Accommodation Village, noise levels under worst-case conditions are predicted to be up to 4.3 dB (A) above the 35 dB (A) assigned noise level. However, modelling was undertaken for the worst-case scenario (mining at highest rates nearest receptors and during worst-case meteorological conditions). It is highly likely that the assigned noise levels will be met as this worst-case scenario is highly unlikely to occur. Indoor noise levels at the accommodation camps are predicted to be 11.8 dB (A) and are therefore compliant with the Australian standard of less than 25 dB (A) for indoor noise.</td>
</tr>
<tr>
<td><strong>Mining Area C EMP Revision 6 Impact Assessment Area [B]</strong></td>
<td>Received noise levels are predicted to be below assigned noise levels. BHP Billiton Iron Ore will continue to manage Mining Area C operations to protect the amenity of occupants at the camps from noise and vibration impacts resulting from activities associated with the operations.</td>
</tr>
<tr>
<td><strong>Cumulative (Proposed Mining Area C Development Envelope) [A + B]</strong></td>
<td>The potential noise impacts resulting from the Proposal and current operations at the Mining Area C hub are in line with requirements of the Environmental Protection (noise) regulations.</td>
</tr>
<tr>
<td><strong>Mitigation</strong></td>
<td>Where possible BHP Billiton Iron Ore will minimise night time mining activities undertaken near key receptors.</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Following impact assessment, BHP Billiton Iron Ore considers that the Proposal meets the EPA’s objective for this factor. Human health (noise) is therefore not considered a key environmental factor for this Proposal.</td>
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<th>Meaning</th>
</tr>
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<tbody>
<tr>
<td>%</td>
<td>percent</td>
</tr>
<tr>
<td>ACMC</td>
<td>Aboriginal Cultural Material Committee</td>
</tr>
<tr>
<td>AER</td>
<td>annual environmental report</td>
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<tr>
<td>AH Act</td>
<td>Aboriginal Heritage Act 1972 (WA)</td>
</tr>
<tr>
<td>Air NEPM</td>
<td>Ambient Air Quality National Environment Protection Measure</td>
</tr>
<tr>
<td>AMD</td>
<td>acid and metalliferous drainage</td>
</tr>
<tr>
<td>ARI</td>
<td>average recurrence interval</td>
</tr>
<tr>
<td>BHP Billiton Iron Ore</td>
<td>One of the BHP Billiton businesses</td>
</tr>
<tr>
<td>BIF</td>
<td>banded iron formation</td>
</tr>
<tr>
<td>BWT</td>
<td>below water table</td>
</tr>
<tr>
<td>CAR</td>
<td>Comprehensive, adequate, representative (National Reserve System)</td>
</tr>
<tr>
<td>CO₂-e</td>
<td>Carbon Dioxide Equivalent</td>
</tr>
<tr>
<td>CPWRMP</td>
<td>Central Pilbara Water Resource Management Plan</td>
</tr>
<tr>
<td>DAA</td>
<td>Department of Aboriginal Affairs</td>
</tr>
<tr>
<td>dB(A)</td>
<td>Decibels (A-weighted), Loudness a perceived by the human ear</td>
</tr>
<tr>
<td>DEC</td>
<td>Department of Environment and Conservation (now DPaW)</td>
</tr>
<tr>
<td>DER</td>
<td>Department of Environment Regulation</td>
</tr>
<tr>
<td>development envelope</td>
<td>‘The maximum area within which the disturbance footprint will be located’ as per the requirements of Environmental Assessment Guideline 1 for Defining the Key Characteristics of a Proposal (EAG 1) (EPA, 2012a).</td>
</tr>
<tr>
<td>DMA</td>
<td>Decision Making Authority</td>
</tr>
<tr>
<td>DMP</td>
<td>Department of Mines and Petroleum</td>
</tr>
<tr>
<td>DoW</td>
<td>Department of Water</td>
</tr>
<tr>
<td>DoTE</td>
<td>Department of the Environment (now Department of Environment and Energy)</td>
</tr>
<tr>
<td>DPaW</td>
<td>Department of Parks and Wildlife</td>
</tr>
<tr>
<td>EAG</td>
<td>environmental assessment guideline</td>
</tr>
<tr>
<td>environmental factor</td>
<td>‘An environmental factor is described as the part of the environment that may be impacted by an aspect of the proposal. There are 15 environmental factors which have been selected to be relevant and practical for the EIA process.’ (EPA, 2013b)</td>
</tr>
<tr>
<td>EIA</td>
<td>environmental impact assessment</td>
</tr>
<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
</tr>
<tr>
<td>EMS</td>
<td>environmental management system</td>
</tr>
<tr>
<td>EP Act</td>
<td>Environmental Protection Act 1986 (WA)</td>
</tr>
<tr>
<td>EPBC Act</td>
<td>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Authority</td>
</tr>
<tr>
<td>ESD</td>
<td>environmental scoping document</td>
</tr>
<tr>
<td>GARD</td>
<td>Global Acid Rock Drainage</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic information systems</td>
</tr>
<tr>
<td>GL/a</td>
<td>gigalitre per annum</td>
</tr>
<tr>
<td>ha</td>
<td>hectare</td>
</tr>
<tr>
<td>H₂SO₄</td>
<td>Sulfuric Acid</td>
</tr>
<tr>
<td>Hope Downs 1</td>
<td>Refers to the third party mine operated Hamersley Hope 1 Mine Project located to the east of the Proposed Mining Area C Development Envelope</td>
</tr>
<tr>
<td>IBRA</td>
<td>Interim Biogeographic Regionalisation for Australia</td>
</tr>
<tr>
<td>ILUA</td>
<td>Indigenous Land Use Agreements</td>
</tr>
<tr>
<td>key environmental factor</td>
<td>‘A factor is termed a key environmental factor if the EPA considers that there is currently a lack of confidence that the proposal is likely to meet the environmental objective for that factor. Key environmental factors are</td>
</tr>
<tr>
<td>Abbreviation, Acronym or Key Terminology</td>
<td>Meaning</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>considered through the full assessment process. At the conclusion of its assessment, the EPA reports to the Minister for Environment on the key environmental factors.' (EPA, 2013b)</td>
<td></td>
</tr>
<tr>
<td>kL</td>
<td>Kilolitres</td>
</tr>
<tr>
<td>kL/d</td>
<td>Kilolitres per day</td>
</tr>
<tr>
<td>km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>km²</td>
<td>Square kilometre</td>
</tr>
<tr>
<td>LA10</td>
<td>is the noise level just exceeded for 10% of the measurement period, A-weighted and calculated by Statistical Analysis</td>
</tr>
<tr>
<td>m</td>
<td>Metre</td>
</tr>
<tr>
<td>mbgl</td>
<td>Metre below ground level</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetres</td>
</tr>
<tr>
<td>mm/s</td>
<td>Millimetres per second</td>
</tr>
<tr>
<td>μm</td>
<td>Micrometre</td>
</tr>
<tr>
<td>mg/L</td>
<td>Milligram per litre</td>
</tr>
<tr>
<td>MS</td>
<td>Ministerial Statement</td>
</tr>
<tr>
<td>mitigation hierarchy</td>
<td>‘There are four steps in the mitigation hierarchy – avoid, minimise, rehabilitate and offset. It is expected that the first three steps of the mitigation hierarchy are to be applied to the greatest extent practicable before determining the residual impact and, if significant, any consideration of an offset.’ (Government of Western Australia, 2014)</td>
</tr>
<tr>
<td>ML/d</td>
<td>Megalitre per day</td>
</tr>
<tr>
<td>Mt</td>
<td>Million tonnes</td>
</tr>
<tr>
<td>Mtpa</td>
<td>Million tonnes per annum</td>
</tr>
<tr>
<td>NAPP</td>
<td>Net acid production potential</td>
</tr>
<tr>
<td>NVCP</td>
<td>Native vegetation clearing permit</td>
</tr>
<tr>
<td>OEPA</td>
<td>Office of the Environmental Protection Authority</td>
</tr>
<tr>
<td>OLC</td>
<td>Overland conveyor</td>
</tr>
<tr>
<td>OSA</td>
<td>Overburden storage area</td>
</tr>
<tr>
<td>P1, P2, P3, P4</td>
<td>Priority 1, 2, 3 or 4 flora or fauna species, as determined by the Department of Parks and Wildlife and maintained on the Priority flora and fauna list.</td>
</tr>
<tr>
<td>PAF</td>
<td>Potentially acid-forming</td>
</tr>
<tr>
<td>PEAHR</td>
<td>Project Environment and Aboriginal Heritage Review</td>
</tr>
<tr>
<td>PEC</td>
<td>Priority Ecological Community</td>
</tr>
<tr>
<td>PER</td>
<td>Public Environmental Review</td>
</tr>
<tr>
<td>PM10</td>
<td>Particulate matter with an equivalent aerodynamic equal to or less than 10 μm in diameter.</td>
</tr>
<tr>
<td>preliminary key environmental factor</td>
<td>‘At the level of assessment stage, the key environmental factors are described as preliminary key environmental factors, as further consideration through the assessment process may either confirm them as key environmental factors, or find that they are no longer key environmental factors as the objective can be met without the need for conditions.’ (EPA, 2013b)</td>
</tr>
<tr>
<td>Proposal</td>
<td>To develop and operate a new satellite iron ore deposit located immediately south of the existing Mining Area C operation at Southern Flank which will become part of the Mining Area C operations</td>
</tr>
<tr>
<td>RIWI Act</td>
<td>Rights in Water and Irrigation Act 1914 (WA)</td>
</tr>
<tr>
<td>SMUs</td>
<td>Soil management units</td>
</tr>
<tr>
<td>SRE</td>
<td>Short-range endemic</td>
</tr>
<tr>
<td>TAR</td>
<td>Triennial aquifer review</td>
</tr>
<tr>
<td>TSP</td>
<td>Total suspended particulates</td>
</tr>
<tr>
<td>WAIO</td>
<td>Western Australia Iron Ore – represents the same entity as BHP Billiton Iron Ore</td>
</tr>
<tr>
<td>Abbreviation, Acronym or Key Terminology</td>
<td>Meaning</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>WC Act</td>
<td><em>Wildlife Conservation Act 1950 (WA)</em></td>
</tr>
<tr>
<td>WCED</td>
<td>World Commission on Environment and Development</td>
</tr>
<tr>
<td>WMAT</td>
<td>waste material</td>
</tr>
</tbody>
</table>
1. Introduction

1.1 Overview and purpose

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) currently operates an iron ore mining operation at Mining Area C (Northern Flank) under Ministerial Statement (MS) 491, located approximately 100 kilometres (km) northwest of Newman township in the Pilbara region of Western Australia (Figure 1). BHP Billiton Iron Ore is seeking environmental approval under Part IV of the Environmental Protection Act 1986 (EP Act) to develop and operate a satellite ore body at Southern Flank as part of its Mining Area C operations and to expand the scope of disturbance currently approved at the Mining Area C hub (the Proposal) (Figure 2) under a single ministerial statement and development envelope (Proposed Mining Area C Development Envelope) (Figure 3).

Other BHP Billiton Iron Ore deposits are reaching the end of their economic life, with available ore reserves insufficient to meet current production volume by approximately 2020. Additional ore sources are required to provide sufficient feed to sustain the current level of iron ore production from the BHP Billiton Iron Ore Pilbara mines. The Southern Flank ore body has been identified as one option to sustain current quantities of iron ore.

The Proposal will involve conventional open-pit iron ore mining of the mineralised Marra Mamba Iron Formation. The bulk of this orebody lies above the water table but will require mine dewatering for the ore below the water table in advance to facilitate dry mining conditions.

A Referral Form was submitted for the Proposal in accordance with s38(1) of the EP Act and the Western Australian Environmental Protection Authority’s (EPA) General Guide on Referral of Proposals (EPA, 2010). The level of assessment was set as a Public Environmental Review (PER) with a 4-week public review period.

The purpose of this PER is to provide information to the public, EPA and other decision making authorities (DMAs) on the Proposal and its potential environmental impacts. The PER will also support the EPA’s environmental impact assessment (EIA) of the Proposal. This document provides information regarding the preliminary key environmental factors that were determined in the Environmental Scoping Document (ESD) (EPA, 2016b) and other environmental factors relevant to the Proposal, as well as details of a range of technical studies that have been carried out to address potential impacts for each of the relevant environmental factors.

BHP Billiton Iron Ore has used extensive regional data sets to undertake environmental impact assessments, resulting in a high degree of confidence in the identification of potential environmental impacts. Where residual impacts have been assessed as significant the application of the mitigation hierarchy has resulted in a reduction of potential impacts and the EPA objective being met. Where there is technical or data uncertainty, this has been documented and the precautionary principle applied.

BHP Billiton Iron Ore has comprehensively evaluated the characteristics and potential impacts of this Proposal and considers that, with the proposed management measures, this Proposal meets the EPA objectives.

1.2 The proponent

This Proposal is submitted by BHP Billiton Iron Ore of 125 St. George’s Terrace, Perth, Western Australia, acting as manager and agent for the proponent, Mount Goldsworthy Joint Venture.
The Mount Goldsworthy Joint Venture comprises the companies listed below with their respective interests:

- BHP Billiton Minerals Pty Ltd (ABN 93 008 694 782) 85%;
- Mitsui Iron Ore Corporation Pty Ltd (ABN 16 050 157 456) 7%; and
- Itochu Minerals & Energy of Australia Pty (ABN 44 009 256 259) 8%.

BHP Billiton Iron Ore has the authority to act for the Mount Goldsworthy Joint Venture and is authorised as the manager and agent of the proponent to submit this Proposal and execute the works as approved (Appendix 1). All references to BHP Billiton Iron Ore in this PER are references to it acting in that capacity.

1.3 Proposal location and tenure

The Proposal area is located in the Pilbara region of Western Australia (Figure 1) and is located approximately 100 km northwest of the Newman township in the Pilbara region of Western Australia (Figure 2). The Southern Flank ore body is positioned approximately 8 km south of BHP Billiton Iron Ore’s Mining Area C Development Envelope (Figure 2). The Proposal area is located primarily on Mineral Lease ML281SA and therefore also subject to the same State Agreement legislation as the current mining operations at Mining Area C (Figure 3).

1.4 The Proposal context

BHP Billiton Iron Ore proposes to extract approximately 80 million tonnes per annum (Mtpa) of iron ore from the Southern Flank orebody, or a total of approximately 150 Mtpa from the Mining Area C operation. The Southern Flank orebody represents an option for long-term replacement of the BHP Billiton Iron Ore Yandi Operations. The Proposal is predominately comprised of above water table mining through conventional open-cut mining methods, however will involve extraction of groundwater in advance of mining to allow campaign mining of iron ore and overburden below the groundwater table.

The existing Mining Area C operation comprises approval for 14 deposits under MS 491. The Southern Flank orebody will form part of the Mining Area C operation and if approved will operate under a new single MS, and MS 491 will be superseded. Therefore, this Proposal is a Revised Proposal.

BHP Billiton Iron Ore is currently seeking approval of a Strategic Proposal in respect to development of new iron ore mines, expansion of existing iron ore mines and associated infrastructure in the Pilbara under the strategic assessment provisions of the Western Australian EP Act and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Southern Flank orebody development was originally included within the scope of the Strategic Proposal being assessed under the EP Act (BHP Billiton Iron Ore, 2016c). To meet Business requirements, BHP Billiton Iron Ore requested under s43A of the EP Act for the exclusion of the Southern Flank deposit from the Strategic Proposal, in February 2016. The EPA consented to this request on 14 March 2016. While the Proposal has been excised from the scope of the Strategic Proposal, impacts of the Proposal are included in the cumulative impact assessment that was undertaken for the Strategic Proposal.

The Southern Flank deposit was not excluded from the scope of the Strategic Proposal being assessed under the EPBC Act (BHP Billiton Iron Ore, 2016d). If the Commonwealth Strategic Proposal is approved, the Proposal will be subject to requirements of the Program endorsed by the Commonwealth Environment Minister and conditions of the class of actions decision. These approvals will regulate potential impacts to Matters of National Environmental Significance.
MINING AREA C - SOUTHERN FLANK
Regional Overview

BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Regional Overview

Scale @ A4: 1:1,800,000  Project No: A7800112 REV B
Date: 1/02/2017  Checked: R. GREGORY  Figure: 1
Revision: REV B  Prepared: S. TRINDER  Reviewed: S. WILLIAMSON

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Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

Legend
- Town
- Proposed Mining Area C Development Envelope
- BHP Billiton Rail
- FMG Rail
- Rio Tinto Rail
- Highway
- National Park
- Nature Reserve

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_012_E_MAC_Southern_Flank_PER_Map01_RevB.mxd
Liability

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As part of Condition 7 and Proponent Commitments 1, 2 and 3 of MS 491, BHP Billiton Iron Ore sought and received acceptance of Environmental Management Plan (EMP) Revision 6 (BHP Billiton Iron Ore, 2015a) in January 2016. The EIA that was undertaken for this EMP revision included a life of mine assessment of all 14 deposits in the Northern Flank that are approved under MS 491 and comprised an indicative impact assessment area of 11,377 ha. The current approved disturbance for the Mining Area C Northern Flank operation under MS 491 is 5,385 ha. The predicted environmental impacts from additional clearing, located in the Mining Area C Development Envelope, are documented in EMP Revision 6 (BHP Billiton Iron Ore, 2015a) and are discussed in Section 11 of this PER document. As the additional clearing may occur anywhere in the 11,377 ha the EIAs have taken a precautionary approach and assessed and reported on the potential impacts for the entire 11,377 ha, not just the additional clearing. This additional clearing forms part of this Proposal.

1.5 Structure of this document

The structure of this document is as follows:

Section 1: Provides an overview of the proponent, the Proposal, its location and land tenure.

Section 2: Provides a description of the Proposal, a summary of the physical and operational elements of the Proposal and existing environmental approvals.

Section 3: Provides the justification for the development and gives an overview of alternatives considered.

Section 4: Describes BHP Billiton Iron Ore’s consultation approach and consultation undertaken as part of the Proposal.

Section 5: Describes the regional biophysical environment for the Proposal and surrounding areas.

Section 6: Describes the regional social environment for the Proposal and surrounding areas.

Section 7: Describes the process used to undertake the EIA presented in this public environmental review document.

Section 8: Summarises the environmental studies and survey effort undertaken as part of this Proposal.

Section 9: Describes the process used to identify relevant environmental factors.

Section 10: Describes BHP Billiton Iron Ore’s environmental management system (EMS) and use of regional management plans.

Section 11: Provides an assessment of each of the preliminary key environmental factors, identifies potential impacts, evaluates the significance of the EPA environmental factors and describes the application of the mitigation hierarchy and proposed management measures in relation to this Proposal.

Section 12: Provides an assessment of each of the other environmental factors, identifies potential impacts, evaluates the significance of the EPA environmental factors, and describes the application of the mitigation hierarchy and proposed management measures in relation to this Proposal.

Section 13: Provides the conclusion for this document.

Section 14: Provides a reference list of documents referred to in this Proposal.
2. Proposal description

The Mining Area C operation was approved in 1998 under Part IV of the EP Act as the Multiple Iron Ore Mine Development Mining Area C Northern Flank via MS 491. A draft Environmental Management Plan (EMP) was attached to the Mining Area C Public Environmental Review, which provided details of the management requirements during construction and operation of the Deposit C and Brockman Detrital deposits. MS 491 provided an ongoing mechanism for the development of the remaining 12 deposits in the Northern Flank of Mining Area C (Proponent Commitment 2), subject to the EMP being reviewed and updated as deposits are developed (Proponent Commitment 3). Since 1998 five updated versions of the EMP have been submitted and endorsed by the Office of the Environmental Protection. EMP Revision 6 undertook a cumulative impact of all 14 deposits originally approved under MS 491 and therefore was indicative of a Life of Project EMP.

The current MS 491 allows for 5,385 ha of clearing anywhere within a nominal area of 11,377 ha and a Development Envelope of 25,053.2 ha. For the purpose of impact assessment, EMP Revision 6 used an indicative impact assessment area of 11,377 ha.

This Proposal seeks an increase in the clearing within the current approved Development Envelope of 5,942 ha and an extension of the Development Envelope by 10,218 ha to the south of the current development envelope to allow for the development of the Southern Flank satellite ore body. Associated with the Southern Flank ore body development is additional clearing of 13,729.2 ha (for a total of 19,761.2 ha additional), this clearing also is part of the Proposal.

2.1 Development overview

The key components of the Proposal are:

- Campaign open-cut mining at the Southern Flank satellite orebody at a nominal base mining rate of 80 Mtpa;
- Primary crushing of ore at the Southern Flank satellite orebody;
- Transportation of ore mined at Southern Flank via overland conveyor to stockpiles and ore handling facilities located at the Mining Area C hub;
- Use of existing and addition of new ore processing facilities, train loadout and associated infrastructure at the Mining Area C hub;
- Dewatering of the orebody aquifers and the preferential use of the water for operational purposes, with an option to manage the surplus volumes via managed aquifer recharge or infiltration basins, as outlined in the proposed Central Pilbara Water Resource Management Plan (CPWRMP) (discussed in Section 11.4);
- Clearing of 19,671.2 ha Native Vegetation. Of this clearing 13,729.2 ha is related to clearing for the development of the satellite Southern Flank orebody and associated infrastructure and 5,942 ha is related to additional clearing for development of the 14 deposits at Mining Area C located in the currently Approved Mining Area C Development Envelope; and
- Extension of overburden storage areas (OSAs) for current Mining Area C operations (OSA 14).

2.1.1 Mining method

The Proposal involves campaign mining of iron ore and overburden through conventional open-cut mining methods. Campaign mining involves drilling, blasting, and categorisation of blasted material into iron ore or waste rock.
2.1.2 Ore processing and transport

The Proposal will be supported by expanded infrastructure and facilities at the existing Mining Area C hub up to a nominal combined processing rate of 150 Mtpa of blended ore. Primary crushing will occur at Southern Flank, and an overland conveyor will be used to transport crushed ore to the Mining Area C hub.

Approximately 1,850 million tonnes (Mt) of iron ore is estimated to be mined over the life of the Proposal.

Access to some of the orebodies in the Southern Flank development will require mine dewatering ahead of mining to facilitate dry mining conditions. Ore will be railed to Port Hedland via the BHP Billiton Iron Ore main line.

2.1.3 Overburden management

Overburden will be stockpiled in approved OSAs. Where possible, overburden will be progressively placed back into the pit void to minimise required clearing and to assist in achieving closure objectives at the Southern Flank orebody. Topsoil, where safely stripped prior to mining activity occurring, will first be removed and placed into stockpile areas for later use in rehabilitation. The likelihood of encountering small volumes of potentially acid-forming (PAF) material is low given the lithologies underlying the Southern Flank footprint (i.e. Mount McRae Shale). Technical studies to assess the likelihood of encountering PAF and a broader assessment of acid and metalliferous drainage (AMD) risk have been carried out. This is further explained in Section 11.5.

2.1.4 Mine dewatering, water use and disposal of surplus water

The Proposal will require in-pit and ex-pit mine dewatering (i.e. groundwater abstraction) to facilitate dry mining conditions. Groundwater abstraction (i.e. dewatering volumes and monitoring) is regulated by the Department of Water (DoW) licensing (5C licence) and groundwater operating strategies under the Rights in Water and Irrigation Act 1914 (RIWI Act).

During operations, the abstracted water will be used preferentially to supply the Proposal’s water requirements. Surplus water not used at the Proposal’s mining operations will be managed in accordance with the CPWRMP. This Plan will include the following hierarchy of management options:

- reused on-site in mining operations;
- transferred to other nearby operations for use onsite; or
- returned to the aquifer via managed aquifer recharge at Camp Hill or Juna Downs or via infiltration basins.

In relation to the hierarchy of preferred options stated above, it is important to note that managed aquifer recharge into the dolomite formations and orebodies has been shown to be a suitable option for the management of surplus water. The overall strategy is further explained in Section 11.4.

2.2 Key characteristics of the Proposal

Environmental Assessment Guideline 1 for Defining the Key Characteristics of a Proposal (Environmental Assessment Guideline (EAG) 1 (EPA, 2012a)) provides guidance on the Key Proposal Characteristics. In accordance with the guidance provided in EAG 1, BHP Billiton Iron Ore has developed key characteristics for the Proposal (Table 1).
Table 1: Key characteristics of the Proposal

Summary of the Proposal

<table>
<thead>
<tr>
<th>Proposal Title</th>
<th>Mining Area C Southern Flank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proponent Name</td>
<td>BHP Billiton Iron Ore Pty Ltd on behalf of the Mount Goldsworthy Joint Venture</td>
</tr>
<tr>
<td>Short Description</td>
<td>The Proposal is to revise the existing Mining Area C operations, approximately 100 km northwest of Newman in the Shire of East Pilbara. The scope of the Proposal is to develop and operate an open-cut mine on a satellite orebody located at Southern Flank, with construction of an overland conveyor from the Southern Flank orebody to infrastructure at the Mining Area C hub and to increase the disturbance at the existing Mining Area C hub. The scope includes exploration activity, as well as the construction and operation of associated infrastructure.</td>
</tr>
</tbody>
</table>

Physical Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Location</th>
<th>Current Approval (MS 491)</th>
<th>Proposed Change</th>
<th>Proposed Extent Authorised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Vegetation Clearing</td>
<td>Additional Development Envelope. Proposed Mining Area C Development Envelope (Proposed Extent). Refer Figure 4.</td>
<td>Clearing of 5,385 ha anywhere within a nominal impact assessment area of 11,377 ha and a Development Envelope of 25,815 ha.</td>
<td>An increase in the Proposed Mining Area C Development Envelope by 10,218 ha. The Proposal represents 19,671.2 ha of additional clearing, of which 5,942 ha is within the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>Clearing no more than 25,053.2 ha within a 36,032 ha Proposed Mining Area C Development Envelope.</td>
</tr>
</tbody>
</table>

Operational Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Location</th>
<th>Current Approval</th>
<th>Proposed Change</th>
<th>Proposed Extent Authorised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewatering</td>
<td>Dewatering will occur within the Proposed Mining Area C Development Envelope as shown in Figure 4.</td>
<td>RIWI licence allows for abstraction of up to 15.3 gigalitres per annum (GL/a) of groundwater.</td>
<td>Up to an additional 22 GL/a of groundwater abstraction (peak).</td>
<td>Dewatering from the Mining Area C hub mine will be undertaken in accordance with licencing under the RIWI Act, at a nominal maximum volume of 37 GL/a.</td>
</tr>
<tr>
<td>Surplus water management</td>
<td>Surplus water will be re-used within the Proposed Mining Area C Development Envelope. Managed aquifer recharge systems or infiltration basins will be located within or in the vicinity of the Proposed Mining Area C Development Envelope.</td>
<td>EP Act Part V approval for Managed Aquifer Recharge of 5.84 GL/a.</td>
<td>Management in accordance with the CPWRMP.</td>
<td>Management in accordance with the CPWRMP.</td>
</tr>
</tbody>
</table>
2.3 Development of the mining operation

BHP Billiton Iron Ore proposes to commence mining at Southern Flank in approximately 2020, subject to market conditions and all relevant government approvals. According to the proposed mine plan, dewatering for those areas where mining is below the water table is expected to commence a number of years (approximately up to 5 years) following assessment and approval of this Proposal.

2.4 Development envelope

In accordance with EAG 1 (EPA, 2012a), a ‘development envelope’ has been defined for this Proposal and is illustrated in Figure 4. This is the area in which BHP Billiton Iron Ore is seeking approval to implement the Proposal.

Figure 5a illustrates and Table 2 defines the current Approved Development Envelope (Approved Mining Area C Northern Flank Development Envelope) It also shows the areas that has been assessed in accordance with an indicative footprint, based on current mine plan and design. The Groundwater Assessment Area, and its relativity to the Development Envelope is shown in Figure 5b.

Table 2: Terminology and definitions of areas referred to in this Proposal

<table>
<thead>
<tr>
<th>Area</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed Mining Area C Development Envelope</td>
<td>This spatial area is the proposed development envelope for the Mining Area C hub. It consists of the addition of the Approved Mining Area C (Northern Flank) Development Envelope and the Additional Development Envelope and will constitute the boundary of the new MS if approved.</td>
</tr>
<tr>
<td>Approved Mining Area C (Northern Flank) Development Envelope</td>
<td>This spatial area is the boundary currently approved as the development envelope under MS 491.</td>
</tr>
<tr>
<td>Mining Area C EMP Revision 6 Impact Assessment Area¹</td>
<td>This is the spatial area that was used for EIAs for the development of EMP Revision 6 in January 2016 in line with Condition 7 of MS 491.</td>
</tr>
<tr>
<td>Additional Development Envelope</td>
<td>This spatial area is the additional development envelope to that currently approved under MS 491.</td>
</tr>
<tr>
<td>Indicative Additional Impact Assessment Area</td>
<td>This is the indicative spatial area based on the mine plan and design at the time of submission and is used as an assessment tool for the flora and vegetation, terrestrial fauna and subterranean fauna (troglofauna) factors.</td>
</tr>
<tr>
<td>Mining Area C EMP Revision 6 Groundwater Assessment Area²</td>
<td>This spatial area represents the 2 m drawdown contour as assessed for impact under EMP Revision 6.</td>
</tr>
<tr>
<td>Groundwater Assessment Area</td>
<td>This spatial area represents the additional area that has a predicted drawdown of 2 m or more as a result of this Proposal. This area is used as an EIA tool for the hydrological processes, inland environmental water quality and subterranean fauna (stygofauna) factors.</td>
</tr>
<tr>
<td>Modified Indicative Additional Impact Assessment Area</td>
<td>This is the Indicative Additional Impact Assessment Area following application of the ‘avoid’ element of the mitigation hierarchy.</td>
</tr>
</tbody>
</table>

¹ In supporting environmental impact assessments undertaken for this Proposal this area is called the Approved Impact Assessment Area.
² In supporting EIAs and modelling report this area is referred to as the Approved Groundwater Assessment Area.
Liability

BHPBIO does not warrant that this map is free from errors or omissions. BHPBIO shall not be
in any way liable for loss, damage or injury to the user of this map or any other person or
organisation consequent upon or incidental to the existence of errors or omissions on this
map. This map has been compiled with data from numerous sources with different levels of
reliability and is considered by the authors to be fit for its intended purpose at the time of
publication. However, it should be noted that the information shown may be subject to change
and ultimately, map users are required to determine the suitability of use for any particular
purpose.
The Indicative Additional Impact Assessment Area is used for the purposes of the impact assessments undertaken by BHP Billiton Iron Ore and presented in this PER. It is an assessment tool that has been developed based on the mine plan and design at the time of submission. As the mine plan and design may evolve over time, implementation of the Proposal may result in different areas of actual disturbance within the Proposed Mining Area C Development Envelope. It is anticipated that any changes would be minor.

In light of this, a conservative approach has been taken for assessing the impacts of the Proposal. The footprint adopted in the Indicative Additional Impact Assessment Area includes a buffer and represents a credible ‘worst-case’ implementation scenario. This assessment approach provides future flexibility for the location of mine components within the Proposed Mining Area C Development Envelope while also ensuring full extent of environmental impacts have been identified and assessed.

The ‘mitigation hierarchy’ was applied to the footprint in the Indicative Additional Impact Assessment Area to determine the residual impacts. This involved modifications to the indicative footprint to avoid some of the potential impacts, in particular to avoid impacts to known ghost bat (Macroderma gigas) roosts and identified prospective troglofauna habitat. The resultant indicative modified footprint is shown in Figure 6. The predicted impacts were then reviewed and determined that the residual impacts of the modified credible worst-case implementation scenario can be managed.

While the Indicative Additional Impact Assessment Area and Modified Indicative Additional Impact Assessment Area are assessment tools only, BHP Billiton Iron Ore will, where practicable, align Proposal disturbance with the areas shown as the Modified Indicative Additional Indicative Impact Assessment Area shown in Figure 6.

2.5 Existing approvals

2.5.1 State Agreement Act

The Proposal is located on land that is held pursuant to the Iron Ore (Mount Goldsworthy) Agreement Act 1964. Mining Area C has been the subject of multiple approved proposals under this Agreement since 2002.

2.5.2 Other operations within the area

BHP Billiton Iron Ore currently operates a number of iron ore mines and associated rail and port infrastructure within the Pilbara region of Western Australia (Figure 1 and Figure 2). Current BHP Billiton Iron Ore mining operations in proximity to the Proposal include:

- Yandi, located northeast of the Proposal; and
- Newman Joint Venture hub, located approximately 90 km southwest of the Proposal, which consists of Mount Whaleback, Eastern Ridge and Orebodies 29, 30 and 35.

Hope Downs Management Services Pty Ltd also operates within the Northern Flank Valley (North and South Deposits) with the approved Hope Downs 1 mining operation located immediately adjacent to the eastern boundary of the current approved Mining Area C operation and the approved Baby Hope operation located immediately to the southeast. Other mining operations in the broader area include West Angelas and Yandicoogina.
Liability

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BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Modified Footprint

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area
Modified Indicative Additional Impact Assessment Area
Great Northern Highway
BHP Billiton Rail
Rio Tinto Rail

Scale @ A4: 1:150,000
Prepared: S. TRINDER
Project No: A780018 REV B
Date: 13/02/2017
Checked: R. GREGORY
Figure: 6
Reviewed: S. WILLIAMSON
Revision: Rev B

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2.5.3 Environmental Protection Act 1986 Part IV approvals

In 1998, BHP Billiton Iron Ore received approval under Part IV of the EP Act for the Multiple Iron Ore Mine Development Mining Area C Northern Flank via MS 491. BHP Billiton Iron Ore prepared a draft EMP, which was appended to the PER (Woodward-Clyde, 1997). The initial draft EMP was prepared in accordance with PER Proponent Commitment 1 and provided details of the management requirements during construction and operation of the C and Brockman Detrital deposits, the Mining Area C ore handling facilities, train loadout facility and associated mine services and infrastructure. The EMP was finalised in 2003 prior to the commencement of operations at Mining Area C. MS 491 provides an ongoing mechanism for the development of the remaining 12 deposits (Proponent Commitment 2), subject to the EMP being reviewed and updated as deposits are developed (Proponent Commitment 3). The current MS 491 allows for clearing of up to 5,385 ha anywhere within an area of 11,377 ha, of which 4,792 ha have been cleared as of 31 December 2016 (Figure 7).

Following approval of this Proposal, a new MS will be issued that will cover the existing Mining Area C Northern Flank operations and the proposed Southern Flank satellite orebody operations, and MS 491 will be superseded. The Proposal accommodates additional clearing within the Mining Area C Development Envelope assessed in line with Proponent Commitments 2 and 3 under MS 491 and accepted as part of EMP Revision 6 by the Office of the Environmental Protection Authority (OEPA).

2.5.4 Environmental Protection Act 1986 Part V approvals

2.5.4.1 Native vegetation clearing permits

Under Part V of the EP Act, BHP Billiton Iron Ore currently holds three active native vegetation clearing permits (NVCPs) over parts of the Proposed Mining Area C Development Envelope for mineral exploration and production and associated activities (Table 3). The permits have been issued by the Department of Mines and Petroleum (DMP).

Table 3: BHP Billiton Iron Ore current NVCPs

<table>
<thead>
<tr>
<th>Permit number</th>
<th>Purpose</th>
<th>Area of clearing approved (ha)</th>
<th>Total amount cleared to Dec 2016 (ha)</th>
<th>Area remaining (ha)</th>
<th>Expiry date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPS 4337/1 Mulla Mulla camp</td>
<td>Mine camp and associated infrastructure.</td>
<td>70</td>
<td>50</td>
<td>20</td>
<td>31 July 2017</td>
</tr>
<tr>
<td>CPS 7139/1 Central Pilbara West Exploration Strategic Permit</td>
<td>Rehabilitation, geotechnical investigations, access tracks, mineral exploration, hydrogeological drilling, water bores and association activities.</td>
<td>1,000</td>
<td>4</td>
<td>996</td>
<td>30 November 2026</td>
</tr>
<tr>
<td>CPS 4630/2</td>
<td>Southern Flank Exploration.</td>
<td>280</td>
<td>280</td>
<td>0</td>
<td>Surrendered; superseded by CPS 7139/1</td>
</tr>
<tr>
<td>CPS 2295/1</td>
<td>Mineral Exploration Southern Flank.</td>
<td>305</td>
<td>238</td>
<td>NA</td>
<td>Expired</td>
</tr>
<tr>
<td>CPS 4831/3 Mining Area C Warehouse</td>
<td>Mineral production and associated infrastructure.</td>
<td>38</td>
<td>21</td>
<td>17</td>
<td>10 March 2017</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1693</strong></td>
<td><strong>593</strong></td>
<td><strong>1033</strong></td>
<td></td>
</tr>
</tbody>
</table>
Liability
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MINING AREA C - SOUTHERN FLANK
Land Disturbance within Proposed Mining Area C Development Envelope as at the end of Dec 2016

Disturbance Footprint by Approval
- Clearing under Exemption - (31 ha)
- Ministerial Statement, 491 - (4792 ha)
- NVCP, 2295 - (338 ha)
- NVCP, 4337 - (50 ha)
- NVCP, 4630 - (281 ha)
- NVCP, 4831 - (21 ha)
- NVCP, 5105 - (2 ha)
- Mining Act - (45 ha)
- State Agreement (22 ha)
Exploration activities in the Proposed Mining Area C Development Envelope are currently being carried out and were reported on in the 2016 *Annual Environmental Report (AER)* (BHP Billiton Iron Ore, 2016e). In accordance with Part V Division 2 of the EP Act, BHP Billiton Iron Ore has obtained NVCPs, where necessary, from the DMP for exploration works.

A requirement of an approved NVCP is to report back to the DMP annually for the life of each permit. Further details of the conditions and reporting requirements of these NVCPs can be found in the 2016 AER (BHP Billiton Iron Ore, 2016e). Clearing undertaken to date under the permits as outlined in Table 3 is shown in Figure 7.

### 2.5.4.2 Licence to Operate

BHP Billiton Iron Ore currently holds a Licence to Operate for the current approved Mining Area C operations, namely Mining Area C Operations: L7851/2002/6.

BHP Billiton Iron Ore has consulted with the Department of Environment Regulation (DER) regarding this Proposal. A licence amendment will be sought for all activities that trigger a prescribed premises requirement under Schedule 1 of the Environmental Protection Regulations 1987, if or when this Proposal is approved under Part IV of the EP Act.

The current approved Mining Area C operation has environmental reporting and statutory requirements in accordance with BHP Billiton Iron Ore’s Licence to Operate, issued by the DER under Part V of the EP Act. As required, BHP Billiton Iron Ore reports annually on key environmental parameters for its mining operations in its AER. The report includes reporting requirements, such as exploration and mining activities, overburden management, land disturbance, topsoil management, rehabilitation activities and monitoring, surface water and groundwater quality, air quality monitoring and particulate matter management, native flora and weed management, and native fauna and introduced species. For more information on these environmental parameters, please refer to the 2016 BHP Billiton Iron Ore AER (BHP Billiton Iron Ore, 2016e).

### 2.5.5 Rights in Water and Irrigation Act 1914

The Proposal will involve conventional open-pit iron ore mining activities below the water table and will require mine dewatering ahead of mining below the water table to facilitate dry mining conditions.

BHP Billiton Iron Ore holds several 5C licences for dewatering or water abstraction that support the current approved Mining Area C operations:

- GWL110044(9): licences dewatering for mining operations; and
- GWL178477 (1) and GWL174613 (1): licence abstraction from potable borefields west of current mining operations.

Groundwater has been monitored and reported in annual and triennial aquifer review reports since 2001. The current groundwater well licence permits the annual abstraction within the Approved Mining Area C Development Envelope of 15,330,000 kilolitres (kL). This dewatering is carried out in accordance with the Groundwater Operating Strategy for Mining Area C (BHP Billiton Iron Ore, 2015b). The licensed activities include dewatering, dust suppression, mine processes, construction and potable water supply.

BHP Billiton Iron Ore’s triennial aquifer review (TAR) for the current Mining Area C operations (BHP Billiton Iron Ore, 2016f) provides a history of groundwater monitoring in adjacent areas. The TAR also includes an analysis of groundwater levels and water quality trends.

BHP Billiton Iron Ore’s TAR for Mining Area C (BHP Billiton Iron Ore, 2016f) has reported that:
• Groundwater levels upgradient of Coondewanna Flats (an environmental receptor) continue to respond to regional rainfall events, and no changes from dewatering at Mining Area C have been observed at the receptor.

• Water levels downgradient of Weeli Wolli Spring (an environmental receptor) are dominated by dewatering stresses from Hope Downs, and no changes from dewatering at Mining Area C have been observed at the receptor.

• Abstraction at the Mining Area C borefield did not result in adverse impacts to groundwater quality during the review period.

• During the financial year 2016, the total groundwater abstracted was 52% of the approved allocation.

• The abstracted water is weakly acidic to weakly alkaline with pH ranging from 6.8 to 8.7.

For the Proposal, additional groundwater abstraction (i.e. dewatering volumes and monitoring) will be managed by DoW licensing (5C licence) and a groundwater operating strategy under the RIWI Act and implemented in accordance with the proposed CPWRMP. BHP Billiton Iron Ore has consulted with the DoW regarding the proposed strategy and management plan.
3. Development justification and alternatives considered

This section outlines the rationale for and benefits of the Proposal and summarises the alternatives considered. The intent of this section is to provide an overview of the alternative locations, plans and designs that have been considered by BHP Billiton Iron Ore during development of the Proposal and how these have been optimised to minimise environmental impacts resulting from the Proposal. This is in line with Clauses 5 and 10.2.4 of the Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012.

3.1 Proposal rationale and benefits

The demand for iron ore makes mining a vital component of the State and national economy. In 2015, despite a sharp decline in commodity prices, the value of the Western Australian mineral and petroleum industry reached just over $91 billion (DMP, 2016a). Iron ore is the State’s most valuable sector of the mining industry, accounting for approximately $50 billion (70%) of the total mineral sales in 2015. Almost 741 Mt of iron ore were exported during 2015, representing an increase of 8% from 2014 (DMP, 2016a).

As of March 2016, Western Australia had an estimated $94 billion worth of resource projects under construction or in the committed stage of development, with a further $44 billion identified as being allocated to planned or possible projects in coming years (DMP, 2016a). This Proposal sustains approximately 10% of Western Australians iron ore current exports and therefore will provide significant revenues and contribute to ongoing construction activities that are planned for the State.

The Proposal will sustain mining output for BHP Billiton Iron Ore as existing deposits are depleted as the current level of production at the existing BHP Billiton Iron Ore mining operations in the Pilbara region cannot be sustained. It is expected that the life of the Mining Area C mining operation, inclusive of Northern and Southern Flanks, will be approximately 30 years, commencing in approximately 2020.

If implemented, the Proposal will result in economic and community benefits for both Australia, Western Australia and the Pilbara region by:

- providing royalties and taxation payments from the sale of iron ore products;
- contributing to the value of mineral exports;
- delivering capital investment;
- continuing direct and indirect employment opportunities in the Pilbara region;
- continuing demand for goods and services and thereby supporting the Pilbara regional economy; and
- contributing to the sustainability of the Pilbara iron ore industry.

The Proposal is located adjacent to the existing Mining Area C operation and wherever possible will make use of the existing or upgraded ore processing facilities, non-processing infrastructure, utilities, rail facilities, infrastructure, communications, roads, camps and other assets. This will vastly reduce the disturbance footprint and the amount of new infrastructure that would have otherwise been necessary for a project of this volume and scale, especially when compared to a new greenfield development.

New employment will be created during the mine construction phase of the Proposal, and the operating life of existing mining operations and rail infrastructure in the Pilbara region will be extended. This will maintain the overall operational workforce within the Pilbara.
The Banjima and Nyiyaparli people (the Traditional Owners) will continue to benefit under the terms of the respective Indigenous Land Use Agreements (ILUAs) across the area. These ILUAs aim to deliver economic and social benefits to the Indigenous stakeholders.

BHP Billiton Iron Ore is committed to providing employment opportunities to local Indigenous peoples through a number of pathways including traineeships on the job or through a relevant registered training organisation, apprenticeships, graduate roles and general recruitment.

In addition, the ongoing mining activities of BHP Billiton Iron Ore in the Pilbara region will continue to support existing social and economic development projects, as well as contribute to future projects.

The above aspects make the Proposal a highly desirable option, for the benefit of both the Pilbara iron ore industry and the wider community.

BHP Billiton Iron Ore is also an industry leader in providing research advancements in the study of Pilbara species distribution and attributes. BHP Billiton Iron Ore contributes to the scientific community and the Pilbara environment through support and funding of research projects and other environmental initiatives. A number of these endeavours are listed in Table 4. Further research into species that are present in the Proposal area (e.g. ghost bats and troglofauna) will be undertaken as part of this ongoing research work.

### Table 4: Recent environmental research projects in Western Australia supported or funded by BHP Billiton Iron Ore.

<table>
<thead>
<tr>
<th>Environmental Initiative</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rehabilitation</strong></td>
<td></td>
</tr>
<tr>
<td>Pilbara Seed Atlas</td>
<td>Climate-controlled seed store on site.</td>
</tr>
<tr>
<td>Restoration Seed Bank</td>
<td>Significant improvement to seed management practices, resulting in a step change in revegetation of rehabilitated areas.</td>
</tr>
<tr>
<td>Pilbara Restoration Initiative</td>
<td>Facilitated Pilbara Industry engagement in rehabilitation issues and research.</td>
</tr>
<tr>
<td>Pilbara Rehabilitation Group</td>
<td></td>
</tr>
<tr>
<td><strong>Ecohydrology</strong></td>
<td></td>
</tr>
<tr>
<td>Coondewanna Flats ecohydrology study</td>
<td>Determination of groundwater-dependent ecosystem requirements.</td>
</tr>
<tr>
<td>Wetland values of eastern Pilbara</td>
<td>Identification and evaluation of ecohydrological assets and their ecological linkages.</td>
</tr>
<tr>
<td>Dynamics of woody vegetation and water in the central Pilbara</td>
<td>Improved understanding of biogeochemistry of floodplain and riparian landscapes, dynamics of water and tree populations in riparian woodlands, and woody scrub encroachment, fire and climate.</td>
</tr>
<tr>
<td>Ecological responses of native fish to extreme flow variability in arid Australia</td>
<td>Understanding of the impact of altered water flows on native fish in arid Australia.</td>
</tr>
<tr>
<td><strong>Regional habitat mapping and modelling</strong></td>
<td></td>
</tr>
<tr>
<td>Regional vegetation and habitat mapping</td>
<td>Standardisation of environmental studies approach.</td>
</tr>
</tbody>
</table>
### Environmental Initiative

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological community–level modelling</td>
<td>Production of a consolidated vegetation and habitat map for all BHP Billiton Iron Ore tenements.</td>
</tr>
<tr>
<td>Conservation significant species habitat modelling</td>
<td>Modelled approach to identifying biodiversity values of the Pilbara.</td>
</tr>
<tr>
<td>Troglofauna habitat modelling</td>
<td></td>
</tr>
</tbody>
</table>

#### Terrestrial fauna

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilbara leaf-nosed bat genetic research</td>
<td>Genetic mapping of threatened species for population linkages.</td>
</tr>
<tr>
<td>Ghost bat ecology</td>
<td>Genetic studies, hormone analysis, diet analysis, regional surveys.</td>
</tr>
<tr>
<td>Northern quoll ecology</td>
<td>Study on northern quoll ecology and demography, including analysis of influence of previously disturbed areas on species.</td>
</tr>
<tr>
<td>Airlie Island skink regional survey</td>
<td>Survey of Pilbara coastline between Onslow and Derby to determine additional locations of this species and map suitable habitat.</td>
</tr>
<tr>
<td>Pilbara olive python genetic study</td>
<td>Analysis of Pilbara olive python populations to determine if any genetic substructuring is present.</td>
</tr>
<tr>
<td>Habitat fragmentation study</td>
<td>Study to determine the impacts of linear infrastructure on vertebrate fauna and the use of culverts to mitigate these impacts.</td>
</tr>
</tbody>
</table>

#### Taxonomy

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAMinals</td>
<td>Making invertebrate taxonomic information more robust and available to the public through the Western Australian Museum.</td>
</tr>
<tr>
<td>Western Australian Herbarium</td>
<td>Improved taxonomic key for flora of the Pilbara, including increased collection of voucher specimens.</td>
</tr>
<tr>
<td>Western Australian Museum</td>
<td>Improved taxonomic key for invertebrate fauna of the Pilbara, including increased collection of voucher specimens.</td>
</tr>
<tr>
<td>Pilbara mygalomorph genetic study</td>
<td>Analysis of all available mygalomorph taxa within the Pilbara to determine genetic lineages.</td>
</tr>
<tr>
<td>Idiopid taxonomic review</td>
<td>Taxonomic review of West Australian idiopid spiders.</td>
</tr>
</tbody>
</table>

### 3.2 Evaluation of alternatives

BHP Billiton Iron Ore undertakes an iterative planning and design process whereby initially a number of broad alternatives are assessed and as the project planning matures the design, location and mine plans become more detailed. During this iterative process, BHP Billiton Iron Ore retains a focus on reducing the environmental impacts of its activities as far as it is reasonably practicable.
As part of the planning and design process for this Proposal, a number of broad alternatives with respect to location, plans and designs were assessed prior to referral of the Proposal. These included development of:

- iron ore resources able to be transported to the existing Yandi ore processing facilities; and
- new deposits with associated processing facilities and connections to the existing rail network.

After strategic consideration of these alternatives the development of a satellite orebody in the vicinity of Mining Area C was selected as the preferred investment alternative by BHP Billiton Iron Ore. These decisions are determined via the alternative option phase of the project whereby various alternatives are evaluated against one another to ensure the most optimal alternatives are progressed through the project. Whilst the decision to proceed with the Proposal is reflective of many variables, key amongst them are resource ore characteristics that can support high production rates, favourable product offering, low strip ratio, low processing intensity and above the water table position of many of the planned pits. This alternative was referred to the OEPA in May 2016.

Following the BHP Billiton Iron Ore decision of the preferred investment alternative, the internal project evaluation process further integrates environmental considerations into BHP Billiton Iron Ore’s investment decision-making to ensure that potential impacts to the environment are minimised. This is completed through the value optimisation phase of the project where various design alternatives are traded off against one another to ensure the most optimal design, with respect to the triple bottom line, are progressed through the project. Major benefits include the reduction of the disturbance footprint through the use of existing fixed infrastructure located at Mining Area C and the consideration of environmental factors, such as ecology, dust and noise generation, through advanced engineering design. Specific alternatives that have been evaluated as part of the value optimisation phase are discussed below. Further optimisation of the design and mine plan will continue prior to execution of the project. Any optimisation will continue to focus on minimisation of environmental impacts.

### 3.2.1 Evaluation of crusher and ore transport alternatives

Through the project evaluation, two overland conveyer (OLC) alternatives were considered these were either ‘single-flight series’ or a ‘Dual-flight parallel’ OLC arrangement. The key differentiating factors that influenced the decision, were the:

- increased operability through reduced interaction with mining operations thus improving safety;
- lower production risk due to reduced concentration of production throughput; and
- lower interaction with planned OSAs.

Optimisation of the final design incorporated factors such as, but not limited to minimisation of environmental and heritage impacts, safety, maintainability, initial capital cost and future operating costs.

Consideration during planning and design of crushers, ore handling infrastructure and transport, was made of the following.

**Dust.** The location of crushers, ore handling infrastructure and conveyors was chosen in consideration of the location of key receptors at the accommodation camps to minimise impacts of dust emissions to these receptors. Various dust emissions control technologies were reviewed for inclusion into the engineering design, to assist in minimisation of emissions and hence reduction in impacts.
**Power Consumption.** Through the assessment of various ore transportation alternatives and routes, reduced power consumption became a key driver in the final decision on the selected OLC route. A reduction in power consumption ultimately reduces greenhouse gas emissions.

**Consumable Use.** Through the assessment of various ore transportation alternatives and routes, reduced consumable use became a key driver in the final decision on the selected OLC route. For example, this included the conveyor belts utilised in the OLC. Ultimately, this results in lower amounts of landfill and use of materials.

The optimisation of crusher and transport locations and designs have resulted in a reduction in potential dust emissions, landfill volumes and greenhouse gas emissions.

### 3.2.2 Use of existing fixed infrastructure at Mining Area C

Where possible, existing fixed infrastructure at Mining Area C will be used, in part, to reduce the environmental disturbance footprint of the Southern Flank operations and avoid duplication of infrastructure.

### 3.2.3 Evaluation of waste rock disposal alternatives

The mine plan has been modified, where practical to allow waste to be progressive in-filled during the life of the Southern Flank mine, rather than being stored in out of pit OSAs. This will minimise the footprint needed for OSAs and reduce the quantity of native vegetation required for the Proposal. The location of the OSAs was modified to reduce the potential visual and amenity impacts to Great Northern Highway users. Further information on these potential impacts is provided in Section 12.4. The use of progressive infill and movement of OSAs have resulted in potential vegetation disturbance, amenity and visual impacts being reduced.

### 3.2.4 Evaluation of option not to conduct the Proposal

The Proposal will sustain the current level of BHP Billiton Iron Ore’s production in the Pilbara as the Southern Flank production volume will replace existing deposits as they become depleted. If the Proposal were not to proceed, the State would forego substantial economic benefits, including the:

- loss of social, economic and employment opportunities in the Pilbara and in the State;
- loss in value of Western Australia’s and Australia’s raw materials exports;
- loss of royalty revenue to the Western Australian Government;
- non-utilisation of viable iron ore deposits at Southern Flank; and
- decline in production from BHP Billiton Iron Ore Pilbara mining operations.

Not proceeding will also result in the premature reduction of the existing workforce at the Yandi operations, as well as a loss of support to the Pilbara community and infrastructure.

If the Proposal does not proceed, the world’s demand for iron ore will ultimately be met through the development of iron ore deposits elsewhere, which may have more potential for environmental impacts than this Proposal. Potentially, these alternative deposits could be located overseas, which will result in the loss of benefits to the Pilbara, the State and Australia.
4. Consultation

4.1 Key stakeholders

BHP Billiton’s commitment to community engagement is articulated in the Company’s *Code of Business Conduct* (BHP Billiton, 2016a), which states:

> Our ability to build relationships and work collaboratively and transparently with our host communities is critical to our long term success. BHP Billiton aims to be valued and respected by the communities in which we operate.

To support this commitment, BHP Billiton Iron Ore has comprehensive Company standards and dedicated resources to ensure its activities are underpinned by continuous community engagement and feedback.

BHP Billiton Iron Ore undertakes regular and ongoing stakeholder engagement as part of its core business activities. BHP Billiton’s Our Requirements Community sets out the Company’s approved mandatory and minimum performance requirements for community engagement (BHP Billiton, 2016b). BHP Billiton aims to facilitate regular, open and honest dialogue to understand expectations, concerns and interests of stakeholders and to incorporate them into business planning to help build strong, mutually beneficial relationships.

Based on an analysis of the Proposal location, affected land users, and potential impacts and risks, BHP Billiton Iron Ore has identified the following key stakeholders who have, will continue to be, or will be engaged as part of this Proposal:

**Western Australian Government Departments**
- Office of Environmental Protection Authority (OEPA)
- Department of Parks and Wildlife (DPaW)
- Department of Water (DoW)
- Department of Mines and Petroleum (DMP)
- Department of Environment Regulation (DER)
- Department of State Development
- Department of Aboriginal Affairs (DAA)
- Shire of East Pilbara

**Traditional Owners and Community**
- Newman Community Consultative Group
- Banjima Implementation Committee and Environment Subcommittee
- Nyiyaparli Implementation Committee and Environment Subcommittee

Other stakeholders (e.g. Department of Regional Development) will be engaged as part of the public submission process that forms part of the PER process (see Section 7) or specifically if requested.

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3 BHP Billiton Our Requirements documents set out minimum company standards, processes and procedures that must be met across the globe.
The objective of the stakeholder engagement for this Proposal is to:

- confirm the approval process for the development of the Proposal with relevant government agencies and local authorities;
- provide information and an opportunity to comment for groups or individuals who may potentially be interested in the development of the Proposal;
- periodically provide updated information and results of the environmental assessment and planning process to stakeholders as more information becomes available; and
- where practicable, allow for adjustments to the design or management of the Proposal to accommodate the concerns or issues raised by stakeholders during the consultation process.

4.2 Stakeholder comments and proponent responses
Table 5 outlines the consultation that has been undertaken to date in relation to this Proposal. The table documents broad-level comments raised by stakeholders and provides BHP Billiton Iron Ore’s response to these comments.

4.3 Ongoing consultation
BHP Billiton Iron Ore will continue to engage relevant stakeholders as the Proposal and the EIA process progress to ensure that all concerns have been addressed. BHP Billiton Iron Ore, as part of the PER process, will provide a Supplementary Report that provides a response to public submissions provided to BHP Billiton Iron Ore by the OEPA.
Table 5: Summary of consultation with stakeholders

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Consultation Details</th>
<th>Topics/Issues Discussed</th>
<th>Proponent Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State Agencies</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>OEPA</td>
<td>3 March 2016 – Overview of Southern Flank Project given, including discussion on approvals pathway, preliminary key factors, schedule and consultation plan.</td>
<td>Outcome was that OEPA supports referral of revised Mining Area C and inclusion of extra disturbance at Mining Area C into one PER process.</td>
<td>BHP Billiton Iron Ore referred the project as a Revised Proposal to the Mining Area C ministerial approval.</td>
</tr>
<tr>
<td></td>
<td>13 May 2016 – Discussion on referral and scoping document.</td>
<td>OEPA to review and provide comments on draft referral document.</td>
<td>OEPA comments addressed in referral document. BHP Billiton Iron Ore reviewed and provided comments on the draft ESD.</td>
</tr>
<tr>
<td></td>
<td>5 September 2016 – Discussion on preliminary outcomes from EIAs.</td>
<td>Outcomes from impact assessments for preliminary key factors were presented and discussed.</td>
<td>Agreement for OEPA to attend detailed session on ghost bat impact assessment with DPaW.</td>
</tr>
<tr>
<td>DPaW</td>
<td>23 March 2016 – Overview of Southern Flank Project given, including discussion on approvals pathway, preliminary key factors, schedule and consultation plan with a focus on biological factors.</td>
<td>Recommended BHP Billiton Iron Ore confirm public availability of information pertaining to Ben’s Oasis and with the EPA for any information on the chocolate wattled bat.</td>
<td>Subsequent EIA demonstrated that the current Proposal predicts no impacts different from those assessed in EMP Revision 6 at Weeli Wolli Spring and Ben’s Oasis and therefore no specific biological EIAs were required for the Priority Ecological Community (PEC).</td>
</tr>
<tr>
<td></td>
<td>23 May 2016 – Outcomes of EIAs for flora and vegetation, terrestrial fauna and subterranean fauna presented. Detailed discussion on preliminary results from ghost bat studies.</td>
<td>Advised that assessment of impacts to flora populations required. DPaW advised that any conclusions relating to the ghost bat should be based on sound scientific evidence. Where outcomes are not certain, BHP Billiton Iron Ore should provide assumptions and limitations and, if required, detail any further work that will be undertaken. If artificial roosts are proposed, the current roost should be used as a demonstration of this mitigating option. Request for early engagement on ghost bat work and outcomes, given short duration of public review period. Ensure ecological basis for use of 2 m drawdown contour for stygofauna is clear.</td>
<td>BHP Billiton Iron Ore committed to a peer review of ghost bat studies and further early engagement regarding the outcomes of these studies.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Consultation Details</td>
<td>Topics/Issues Discussed</td>
<td>Proponent Response</td>
</tr>
<tr>
<td>-----------------------------------</td>
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<tr>
<td>23 September 2016 – Detailed discussion held regarding ghost bat work undertaken to date, key findings and proposed management measures.</td>
<td>Population estimation based on DNA. Short-term and long-term management measures. Ability and ease of direct cave location and monitoring. Artificial roosts.</td>
<td>Detailed information of ghost bat sampling and impact assessment, including peer review evaluation to be included within PER and Appendices.</td>
<td></td>
</tr>
<tr>
<td>DoW</td>
<td>20 April 2016 – Overview of Southern Flank Project given.</td>
<td>Due to the advanced and different approach to groundwater modelling, a third-party review of the modelling work was suggested.</td>
<td>An independent review of the groundwater modelling work has been commissioned and will be included in the PER document.</td>
</tr>
<tr>
<td></td>
<td>20 June 2016 – Detailed discussion on approach to numerical groundwater modelling was held.</td>
<td>DoW requested a formal review of the final model documents early in the submission process. DoW is comfortable that the modelling approach is an appropriate tool for the purposes of predicting impacts of the Proposal, given the range of uncertainty in the early stages of the project.</td>
<td>Modelling and detailed technical reports will be made available to DoW early in the process.</td>
</tr>
<tr>
<td>DER</td>
<td>19 September 2016 – Overview of the project, work undertaken and findings to date were presented.</td>
<td>Scope and spatial characteristics of the Proposal. Overview provided on hydrological, air quality and amenity aspects of the Proposal.</td>
<td>DER requested that BHP Billiton Iron Ore provide an approvals strategy, including timing for the Part V process related to this project. DER requested clarification of the water surplus from the Proposal.</td>
</tr>
<tr>
<td>DAA</td>
<td>Meetings have been ongoing and will continue to be so prior to submission. DAA has agreed to the process and timeframes proposed by BHP Billiton Iron Ore.</td>
<td>Timeframes, number and significance of potential sites, process to ensure timely and accurate assessment by the DAA and the Aboriginal Cultural Material Committee.</td>
<td>BHP Billiton Iron Ore has committed to ongoing consultation with the DAA. BHP Billiton Iron Ore will submit the relevant site cards on a weekly basis. BHP Billiton Iron Ore will keep Banjima people involved pre-submission.</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banjima Implementation Committee</td>
<td>May 26 2016 – Overview of project scope and key elements provided to implementation committee.</td>
<td>Items raised by implementation committee were provision for more closure information, keen to understand approach to and outcomes of cumulative impacts, and request that Weeli Wolli Creek and Coondewanna Flats impacts are assessed.</td>
<td>BHP Billiton Iron Ore committed to providing further information on closure and water impact assessment approach and outcomes.</td>
</tr>
<tr>
<td>Banjima Environment Subcommittee Meeting</td>
<td>14 September 2016 – Discussions were held on process for input to the PER, and an overview of key matters of interest was presented.</td>
<td>Project scope and key environmental issues were discussed (e.g. water, closure, and subterranean fauna). Overview of</td>
<td>BHP Billiton Iron Ore committed to supply draft PER to the group and offered additional briefings prior to public submissions period.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Consultation Details</td>
<td>Topics/Issues Discussed</td>
<td>Proponent Response</td>
</tr>
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<td>------------------------------------------------</td>
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<tr>
<td>Nyiyaparli Environment Subcommittee</td>
<td>7 September 2016 – Discussions were held on process for input to PER, and overview of key matters of interest was presented.</td>
<td>Project scope and key environmental issues were discussed (e.g. water, closure subterranean fauna). Overview of process and timing for the PER was outlined and discussed.</td>
<td>BHP Billiton Iron Ore committed to supply draft PER to the group and offered additional briefings prior to public submissions period.</td>
</tr>
<tr>
<td>Banjima people</td>
<td>27-29 September 2016 – Field visit to Southern Flank heritage sites with six Banjima elders and archaeologist.</td>
<td>Description of Southern Flank proposal given on site, results of ethnographic and archaeological surveys and potential impacts of Proposal were discussed. Discussion specifically with regard to the upcoming s18 application.</td>
<td>Banjima people requested avoidance of sites where possible that archaeological material from sites to be salvaged in accordance with best practise prior to disturbance, stone arrangements to be recorded and stored for return to site at closure. Banjima expressed no objection to s18 application for disturbance of ethnographic and archaeological sites. BHP Billiton committed to where practical and safe to fulfil requests made by Banjima people.</td>
</tr>
</tbody>
</table>
5. Regional biophysical environment

BHP Billiton Iron Ore has been operating in the Pilbara region since the late 1960s. The environmental baseline and monitoring data acquired during this time offer an excellent foundation in assessing the potential environmental factors and impacts for new proposals. The available existing environmental knowledge and its relevance to this Proposal is described below.

5.1 Biogeographic region

The Proposal is situated in the Pilbara bioregion as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway & Cresswell, 1995). The Pilbara bioregion is divided into four subregions; the Proposal lies in the Hamersley subregion. The Hamersley subregion (Figure 8) forms the southern section of the Pilbara Craton (Kendrick, 2001). This subregion is characterised by mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by gorges. The vegetation of the subregion is dominated by *Eucalyptus leucophloia* over *Triodia* hummock grassland on skeletal soils atop mountains and slopes, while swathes of mulga woodland occur over hard and soft grasses on fine-textured soils of the plains and valleys (Kendrick, 2001).

Approximately 50 km north of the Proposal area is the Fortescue Marsh, which is listed in the Directory of Important Wetlands in Australia (Environment Australia, 2001) and is a proposed Ramsar site (DEC, 2009). It is also listed as a PEC by DPaW.

5.2 Regional climate

The Pilbara bioregion is characterised by a semi-arid climate resulting from the influence of tropical maritime and continental air masses and receives primarily summer rainfall. Cyclones can occur during summer, bringing heavy rain and potentially destructive winds to coastal and inland towns. The general seasonal characteristics of this region are hot summers with periodic, heavy rains and mild winters with occasional rainfalls.

Regional temperatures are warmest from October to April, with average monthly maximum temperatures exceeding 30°C during this period. Temperatures are coolest from May to September, with average monthly minimum temperatures below 15°C. The average daily maximum temperature in January is approximately 36°C, while the average daily minimum temperature in July is as low as 13.8°C.

The Pilbara region has a highly variable rainfall, which is dominated by the occurrence of tropical cyclones mainly during the period January to March. The tropical storms from the north bring sporadic and drenching thunder storms. With the exception of these very large events, rainfall can be erratic and localised due to thunderstorm activity. Therefore, rainfall from a single site may not be representative of the spatial variability of rainfall over an entire catchment during an event.

The total annual average rainfall is approximately 310 millimetres (mm) at Newman. The majority of rainfall occurs between December and March, peaking in February, with an average of approximately 81 mm. September and October exhibit the driest conditions, with an average rainfall below 4 mm.

The Wittenoom Bureau of Meteorology station is located approximately 190 km northwest of Newman and is the closest station that records evaporation. Annual average evaporation for Wittenoom is 3,142 mm per year, which exceeds annual rainfall by greater than 2,500 mm per year.
5.3 Regional topography

The main physiographic units in the area are the Hamersley Plateau and the Fortescue Valley (Beard, 1975). Prominent topographic features in the region are Mount Robinson (1,142 m), the Governor (1,051 m) and Mount Meharry (1,250 m).

The Proposed Mining Area C Development Envelope is located in the central Hamersley Range, which, together with the Ophthalmia Range, comprises the majority of the Hamersley Plateau. The Hamersley Plateau is composed of rugged hill country characterised by long strike ridges and hills rising over 300 m above the surrounding plains. The surfaces of these ridges are largely covered with skeletal soils with areas of exposed rock.

The ranges in the Proposal area contain gorges and ridges typical of the region, with gorges approximately 40 m deep, 300 m in width and ranging from 250 m to 1,500 m in length. The ridges are flanked by the Northern Flank valley in the north, the Blackwater valley through the centre and the Southern Flank valley in the south. Outwash plains are gently undulating with overlying alluvial and colluvium soils. The ranges in the northern area (Packsaddle Range) feature of the Brockman Iron Formation and contains a number of deposits, including the Brockman Detrital Deposit. South of the Northern Flank valley is the Jirrpalpur Range and the Southern Flank valley, which are part of the Marra Mamba Iron Formation and topographically lower than the Packsaddle Range. The Marra Mamba Iron Formation also forms ridges to the southwest of Mining Area C, including the, Alligator, Boundary and Parallel ridges. Similarly, the Brockman Iron Formation extends into the western section of Mining Area C, where it forms the western extension to the Packsaddle Range and the Wildflower Range, as well as the Governor-Mount Robinson Range.

5.4 Regional geology

The Pilbara bioregion, where the Proposal is located, is situated in the south-eastern comer of the Pilbara Craton. The cratonic basement comprises Archaean granite-greenstone and is unconformably overlain by the late Archaean to Early Proterozoic deposits of the Hamersley Basin. The Hamersley Basin can be divided into three stratigraphic groups: the Fortescue, Hamersley and Turee Creek groups. Of these groups, the Fortescue and Hamersley groups outcrop in the immediate area of the Proposal.

The Hamersley Group is seen throughout the Hamersley Basin and forms the outcrop of Mining Area C. It is a sedimentary sequence comprising banded iron formations (BIFs), shales and dolomites with minor felsic volcanics and intrusive dolerite dykes and sills. The group contains both the Brockman and Marra Mamba Iron formations, which together host most of the known major iron ore deposits in the Pilbara region.

The six lower-most formations of the Hamersley Group that exist within the area are listed below in order of increasing age:

1. Weeli Wolli Formation.
2. Brockman Iron Formation, comprising:
   - Yandicoogina Shale Member (shale and BIF);
   - Joffre Member (BIF with minor shale bands);
   - Whaleback Shale Member (interbedded shale, chert and BIF); and
   - Dales Gorge Member (interbedded BIF and shale).
3. Mount McRae Shale (graphitic and chloritic shales interbedded with BIF).
5. Wittenoom Formation, comprising:
   - Bee Gorge Member (calcareous shale and dolomite);
   - Paraburdoo Member (dolomite – karstic in part); and
   - West Angela Member (manganese-rich shale with minor BIF and chert bands).

6. Marra Mamba Iron Formation, comprising:
   - Mount Newman Member (BIF with thin shale bands);
   - MacLeod Member (BIF with extensive interbedded shales and ‘podded’ BIF horizons); and
   - Nammuldi Member (cherty BIF with occasional shale bands).

5.5 Regional land systems

The Proposal occurs within the Hamersley Plateaux Zone of the Fortescue Province of the Western Region of the soil-landscape zones of Western Australia (Tille, 2006). The dominant landform features within this zone are rocky ranges and hills and stony plains. Rugged hills, ridges, dissected plateaux and mountains occur on the basalt, BIF and sandstone of the Hamersley Basin, the most notable examples being the Chichester and Hamersley ranges.

Five land systems occur within the Proposed Mining Area C Development Envelope (Table 6). The dominant land systems present are the Newman and Boolgeeda land systems, comprising the plateaux, ridges, mountains and hills and their associated drainage zones of this section of the Hamersley Range.

Table 6: Land systems present in the Pilbara that are present within the Proposed Mining Area C Development Envelope (descriptions from van Vreeswyk et al. 2004).

<table>
<thead>
<tr>
<th>Land System</th>
<th>Percentage of Pilbara IBRA present in Development Envelope</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boolgeeda</td>
<td>7,748 km² or 4.3%</td>
<td>Stony plains with hard Spinifex grasslands or Mulga shrublands. The geology is quaternary colluvium.</td>
</tr>
<tr>
<td>Newman</td>
<td>14,580 km² or 8%</td>
<td>Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.</td>
</tr>
<tr>
<td>Pindering</td>
<td>351 km² or 0.2%</td>
<td>Gravelly hardpan plains supporting groved mulga shrublands with hard and soft spinifex.</td>
</tr>
<tr>
<td>Platform</td>
<td>1570 km² or 0.9%</td>
<td>Narrow, raised plains and highly dissected slopes on partly consolidated colluvium below the footslopes of hill systems such as Newman, relief mostly up to about 30 m but occasionally considerably greater.</td>
</tr>
<tr>
<td>Wannamunna</td>
<td>577 km² or 0.3%</td>
<td>Level alluvial plains with prominent grove patterns of vegetation and shallow loamy soils over hardpan and broad internal drainage plains with deeper more clayey soils, relief up to 5 m. The system is found in south central parts of the survey area as broad flats within the Hamersley Ranges (Newman land system).</td>
</tr>
</tbody>
</table>

5.6 Regional hydrology

The hydrology of the Pilbara is marked by infrequent, high-intensity rainfall events associated with cyclonic rainfall and long, dry periods with high potential evaporation rates. Thus, the hydrology of the
Pilbara is one of extremes, ranging from drought to major floods; and water is a highly variable resource (DoW, 2010).

Natural watercourses within the Pilbara region are ephemeral and flow in response to rainfall. The primary mechanism for runoff occurs when the rate of rainfall exceeds the infiltration capacity of the soil (MWH, 2014). This mechanism is commonly associated with high-intensity cyclonic rainfall and impervious catchments.

The Proposal intersects several surface water catchments. To the east, the catchments are part of the internally draining Coondewanna Flats catchment, an 860 km² catchment that terminates at Lake Robinson within Coondewanna Flats. The western sections of the Proposal area drain into tributaries of Pebble Mouse Creek and Weeli Wolli Creek, which both flow into the Fortescue Marsh sub-catchment Area (also known as the Upper Weeli Wolli catchment and Upper Fortescue catchment) (Figure 9).

Groundwater resources in the Pilbara are replenished through the process of direct infiltration from rainfall and from surface water flows. This groundwater is most readily accessed via alluvial channels and surface water drainage lines (DoW, 2010). Regionally, groundwater flow is a reflection of topography, flowing in a northerly direction towards the coast. There are a range of aquifer types in the Pilbara, with the majority of aquifers in the central and eastern Pilbara comprising complex fractured-rock aquifers with irregular structures and various recharge mechanisms.

Within the Proposed Mining Area C Development Envelope, groundwater flows from west to east through dolomite in the Northern Flank and Southern Flank valleys from Coondewanna Flats, which is a major recharge basin, to Weeli Wolli Spring, where groundwater is forced to the surface and discharges into Weeli Wolli Creek. Locally, groundwater flow within the orebody aquifers is small and broadly aligns with the surface topography (Figure 9).

### 5.7 Biodiversity

The Proposed Mining Area C Development Envelope is situated within the Hamersley-Pilbara biodiversity hotspot, one of Australia’s 15 National Biodiversity Hotspots (Commonwealth of Australia, 2014) is a unique and ancient landscape, with variable climates and diverse geology, situated in a biogeographic transition zone between the tropical north and the semi-arid zone. It provides habitat for a number of threatened, endemic and fire-sensitive species and communities (Commonwealth of Australia, 2014) and has one of the most diverse reptile assemblages in the world (Doughty et al., 2011). The Pilbara’s endemic species include mammals, such as the little red kaluta (*Dasykaluta rosamondae*) and Pilbara leaf-nosed bat (*Rhinonicterus aurantia*); reptiles, such as the Pilbara rock monitor (*Varanus pilbarensis*) and Pilbara barking gecko (*Underwoodisaurus seorsus*); plants, such as the ironplant (*Astrotichia hamptoni*); and a highly diverse and largely endemic subterranean fauna community. It also provides protected habitats for a number of rare or threatened species, including the northern quoll (*Dasyurus hallucatus*) and ghost bat (*Macroderma gigas*).

The Pilbara Biological Survey, undertaken by the DPaW between 2002 and 2007, systematically studied the vertebrate and invertebrate fauna across the Pilbara bioregion using stratified and standardised survey techniques (see McKenzie et al. (2009)).
Vegetation mapping of the Pilbara region has been completed on a broad scale (1:1,000,000) by Beard (1975) and subsequently refined by Shepherd et al. (2002). Mining Area C is situated in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia as per Beard (1975) who broadly mapped the area as ranges and valley plains. The most common vegetation associations within the region were:

- *Eucalyptus leucophloia* (snappy gum) and *Triodia wiseana* (hard spinifex) tree steppe occurring on hills and tall woodlands of *Eucalyptus camaldulensis* (river red gum); and
- *Eucalyptus victrix* (coolibah) and *Acacia aneura* (mulga) along drainage lines and in groves within the valley floors.

There are two vegetation associations (as mapped by Shepherd et al. (2002)) within the Proposed Mining Area C Development Envelope:

- Hamersley 18: Low woodland; mulga (*Acacia aneura*); and
- Hamersley 82: Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*.

While the pre-European extent for each vegetation association was close to 100%, less than 10% of each association occurs within formal or informal reserves.

BHP Billiton Iron Ore commissioned Onshore Environmental to consolidate several decades of vegetation mapping commissioned by BHP Billiton Iron Ore into a single regional geographic information system (GIS) dataset and report (Onshore Environmental, 2014). The consolidated dataset provides methodical and nomenclature consistency across BHP Billiton Iron Ore’s tenure and is updated on an ongoing basis as more surveys are completed. Supplementary field assessments were undertaken to address any gaps in baseline data or to verify the results from earlier surveys. Vegetation associations are currently mapped over 422,425 ha of BHP Billiton Iron Ore tenure. Onshore Environmental (2016) identified eight significant flora species within the Proposed Mining Area C Development Envelope which are discussed in detailed in Section 12.1.

Fauna habitat maps are developed routinely during vertebrate fauna surveys undertaken for BHP Billiton Iron Ore. These are generally developed at the local scale to assist in EIA for mining approvals. In 2014, Biologic Environmental Survey reviewed and consolidated fauna habitat mapping within BHP Billiton Iron Ore tenure to develop a single regional GIS dataset and report (Biologic, 2014a). The consolidated dataset provides methodological and nomenclatural consistency across BHP Billiton Iron Ore’s tenure and is updated on an ongoing basis as more surveys are completed. Biologic (2014a) identified 17 major fauna habitat types within BHP Billiton Iron Ore tenure, of which nine occur within the Proposed Mining Area C Development Envelope.

Short-range endemics (SREs) are defined as terrestrial and freshwater invertebrates with naturally small distributions and that may inhabit discontinuous or fragmented habitats (EPA, 2009). Harvey (2002) proposed a range criterion for terrestrial SRE species of less than 10,000 square kilometres (km²) (or 100 x 100 km), which has been adopted by regulatory authorities in Western Australia (EPA, 2009). SRE invertebrate species often share similar biological, behavioural and life history characteristics that influence their restricted distributions and limit their wider dispersal (Harvey, 2002).

Currently there are seven taxonomic groups of SREs in Western Australia. However, the majority of SRE species and communities are not currently listed, partly due to incomplete taxonomic or ecological knowledge and hence the invertebrate taxonomy for species groups considered to contain SRE taxa is highly dynamic with most SRE groups in the Pilbara being incomplete, or in various stages of development, depending upon the group in question (BHP Billiton Iron Ore, 2015c).
Many terrestrial invertebrate species in the Pilbara are only known from a handful of locations where intensive sampling has been undertaken. Species distributions are therefore dependent upon the size and extent of targeted surveys, as well as the ecology, behaviour, and natural history of the species in question, much of which remains uncertain, especially where the species is undescribed. As of 30 May 2013, a total of 144 SRE or potential SRE species had been recorded within the Pilbara bioregion. Currently, there are 18 confirmed or potential SRE species within the Proposed Mining Area C Development Envelope (Biologic, 2016a).

Subterranean fauna are categorised as either stygofauna or troglofauna. Stygofauna are aquatic and inhabit vugs, fissures and other spaces in groundwater aquifers, while troglofauna are air-breathing and inhabit similar spaces in the unsaturated zone (between the groundwater and the surface). Subterranean fauna usually exhibit adaptations to life underground that include the loss of eyes and skin pigmentation, elongation of appendages and sensory structures, and development of a vermiform body shape. The majority of subterranean fauna in Western Australia are invertebrates.

Subterranean species have very limited dispersal capabilities, meaning many species have localised distributions (Gibert & Deharveng, 2002; Lamoreux, 2004). According to Eberhard et al. (2009), about 70% of Pilbara stygofauna species are likely to be SREs, with many of them having much smaller ranges than the generalised range criterion of 10,000 km² proposed for SRE species by Harvey (2002). An even higher proportion of troglofauna species are likely to be SREs (Lamoreux, 2004), with almost all species having ranges two or three orders of magnitude less than Harvey’s SRE criterion (Halse & Pearson, 2014). Species with restricted ranges are vulnerable to significant species loss following habitat destruction or environmental changes (Ponder & Colgan, 2002; Fontaine et al., 2007). Subterranean species are therefore often a focus of EIAs.

The Pilbara has very high subterranean species richness. Some species are believed to be relics of previous communities present when the climate was wetter, and there is a good representation of species that have moved laterally underground and speciated since the climate has become drier, such as those recorded for stygofaunal ostracods and troglofaunal schizomids. It is conservatively estimated that the Pilbara supports approximately 500 to 550 species of stygofauna, and more than 650 morphospecies of troglofauna have been collected from the Pilbara to date (Bennelongia, 2016a, b).

Two PECs occur in the vicinity of the Proposed Mining Area C Development Envelope (information reproduced from DPaW, 2014) (see Figure 9):

- Weeli Wolli Spring community (Priority 1): Weeli Wolli Spring’s riparian woodland and forest associations are unusual as a consequence of the composition of the understorey. The sedge and herbfield communities that fringe many of the pools and associated water bodies along the main channels of Weeli Wolli Creek have not been recorded from any other wetland site in the Pilbara. The spring and creekline are also noted for their relatively high diversity of stygofauna and this is probably attributed to the large-scale calcrete and alluvial aquifer system associated with the creek. The valley of Weeli Wolli Spring also supports a very rich microbat assemblage.

- Coolibah-lignum flats: *Eucalyptus victrix* over *Muehlenbeckia* community: Woodland or forest of *Eucalyptus victrix* (coolibah) over thicket of *Duma (Muehlenbeckia) florulenta* (lignum) on red

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4 Possible threatened ecological communities that do not meet survey criteria or are not adequately defined are added to a priority ecological community list maintained by DPaW. They are ranked 1, 2 or 3 in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for near threatened, or that have been recently removed from the threatened list, are placed in priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in priority 5 (DPaW, 2014).
clays in run-on zones. Associated species include *Eriachne benthamii, Themeda triandra, Aristida latifolia, Eulalia aurea* and *Acacia aneura*. A series of sub-types have been identified, two of which occur near Southern Flank):

- Priority 3(i) Coolibah and mulga (*Acacia aneura*) woodland over lignum and tussock grasses on clay plains (Coondewanna Flats and Wanna Munna Flats); and
- Priority 1 Coolibah woodlands over lignum (*Duma (Muehlenbeckia) florulenta*) over swamp wandiree (Lake Robinson is the only known occurrence).
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6. Social environment

6.1 Socio-economic setting

The primary land uses in the Pilbara region are:

- pastoralism;
- mining;
- conservation;
- tourism; and
- population centres.

Each of the primary land uses is further described below.

6.1.1 Pastoralism

Pastoralism has been an extensive and important industry in the Pilbara region since the early twentieth century (SLWA, 2010). Pastoral activities involve the free-range grazing of stock over vast areas of land with approximately 58% of the Pilbara IBRA region allocated to pastoral grazing.

Feeder cattle (for live export or slaughter export trade) are now the predominant stock type run by the majority of pastoralists in the Pilbara region (SLWA, 2010). As of 2012, the Pilbara pastoral industry was valued at $52 million (DRD, 2015).

Carwardine et al. (2014) identified the main impacts of these grazing animals in the Pilbara as ‘compaction and erosion of soil, loss of grazing-sensitive plant species, reduced native grass biomass, introduction of weed seeds and trampling of seedlings and mature plants’. Grazing pressure and pastoralism are recognised threats to conservation-significant species, including the greater bilby (Southgate et al., 2007) and northern quoll (Hill & Ward, 2010).

Pastoral leases in the vicinity of the Proposal area include Juna Downs and Marillana pastoral stations. Adjacent to and west of the Proposal area is the Juna Downs Pastoral Lease Exclusion area. This area was excluded from the Juna Downs pastoral lease in 2015, becoming unallocated Crown land. The Department of Lands has direct responsibility for all unallocated Crown land, with DPaW responsible for the management of weeds, feral animals and fire prevention. Consultation with DPaW indicates that this area has been excluded from pastoral lease so as to contribute to the National Reserve System, commonly referred to as the comprehensive, adequate and representative (CAR) system of protected areas. However, this area is not as yet formally recognised as conservation reserve, and formal vesting and management arrangements have yet to be completed by the state government for this area.

6.1.2 Mining

The Pilbara is a globally significant mining and energy region, with these industries accounting for 78% ($33 billion) of the total value of exports from the region in 2012/13 (DRD, 2015) and provides employment to approximately 18,500 people in the Pilbara (Pilbara Development Commission, 2015).

Iron ore is the primary commodity mined in the region, and the vast majority (more than 90%) of Australia’s iron ore comes from the Pilbara (DRD, 2015). There are at least 25 iron ore mines currently operating in the Pilbara, the majority of which are located around the towns of Newman and Tom Price (DMP, 2014). These mines collectively contribute to the export of more than 500 Mtpa of iron ore, which
is railed or trucked from the mines to one of three port facilities located at Port Hedland, Cape Lambert and Karratha (DMP, 2014; DRD, 2015).

In addition to iron ore, manganese, gold, silver and copper are also mined in the Pilbara, although to a much lesser extent (DRD, 2015).

Potential impacts of mining activities in the Pilbara bioregion include the loss, degradation and fragmentation of flora and fauna habitat, the increasing use of water resources and alteration of hydrological regimes, soil and water contamination and the alteration of fire regimes (Carwardine et al., 2014). All of these potential impacts have been assessed and detailed in this PER document.

### 6.1.3 Conservation reserves

Land reserved for conservation purposes amounts to approximately 7% of the Pilbara region, with the major reserves being Karijini and Millstream-Chichester national parks. These parks are supplemented by smaller conservation reserves, such as Mungarooona Range Nature Reserve and Meentheena Conservation Park. In WA, conservation reserves include national parks, conservation parks and nature reserves. Conservation reserves are also sometimes collectively called the “conservation estate”. Conservation reserves are areas of land which are specially set aside under law to protect environmental value(s) inherent to them. Development in and use of conservation reserves is usually restricted to only those activities which are compatible with conservation of environmental values.

### 6.1.4 Tourism

The Pilbara is increasingly recognised for its natural values, and the region has experienced an increase in tourism. Tourism plays an important role in the Pilbara economy by supporting diversification of the economy (Pilbara Development Commission, 2015).

An annual visitor expenditure of over $360 million benefits small, locally owned businesses in the accommodation, food services and other retail sectors (Pilbara Development Commission, 2014). The main tourist attraction in the Pilbara is the natural environment, although industrial and cultural or heritage attractions exist. Natural environment tourist attractions in the Pilbara include (Pilbara Development Commission, 2015):

- national parks;
- gorges, pools and swimming holes (many of which are in national parks);
- islands and marine attractions;
- coastal or beach destinations; and
- outstanding landscapes and isolation.

Tourism within the conservation reserves in the Pilbara is regulated by DPaW; however, tourism undertaken within other tenure and at entry points (e.g. roads and off-road tracks) is not easily regulated and therefore has the potential to result in adverse environmental impacts (Carwardine et al., 2014). Impacts include the introduction of exotic species, vegetation fragmentation, increased risk of fire and pressure on sensitive communities from infrastructure developments.

### 6.1.5 Population centres

The Pilbara region is a large, sparsely populated region with the main population centres being the City of Karratha and the towns of Port Hedland and Newman (DRD, 2015). The majority of established centres have been developed to support the resources sector, with other significant towns including Tom Price and Paraburdoo. Population growth has been predominantly driven by the expansion of the
resources sector in the region, with total population increasing from approximately 43,000 in 2003 to 67,500 in 2015 in line with the rapid expansion of the resources sector over that time (DRD, 2015).

### 6.2 Aboriginal heritage

The Pilbara region hosts a prolific number of Aboriginal rock engravings, some of the most well-known being on the Burrup Peninsula (outside of the Proposal boundary). There are numerous Aboriginal reserves within the Pilbara region, such as Ethel Creek and the Weeli Wolli area. These Aboriginal reserves are Crown land set aside for public purposes (DIA, 2010). The Aboriginal reserve near Weeli Wolli occurs outside the Proposal boundary. Aboriginal heritage sites within the Pilbara bioregion are mainly ethnographic sites that are generally associated with the Dreamtime and ceremonies or archaeological sites that are the remains of material culture. A number of these sites in the Pilbara hold considerable visual amenity value (e.g. rock art and creeks or waterholes at water source sites).

BHP Billiton Iron Ore has conducted large-scale archaeological and ethnographic surveys to identify places of cultural significance within the Pilbara region. Those surveys are ongoing and undertaken with participation by the relevant Traditional Owners of the area. All identified sites are managed in consultation with the Traditional Owners and in compliance with the AH Act.

The Proposed Mining Area C Development Envelope lies mostly within the Banjima Native Title claim, with the southeast corner lying within the Nyiyaparli Native Title claim. BHP Billiton Iron Ore is committed to working cooperatively with the Banjima and Nyiyaparli people and has formalised this commitment through comprehensive ILUAs executed with the Nyiyaparli people in 2012 and the Banjima people in October 2015. The ILUAs provide opportunities for both parties and facilitate long-term collaboration. The ILUAs also outline how BHP Billiton Iron Ore works in partnership with the Nyiyaparli and Banjima people to manage cultural heritage and the environment.

### 6.3 European heritage

In Western Australia, the *Heritage of Western Australia Act 1990* makes provision for the preservation of places of historic significance. Under the Act, places identified as meeting the criteria outlined in s47 of the Act are placed on the State Register of Heritage Places. Places of Commonwealth heritage significance are protected under Part 15 of the EPBC Act.

European settlement of the Pilbara region began in the 1860s (van Vreeswyk *et al.*, 2004), with pastoralism dominating the region for the next 100 years as European settlers arrived with livestock to establish sheep and cattle stations. Many of the European heritage sites in the Pilbara region relate to these historic pastoral stations, natural features (such as pools) and town sites.

The inHerit database (Heritage Council of Western Australia, 2015) indicates that there are over 90 heritage places in the Shire of East Pilbara. No European heritage sites are present within the Proposed Mining Area C Development Envelope.
7. Environmental impact assessment process

7.1 State environmental assessment process

The Proposal was referred to the Western Australian EPA under s38 of the EP Act on 23 May 2016 (BHP Billiton Iron Ore, 2016g). On 4 July 2016, the EPA determined that the Proposal required an environmental assessment at PER level with a four-week public review period (EPA, 2016b). The process for a PER environmental assessment is set out in the Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012 (EPA, 2012b) prescribed under the EP Act. It should be noted that these Administrative Procedures were superseded by new procedures in 2016, however, as BHP Billiton Iron Ore referred the Proposal prior to the change in procedures, BHP Billiton Iron Ore has undertaken assessment as per Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012.

On 25 July 2016, the EPA issued an ESD (EPA, 2016b) for the Proposal. The purpose of an ESD is to:

- provide proposal-specific guidelines on the preliminary key environmental factors that are to be addressed during the environmental review;
- identify the required work that needs to be carried out; and
- provide details on the timing of the environmental review.

The purpose of a PER is to document the proponents assessment of the potential impacts of a proposal with regards to the environmental factors as outlined in the ESD. The EIA will be conducted in accordance with various relevant EPA procedures, position statements and guidance documents, as detailed in the subsections below.

The PER must address all elements of the ESD (EPA, 2016b). The EPA expects the proponent to consult with relevant stakeholders to ensure any environmental factors important to the public are addressed. The PER should document all consultation undertaken (Section 4).

Once the PER is submitted, the EPA will determine whether the PER document adequately addresses the requirements of the ESD and the EPA’s expectations. If acceptable, the EPA will release the PER for the public review period, during which time the public can provide submissions. After the public review period closes, the EPA will provide a summary of comments to the proponent (along with copies of all submissions received). The proponent must then adequately respond to topics raised in the public comments.

Following this process, the EPA then assesses the Proposal including the PER document, the submissions received, and the proponent’s response to submissions. After consultation with the proponent, key government agencies, and other relevant stakeholders on the draft conditions, the EPA will submit its assessment report, containing its recommendation on whether the Proposal may be implemented and the recommended conditions of approval, to the Minister for Environment and to the public.

Within 14 days of publication of the EPA’s assessment report, any person may lodge an appeal to the Minister for Environment against the recommendations or content of the report. After appeals are considered, the Minister determines whether or not the proposal should be implemented and decides on the conditions that implementation of the Proposal is subject to.

The environmental assessment process for a PER is detailed in Figure 10.
Figure 10: Public environmental review assessment process
7.2 Commonwealth environmental assessment process

BHP Billiton Iron Ore is seeking approval of a Strategic Assessment Program under the strategic assessment provisions of the EPBC Act (BHP Billiton Iron Ore, 2016d). A strategic assessment is conducted in accordance with Part 10 of the EPBC Act. Strategic assessments provide an alternative approach to project-by-project impact assessment under Part 9 of the EPBC Act and examine proposed developments at a broader landscape scale and timeframe in relation to the requirements of the EPBC Act, taking into consideration impacts on matters of national environmental significance (the protected matters).

The Impact Assessment Report prepared as part of the Commonwealth strategic assessment process considered potential impacts to Matters of National Environmental Significance within the footprint of this Proposal. Matters of National Environmental Significance relevant to this Proposal are the ghost bat (*Macroderma gigas*), northern quoll (*Dasyurus hallucatus*), Pilbara leaf-nosed bat (*Rhinonicterus aurantia*) and Pilbara olive python (*Liasis olivaceus barroni*). All of these species are listed under the state *Wildlife Conservation Act 1950* and are assessed in Section 11.2.4.

7.3 Legislation, policy and guidance

The Proposal is required to comply with relevant legislation and regulations and is guided by relevant policies and strategies. The relevant legislation, regulations, policies, strategies, EPA position statements, EPA guidance statements and other guidance documents relevant to this Proposal are outlined in Table 7. A summary of how BHP Billiton Iron Ore has addressed the guidance outlined within the ESD for this Proposal is also provided in Table 7.

A range of other relevant guidance, policies and legislation has also informed the impact assessments undertaken for this Proposal.
Table 7: Legislation, policies and guidance material relevant to this Proposal

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<th>Factor/area</th>
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<td>EPA Legislation</td>
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| General     | EP Act.                                | The EP Act provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with those things. The object of the act is to protect the environment of the State of Western Australia, having regard to a number of principles described in s. 4A of the EP Act. | Flora and vegetation, terrestrial fauna, subterranean fauna, landforms, hydrological processes, inland waters environmental quality, heritage, air quality, human health, amenity and terrestrial environmental quality may be impacted by matters regulated by the EP Act. The EIA detailed in this PER document has been conducted in accordance with Part IV of the EP Act. Approval of the Proposal is sought under Part IV of the EP Act. Further approvals (e.g. works approvals, clearing permits or environmental licences) may be required under Part V of the EP Act. | • Flora and vegetation – Section 11.1  
• Terrestrial fauna – Section 11.2  
• Subterranean fauna – Section 11.3  
• Hydrological processes – Section 11.4  
• Landforms and terrestrial environmental quality – Sections 12.1 and 12.2  
• Inland waters environmental quality – Section 11.5  
• Air quality – Section 12.3  
• Amenity – Section 12.4  
• Heritage – Section 11.6  
• Human health – Section 12.5 |

| Policy and Guidance Considered in this Proposal |                                        |                |                    |                                   |
| Flora and Vegetation; Terrestrial Fauna | Position Statement No. 2: Environmental Protection of Native Vegetation (EPA, 2000a). | This position statement outlines the EPA’s expectations with regards to impact assessment and management of land clearing. The EPA adopts the principles and related objectives and actions of the National Strategy for the | The assessment detailed in the PER demonstrates that clearing required in relation to the Proposal is environmentally acceptable because:  
• different options have been compared to evaluate protection of biodiversity at the species and ecosystem levels, and it is | • Flora and vegetation – Section 11.1  
• Terrestrial fauna – Section 11.2 |
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<td>Conservation of Australia’s Biological Diversity. The EPA considers that clearing in non-agricultural areas of the state may be environmentally acceptable if the proponent demonstrates clearly that the proposal meets the elements set out in Section 4.3 of the position statement and that actions to meet the two key objectives of the National Strategy for the Conservation of Australia’s Biological Diversity are being met, namely: By the year 2000 Australia will be:</td>
<td>demonstrated that all reasonable steps have been taken to avoid, minimise or mitigate disturbance of existing native vegetation;</td>
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<td>• Arresting and reversing the decline of remnant native vegetation; and</td>
<td>• no known species of plant or animal is likely to significantly impacted as a consequence of the Proposal and the risks to threatened species are considered to be acceptable;</td>
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<td>• Avoiding or limiting any further broad-scale clearance of native vegetation, consistent with ecologically sustainable management and bioregional planning, to those instances in which regional biological diversity objectives are not compromised. This position statement also requires that if the project is large, there is a ‘comprehensive, adequate and secure representation of scarce or endangered habitats within the project area and/or areas which are</td>
<td>• no association or community of indigenous plants or animals is likely to be significantly impacted as a result of the Proposal;</td>
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<td>• vegetation removal under the Proposal will not compromise any vegetation type by taking it below the threshold level of 30% of the pre-clearing extent of the vegetation type;</td>
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<td>• the on-site and off-site impacts of the project have been identified and BHP Billiton Iron Ore’s impact assessments have indicated that these can be managed to an acceptable level.</td>
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<td>biologically comparable to the project area, protected in secure reserves’. The proponent also needs to demonstrate the proposal meets these elements and that actions to meet the two key objectives of the national Strategy for the conservation of Australia’s Biological Diversity are being met.</td>
<td>Extensive baseline studies and detailed EIAs have been undertaken to document the biodiversity of the area and to determine likely impacts from the Proposal. All surveys have been undertaken in accordance with EPA standards, requirements and protocols and have obtained sufficient information to address biodiversity conservation and ecological function values. Detailed genetic studies have been undertaken on the ghost bat to support the impact assessment process. All reasonable measures have been undertaken to avoid impacts to biodiversity, including through implementation of the mitigation hierarchy (avoid, mitigate, rehabilitate, offset). While there will be impacts to biodiversity from implementation of the Proposal, these are not considered to result in an unacceptable loss. Supporting documentation has been made available via the PER process. All data collected during these surveys have been</td>
<td>• Flora and vegetation – Section 11.1&lt;br&gt; • Terrestrial fauna – Section 11.2</td>
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Flora and Vegetation; Terrestrial Fauna

Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002a).

This position statement provides a basis for outlining the requirements of biodiversity protection and the requirements for terrestrial biological surveys for EIA in Western Australia.

In particular:
The EPA expects proponents to demonstrate in their proposals that all reasonable measures have been undertaken to avoid impacts on biodiversity. Where some impact cannot be avoided, the proponent must demonstrate that the impact will not result in unacceptable loss.

Information gathered for EIA must meet state, national, and international agreements, legislation and policy in regard to biodiversity conservation.

The EPA will use the IBRA as the largest unit for EIA decision-making in relation to the conservation of biodiversity.
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| Flora and Vegetation | Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for EIA in Western Australia (EPA, 2004a). | The EPA expects proponents to ensure that terrestrial biological surveys provide sufficient information to address both biodiversity conservation and ecological function values in the context of the type of proposal being considered and the relevant EPA objectives for protection of the environment.  
The EPA expects that terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the particular region, to aid the overall biodiversity understanding and assessment by facilitating transfer into state biological databases. | submitted to DPaW via the licence returns process.                                                   | Flora and vegetation – Section 11.1 |

All botanical surveys undertaken for BHP Billiton Iron Ore have been undertaken in compliance with EPA Guidance Statement 51.
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<tr>
<td>Flora and Vegetation</td>
<td>Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA &amp; DPaW, 2015).</td>
<td>This guide was developed by the EPA to ensure that data collected for EIA are of an appropriate standard. It provides detailed guidance on survey methods for botanical surveys undertaken in Western Australia.</td>
<td>All botanical surveys undertaken post 2015 for BHP Billiton Iron Ore are conducted in accordance with the requirements of this document. There has been no work undertaken specifically for this project since this time.</td>
<td>• Flora and vegetation – Section 11.1</td>
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<td>Flora and Vegetation; Landforms; Rehabilitation and Decommissioning</td>
<td>Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA, 2006).</td>
<td>This guidance statement promotes the use of completion criteria and definitions for the rehabilitation of natural ecosystems that: Allow success to be measured within realistic timeframes; Are sufficiently precise to allow outcomes to be effectively audited, but are also flexible when required; Are based on sound scientific principles; and Acknowledge the consequences of permanent changes to landforms, soils and hydrology. These include standard criteria that apply to all projects, as well as site-specific criteria used to measure the recovery of ecosystems relative to reference sites. Other key areas of discussion are the importance of scientific research.</td>
<td>Rehabilitation objectives as detailed in the Mining Area C – Southern Flank Mine Closure Plan (Appendix 12) have been set in line with this guidance. The completion criteria set out in the guidance have been applied in the impact assessment where relevant. Environmental land factors are detailed in this Proposal, in line with the guidance statement.</td>
<td>• Flora and vegetation – Section 11.1 • Terrestrial fauna – Section 11.2 • Rehabilitation and decommissioning – Section 11.7 • Landforms – Section 12.1</td>
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| Flora and Vegetation; Subterranean Fauna; Hydrological Processes; Inland Waters Environmental Quality. | *Environmental and Water Assessments Relating to Mining and Mining Related Activities in the Fortescue Marsh Management Area. Advice of the EPA to the Minister for Environment under Section 16(e) of the EP Act, EPA Report 1484 (EPA, 2013c).* | This is a strategic advice prepared by the EPA and provided to the Minister for Environment under s. 16(e) of the EP Act. The advice aims to provide consistent guidance for agencies and proponents to help streamline project assessment and approval processes to deliver positive environmental outcomes for the Fortescue Marsh. The advice divides the Fortescue Marsh management area into zones according to key environmental values, which are prioritised according to relative environmental significance. For each environmental value, management objectives are identified and strategies to achieve these objectives are outlined. | EIAs completed for this Proposal were undertaken in a manner that considered the recommendations in this s. 16(e) report. Cumulative impacts were assessed for the Proposal with existing operations at Mining Area C, taking in account existing land disturbance and dewatering activities. The potential impacts of the Proposal are considered unlikely to extend into the Fortescue Marsh land system. | • Flora and vegetation – Section 11.1  
• Subterranean fauna – Section 11.3  
• Hydrological processes – Section 11.4  
• Inland Waters Environmental Quality – Section 11.5 |
| Flora and Vegetation; Terrestrial Fauna; Subterranean Fauna; Hydrological Processes; Inland Waters Environmental Quality. | *Western Australian Water in Mining Guideline, Water Licensing Delivery Series, Report No 12 (DoW, 2013b).* | This guideline sets out how to meet the DoW’s regulatory requirements for mining projects across Western Australia. It draws on the RIWI Act, policies, water allocation plans and regional experience in water management issues. The guideline provides advice on water management issues that need to be considered in mine planning | This Proposal is consistent with the mine water management objectives detailed in the guideline. This guideline will be considered and applied where relevant in relation to on-site water management. | • Flora and vegetation – Section 11.1  
• Terrestrial fauna – Section 11.2  
• Subterranean fauna – Section 11.3  
• Hydrological Processes – Section 11.4 |
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<td>Terrestrial Fauna</td>
<td>Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA, 2009).</td>
<td>This guidance statement addresses the general standards and common framework, including risk-based assessment, for the sampling and assessment of SRE invertebrate fauna for EIA in Western Australia. It sets out the EPA’s current expectations in respect of the quality and quantity of information derived from these surveys and the consequent analysis, interpretation and reporting. The guidance provides information that the EPA will consider when assessing proposals where SRE invertebrate taxa are relevant environmental factors in the assessment.</td>
<td>All SRE surveys undertaken for BHP Billiton Iron Ore since 2009 have been undertaken in accordance with this guidance statement.</td>
<td>• Terrestrial fauna – Section 11.2</td>
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<tr>
<td>Terrestrial Fauna</td>
<td>Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA &amp; DEC, 2010).</td>
<td>This guide is specific to terrestrial vertebrate fauna. It provides advice on fauna sampling techniques and methodologies for different regions of the state and the analysis, interpretation and reporting requirements for EIA. It should be read in conjunction with Guidance Statement 56 (EPA, 2004b). The guide is intended for use when planning and undertaking terrestrial vertebrate fauna surveys for assessment of the impacts of</td>
<td>All surveys undertaken for BHP Billiton Iron Ore since 2010 have adopted the methods outlined in this guidance document where relevant and practical. The amount of survey work undertaken in the Proposed Mining Area C Development Envelope exceeds the requirements for an assessment of this size and scope. There are no specific published guidelines for surveying ghost bats. Therefore, methods for ghost bat surveys and monitoring have been developed over multiple years with various methodologies</td>
<td>• Terrestrial fauna – Section 11.2</td>
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| Terrestrial Fauna   | Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b). | This guidance statement:  
- addresses the general standards and a common framework for terrestrial fauna and fauna assemblages for EIA in Western Australia, the quality and quantity of information derived from these surveys, and the consequent analysis, interpretation and reporting; and  
- is primarily directed at the subset of biodiversity contained in all terrestrial faunal groups.  
The guidance statement assists in the interpretation and application of the general principles outlined in Position Statement No. 3 (EPA, 2002a) and should be read in conjunction with Guidance Statement No. 51 (EPA, 2004a) when planning for biological surveys. | All vertebrate fauna surveys undertaken for BHP Billiton Iron Ore since 2004 been undertaken in accordance with the requirements of this guidance statement. The amount of survey work undertaken in the Proposed Mining Area C Development Envelope exceeds the requirements of the guidance for an assessment of this size and scope.                                                                                                                                   | Terrestrial fauna – Section 11.2 |
| Subterranean Fauna | Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA, 2007). | Guidance Statement 54 has been withdrawn, but Draft Guidance Statement 54a should still be used to provide information on sampling techniques. The guidance statement outlines the EPA’s position in relation to what are acceptable sampling efforts and methodologies for subterranean fauna. A framework is provided for determining whether an area is likely to have significant subterranean faunal values. The draft guidance statement also describes reporting requirements, including that results of subterranean fauna surveys should be available for public review in the EIA review documentation. | All subterranean fauna surveys undertaken for BHP Billiton Iron Ore since issue of this guidance have been undertaken in accordance the requirements of this draft guidance statement where relevant and practical. The amount of survey work undertaken in the Proposed Mining Area C Development Envelope exceeds the requirements of the guidance for an assessment of this size and scope. | • Subterranean fauna – Section 11.3 |

<p>| Subterranean Fauna | EAG 12: Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia (EPA, 2013d). | This guideline provides guidance on the relevant impact assessment methods where subterranean fauna are likely to be a factor, particularly the standards of survey and the type of information required to understand impacts. The guideline sets out the EPA’s preferred approach for the consideration of subterranean fauna in EIAs. It aims to ensure that the standard of survey and the type of information provided to the EPA | All surveys undertaken for BHP Billiton Iron Ore since issue of this guidance have been undertaken in accordance the requirements of this draft guidance statement where relevant and practical. The amount of survey work undertaken in the Proposed Mining Area C Development Envelope exceeds the requirements of the guidance for an assessment of this size and scope. The impact assessment has been undertaken in accordance with this guideline. | • Subterranean fauna – Section 11.3 |</p>
<table>
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<tr>
<th>Factor/area</th>
<th>State Legislation, Policy and Guidance</th>
<th>Considerations</th>
<th>Proposal Relevance</th>
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<td>have a sound scientific basis to enable the EPA to understand impacts. Where survey alone has not provided sufficient evidence to determine distribution, the guidance recommends the use of surrogates to assist in predictions of impact. Draft Guidance Statement 54a (EPA, 2007) (described above) should still be used to provide information on sampling techniques.</td>
<td>All groundwater modelling used to inform this assessment was carried out in accordance with this guideline. Groundwater modelling is discussed in Section 11.4, Hydrological Processes. Also note that the outcomes of the groundwater modelling were used to inform the Mine Closure Plan, which is discussed in Section 11.5, Rehabilitation and Decommissioning.</td>
<td></td>
</tr>
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</table>
| Hydrological Processes; Inland Waters Environmental Quality | Australian Groundwater Modelling Guidelines (Barnett et al., 2012). Waterlines. National Water Commission | This guideline aims to promote a consistent and sound approach to the development of groundwater flow and solute transport models in Australia. |                                                                                                                                                                                                         | • Hydrological processes – Section 11.4  
• Inland waters environmental quality – Section 11.5  
• Rehabilitation and decommissioning – Section 11.7 |                                    |
| Hydrological Processes.                        | Pilbara Groundwater Allocation Plan. Water Resource Allocation and Planning Report series. Report No 55. (DoW, 2013c) | This plan sets out how the DoW will manage groundwater in the Pilbara through allocation limits, water licensing and ongoing monitoring and evaluation. It provides a framework for licensing decisions and adaptive groundwater management across the Pilbara region. The plan also includes licensing policy that applies across the region, mainly for managing water associated with mining. For EIAs carried out to inform the hydrological processes and inland waters environmental quality factors have been carried out in accordance with this plan. Allocation limits for licences, where required, will be determined on application to the DoW through the Rights in Water and Irrigation Act 1914. |                                                                                                                                                                                                         | • Hydrological processes – Section 11.4  
• Inland waters environmental quality – Section 11.5 |                                    |
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<tr>
<th>Factor/area</th>
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<th>Proposal Relevance</th>
<th>Section in this Document Sections</th>
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</thead>
<tbody>
<tr>
<td><strong>Hydrological Processes</strong></td>
<td>Position Statement No. 4: Environmental Protection of Wetlands (EPA, 2004c)</td>
<td>This position statement defines important environmental values and functions of wetlands and establishes principles for the environmental protection of wetlands in general. A number of principles are articulated to provide guidance for the restoration, maintenance and enhancement of wetlands.</td>
<td>This Proposal has assessed the water attributes consistent with the approach in this position statement. The management approach for wetlands, as outlined in the CPWRMP (Appendix 7) is in alignment with the holistic approach in the position statement, in that environmental assets are managed according to the tiered management approach.</td>
<td>• Hydrological processes – Section 11.4</td>
</tr>
<tr>
<td><strong>Inland Waters Environmental Quality</strong></td>
<td>Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC &amp; ARMCANZ, 2000)</td>
<td>This guideline aims to achieve the sustainable use of Australia’s and New Zealand’s water resources by protecting and enhancing their quality while maintaining economic and social development.</td>
<td>These guidelines have been used to assist in the evaluation of the significance of potential impacts associated with the Proposal for the hydrological processes (Section 11.4) and inland waters environmental quality (Section 11.5) factors. Surface water quality and sedimentation in particular are discussed in Section 11.5. Groundwater and surface water quality will also be regulated through the Part V licensing process, which will include a Groundwater operation strategy that adopts where relevant and practical these guidelines.</td>
<td>• Inland waters environmental quality – Section 11.5</td>
</tr>
<tr>
<td>Factor/area</td>
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<tr>
<td>Inland Waters Environmental Quality</td>
<td>State Water Quality Management Strategy No. 6: Implementation Framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Water Quality Monitoring and Reporting (Guidelines Nos. 4 &amp; 7: National Water Quality Management Strategy) (Government of Western Australia, 2004).</td>
<td>This framework has been developed to implement the National Water Quality Management Strategy Guidelines Nos. 4 and 7 for ambient waters in Western Australia. The scope of the framework relates primarily to environmental protection and water quality matters and notes that the ANZECC Guidelines referred to above will be used by default unless more appropriate information for local water resources is available.</td>
<td>This strategy has been used to assist in the development of the CPWRMP for Proposal for management measures for the hydrological processes (Section 11.4) and inland waters environmental quality (Section 11.5) factors. Surface water quality and sedimentation in particular are discussed in Section 11.5. Groundwater and surface water quality will also be regulated through the Part V licensing process, which will include a Groundwater operation strategy that adopts where relevant and practical this strategy.</td>
<td>• Inland waters environmental quality – Section 11.5</td>
</tr>
<tr>
<td>Heritage</td>
<td>Guidance for the Assessment of Environmental Factors: Assessment of Aboriginal Heritage. No 41. (EPA, 2004d).</td>
<td>This guidance statement provides guidance for consideration of Aboriginal heritage in circumstances where the heritage values are linked directly to the physical and biological attributes of the environment and when the protection and management of those attributes are threatened as a result of a proposed development.</td>
<td>Mining activities have the potential to impact Aboriginal cultural heritage. Aboriginal heritage sites have been identified through surveys and Traditional Owner agreements and assessed for potential cultural significance. Site characteristics have been documented, with no sites identified that have heritage values that are significantly impacted biophysically. The assessment summarised in Section 11.6 is consistent with this Guidance Statement.</td>
<td>• Heritage – Section 11.6</td>
</tr>
<tr>
<td>Heritage</td>
<td>Aboriginal Heritage Due Diligence Guidelines, Version 3.0 (DAA &amp; DPC, 2013).</td>
<td>These guidelines assist land users to understand and meet their obligations under the AH Act.</td>
<td>Mining activities have the potential to impact Aboriginal cultural heritage. In accordance with the guidelines, archaeological and ethnographical surveys have been conducted to identify and characterise heritage sites. Where sites</td>
<td>• Heritage – Section 11.6</td>
</tr>
<tr>
<td>Factor/area</td>
<td>State Legislation, Policy and Guidance</td>
<td>Considerations</td>
<td>Proposal Relevance</td>
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<tr>
<td>Rehabilitation and Decommissioning</td>
<td>Environmental Protection Bulletin No. 19: EPA Involvement in Mine Closure (EPA, 2013e).</td>
<td>The purposes of this bulletin is to outline the roles of the DMP and the EPA in mine closure and explain the circumstances when the EPA will assess mine closure. The EPA will only assess rehabilitation and decommissioning aspects of mine closure where there are potentially significant impacts or risks associated with mine closure that cannot be adequately regulated by the DMP for mine sites that are not subject to the Mining Act 1978.</td>
<td>Potential impacts associated with rehabilitation and decommissioning have been assessed for this Proposal and, in association with this bulletin, have informed the preparation of the Mining Area C Mine Closure Plan (Appendix 12).</td>
<td>Rehabilitation and decommissioning – Section 11.7</td>
</tr>
<tr>
<td>Rehabilitation and Decommissioning</td>
<td>Guidelines for Preparing Mine Closure Plans (DMP &amp; EPA, 2015).</td>
<td>The aim of this guideline is to ensure that, for every mine in Western Australia, a planning process is in place so that the mine can be closed, decommissioned and rehabilitated to meet the DMA’s and EPA’s objectives for rehabilitation and decommissioning. The guideline includes provisions for the consideration of surface water management and groundwater management in mine closure.</td>
<td>The Mine Closure Plan has been updated in accordance with these guidelines. The provisions in the guideline regarding the consideration of surface water management and groundwater management in mine closure have informed the preparation of the updated Mining Area C Mine Closure Plan (Appendix 12).</td>
<td>Rehabilitation and decommissioning – Section 11.7</td>
</tr>
<tr>
<td>Rehabilitation and Decommissioning</td>
<td>Assessment and Management of Contaminated Sites (DER, 2014).</td>
<td>The purpose of this document is to provide guidance on the assessment and management of contaminated sites in Western Australia within the legislative framework provided by the Contaminated Sites Act 2003 and</td>
<td>This guideline has been considered in the development of the Mining Area C Mine Closure Plan (Appendix 12).</td>
<td>Rehabilitation and decommissioning – Section 11.7</td>
</tr>
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<td>Factor/area</td>
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<td>The contaminated sites regulations 2006 and the revised national site assessment framework provided in the National Environment Protection (Assessment of Site Contamination) Measure 1999. This guideline has been prepared to assist environmental practitioners, including environmental consultants and auditors, when planning and implementing the assessment and management of contaminated sites and when preparing reports.</td>
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<tr>
<td>Rehabilitation and Decommissioning</td>
<td>Tailing Storage Facilities in Western Australia – Code of Practice (DMP, 2013).</td>
<td>This code will assist those involved with tailings storage facilities to meet their legislative obligations for work health and safety under the Mines Safety and Inspection Act 1994 and environmental matters under the Mining Act 1978.</td>
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<td></td>
<td>Guide to Preparation of a Design Report for Tailings Storage Facilities (DMP, 2015).</td>
<td>This guide has been provided to assist tailing storage facility (TSF) designers with preparing the design report for a TSF. It describes the preferred structure of the design report for TSFs that should be submitted to the DMP in accordance with Section 4 of the Mining Proposal guidelines as required by the Mining Act 1978 and the tailings storage facilities in Western Australia – Code of Practice.</td>
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<tr>
<td>Terrestrial Environmental Quality;</td>
<td>Leading Practice Sustainable Development Program</td>
<td>This guideline is part of a program that aims to identify the key issues affecting sustainable development in the principals of this handbook have informed the update of the Mining Area C Mine Closure Plan (Appendix 12), with</td>
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<tr>
<th>Proposal Relevance</th>
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<tbody>
<tr>
<td>No tailings storage facilities are planned as part of this Proposal, and therefore this code is not relevant.</td>
<td>• Rehabilitation and decommissioning – Section 11.7</td>
</tr>
<tr>
<td>No tailings storage facilities are planned as part of this Proposal, and therefore this guide is not relevant.</td>
<td>• Rehabilitation and decommissioning – Section 11.7</td>
</tr>
<tr>
<td>The principals of this handbook have informed the update of the Mining Area C Mine Closure Plan (Appendix 12), with</td>
<td>• Terrestrial Environmental Quality – Section 12.2</td>
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<td>Factor/area</td>
<td>State Legislation, Policy and Guidance</td>
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<tr>
<td>Rehabilitation and Decommissioning</td>
<td>for the Mining Industry – Managing Acid and Metaliferous Drainage (Commonwealth Department of Industry, Tourism and Resources, 2007).</td>
</tr>
<tr>
<td>Offsets</td>
<td>Environmental Protection Bulletin No 1: Environmental Offsets – Biodiversity (EPA, 2014a).</td>
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<tr>
<td>Offsets</td>
<td>WA Environmental Offsets Policy (Government of Western Australia, 2011).</td>
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<td>Factor/area</td>
<td>State Legislation, Policy and Guidance</td>
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<tr>
<td>Offsets</td>
<td>WA Environmental Offsets Guidelines (Government of Western Australia, 2014).</td>
</tr>
<tr>
<td>Landforms</td>
<td>Environmental Protection Bulletin 23: Guidance on the EPA Landforms Factor (EPA, 2015a).</td>
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<td>Factor/area</td>
<td>State Legislation, Policy and Guidance</td>
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<tr>
<td>Terrestrial Environmental Quality</td>
<td>Environmental Protection (Unauthorised Discharges) Regulations 2004 (WA).</td>
</tr>
<tr>
<td>Terrestrial Environmental Quality</td>
<td>Global Acid Rock Drainage Guide (GARD Guide). International Network for Acid Prevention, 2010.</td>
</tr>
<tr>
<td>Terrestrial Environmental Quality</td>
<td>Australian Water Guidelines for Fresh and Marine Waters (ANZECC/ARMCANZ, 2000) and its updates.</td>
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<tr>
<td>Sediment Quality Information</td>
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<tr>
<td>Air Quality and Atmospheric Gases; Amenity.</td>
<td>Guidance Statement No. 3: Separation Distances between Industrial and Sensitive Land Uses (EPA, 2005a).</td>
</tr>
<tr>
<td>Air Quality and Atmospheric Gases</td>
<td>A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and Other</td>
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<td>Factor/area</td>
<td>State Legislation, Policy and Guidance</td>
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<tr>
<td>Air Quality and Atmospheric Gases</td>
<td><em>Environmental Protection Bulletin No. 24: Greenhouse Gas Emissions and Consideration of Projected Climate Change Impacts in the EIA Process (EPA, 2015b).</em></td>
</tr>
<tr>
<td>Air Quality and Atmospheric Gases</td>
<td><em>National Greenhouse Accounts (NGA) Factors (Commonwealth Department Environment, 2015).</em></td>
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<tr>
<td>Amenity</td>
<td><em>Guidance Statement No. 33: Environmental Guidance for Planning and Development (EPA, 2008).</em></td>
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<tr>
<td>Human Health</td>
<td><em>EAG 13: Consideration of Environmental Impacts from Noise (EPA, 2014b).</em></td>
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<td>State Legislation, Policy and Guidance</td>
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<tr>
<td>Human Health</td>
<td><em>Environmental Protection (Noise) Regulations 1997</em></td>
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</table>
7.4 Principles of ecologically sustainable development

The concept of sustainable development came to prominence at the World Commission on Environment and Development (WCED) in the report entitled *Our Common Future*, which defined sustainable development as (WCED, 1987):

*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

In recognition of the importance of sustainable development, the Commonwealth Government developed a National Strategy for Ecologically Sustainable Development (Commonwealth of Australia, 1992) that defines ecologically sustainable development as:

*Using, conserving and enhancing the community’s resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.*

The principles of ecologically sustainable development are incorporated into the EP Act. These principles are:

- The Precautionary Principle;
- The Principle of Intergenerational Equity;
- The Principle of the Conservation of Biological Diversity and Ecological Integrity;
- Principles in relation to Improved Valuation, Pricing and Incentive Mechanisms; and
- The Principle of Waste Minimisation.

Table 8 provides a summary of how BHP Billiton Iron Ore has considered the principles of ecologically sustainable development for the Proposal.

**Table 8: Consideration of the principles of ecologically sustainable development**

<table>
<thead>
<tr>
<th>OEEA Principle</th>
<th>Description in EP Act</th>
<th>Relevant Yes/No</th>
<th>If Yes, Consideration</th>
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</thead>
<tbody>
<tr>
<td>Precautionary Principle</td>
<td>Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by:</td>
<td>Yes</td>
<td>Biological surveys, EIAs and application of the mitigation hierarchy have been carried out in line with the precautionary principle. Specialist technical impact assessments have been carried out to assess potential impacts and propose potential management strategies. Where information is not available his has been noted. As a result, BHP Billiton Iron Ore has carefully evaluated all environmental impacts in this PER. Where the potential for serious or irreversible damage was identified, mitigation measures, including avoiding impacts where practical, have been applied and a precautionary approach taken when residual risk is uncertain.</td>
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</table>

- Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and
- An assessment of the risk-weighted consequences of various options.
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<tr>
<th>OEPA Principle</th>
<th>Description in EP Act</th>
<th>Relevant Yes/No</th>
<th>If Yes, Consideration</th>
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</thead>
<tbody>
<tr>
<td>Inter-generational Equity</td>
<td>The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.</td>
<td>Yes</td>
<td>BHP Billiton Iron Ore has prepared a credible EIA to inform the environmental assessment process. Regional datasets have been used to assess impacts to health, diversity and productivity of the environment surrounding the Proposal. Mine closure technical studies and modelling have been carried out to inform this impact assessment and a Mine Closure Plan developed to ensure the Proposal is closed in a manner to ensure that the health, diversity and productivity of the environmental is maintained for future generations. Where, residual impacts were identified following mitigation offsets are proposed.</td>
</tr>
<tr>
<td>Conservation of Biological Diversity and Ecological Integrity</td>
<td>Conservation of biological diversity and ecological integrity should be a fundamental consideration.</td>
<td>Yes</td>
<td>Baseline biological surveys have been completed. Technical impact assessments have been completed to determine potential impacts to biological diversity. Management measures, including adaptive management, have been proposed to mitigate biodiversity and ecological impacts associated with implementation of the Proposal. Management measures and closure objectives are developed to ensure conservation of biological diversity.</td>
</tr>
<tr>
<td>Improved Valuation, Pricing and Incentive Mechanisms</td>
<td>Environmental factors should be included in the valuation of assets and services. The polluter pays principle - those who generate pollution and waste should bear the cost of containment, avoidance or abatement. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.</td>
<td>Yes</td>
<td>Environmental factors have been considered throughout the development of this Proposal. Specialist technical studies have been carried out to optimise the mine design so as to minimise environmental impacts and to inform detailed environmental impact evaluations and management measures that aim to minimise pollution and waste. BHP Billiton Iron Ore will seek a Part V operating licence that will ensure that when or if pollution is generated that is paid for in line with legislation. BHP Billiton has regular, open and honest engagement with our stakeholders helps us to identify, understand and prioritise the sustainability issues and opportunities that matter most to our stakeholders</td>
</tr>
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</table>
and to our business. BHP Billiton has identified measurable sustainability targets for these material sustainability issues and undertake an annual cycle of identification, prioritisation, validation and review of these issues and targets. The target and progress against these targets are reported in the annual Sustainability Report. The Proposals predicted impacts, including emissions, will form part of the reporting against these BHP Billiton Sustainability Targets.

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<tr>
<th>OEPA Principle</th>
<th>Description in EP Act</th>
<th>Relevant Yes/No</th>
<th>If Yes, Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Minimisation</td>
<td>All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.</td>
<td>Yes</td>
<td>Standard waste management measures are a key element for the implementation of this Proposal. It is standard practice for the Proponent to apply the waste management hierarchy (i.e. avoid, reduce, reuse, recycle, recover, treat, contain and dispose) to all sites, and this will be the case in relation to this Proposal.</td>
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### 7.5 Principles of environmental impact assessment

The principles of EIA are outlined in the *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012* (EPA, 2012b), as follows:

1) Consult with all stakeholders, including the EPA, decision-making authorities, other relevant government agencies and the local community as early as possible in the planning of their proposal, during the environmental review and assessment of their proposal, and where necessary during the life of the project. BHP Billiton Iron Ore undertakes regular consultation with stakeholders and has commenced consultation specific to this Proposal (see Section 4).

2) Ensure the public is provided with sufficient information relevant to the EIA of a proposal to be able to make informed comment, prior to the EPA completing the assessment report. BHP Billiton Iron Ore will release this PER document once it is approved for release by the OEPA as outlined in the EIA process in Figure 10.

3) Use best practicable measures and genuine evaluation of options or alternatives in locating, planning and designing their proposal to mitigate detrimental environmental impacts and to facilitate positive environmental outcomes and a continuous improvement approach to environmental management. BHP Billiton Iron Ore has assessed alternatives, optimised mine design and applied the mitigation hierarchy as outlined in Sections 3, 10 and 11.

4) Identify the environmental factors likely to be impacted and the aspects likely to cause impacts in the early stages of planning for their proposal. The onus is on the proponent through the EIA process to demonstrate that the unavoidable impacts will meet the EPA objectives for environmental factors and therefore their proposal is environmentally acceptable. BHP Billiton Iron Ore will address this principle via this PER document and the OEPA ESD provides details to address this principle.
5) Consider the following, during project planning and discussions with the EPA, regarding the form, content and timing of their environmental review:

   a) The activities, investigations (and consequent authorisations) required to undertake the environmental review. BHP Billiton Iron Ore addressed this during pre-referral consultation and via the ESD.

   b) The efficacy of the investigations to produce sound scientific baseline data about the receiving environment. All investigations/impact assessments and surveys have been carried out in accordance with EPA guidelines. BHP Billiton Iron Ore has operating in the Pilbara area for 50 years and during this time has gathered an extensive regional data sets on which the EIAs were based offering a high degree of confidence in impact assessments. Data have been gathered by qualified and relevant personnel and has shown to be (via independent review and use by regulating agencies) to be scientifically robust. Where residual impacts have been assessed as significant for this Proposal the application of the mitigation hierarchy based on a robust scientific methodology has resulted in a reduction of potential impacts to a level BHP Billiton Iron Ore considers reasonable.

   c) The documentation and reporting of investigations. This PER document addresses this principle.

   d) The likely timeframes in which to complete the environmental review; and use best endeavours to meet assessment timelines. BHP Billiton Iron Ore has agreed timelines for completing the impact assessment process via acceptance of the ESD and to date has maintained this timeline.

6) Identify in their environmental review, subject to the EPA’s guidance:

   a) Best practicable measures to avoid, where possible, and otherwise minimise, rectify, reduce, monitor and manage impacts on the environment. BHP Billiton Iron Ore has detailed measures for relevant environmental factors in Sections 11 and 12.

   b) Responsible corporate environmental policies, strategies and management practices, which demonstrate how the Proposal can be implemented to meet the EPA’s environmental objectives for environmental factors. Management practices are outlined for each factor in Sections 11 and 12. Corporate policies and strategies are summarised in Section 10.

BHP Billiton Iron Ore has taken these principles of EIA into consideration throughout the Proposal planning, impact assessments, consultation and development of the PER document.
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8. Environmental studies and survey effort

BHP Billiton Iron Ore has carried out an evaluation of potential impacts of the Proposal, taking into consideration all relevant factors identified by *EAG 8 for Environmental Factors and Objectives* (EPA, 2013a). The outcomes of this evaluation, along with pre-referral consultation with the OEPA, have driven all technical EIA studies that have recently been carried out. Particular focus has been given to those preliminary key environmental factors identified as likely to receive the greatest potential impacts from the Proposal.

BHP Billiton Iron Ore has undertaken extensive baseline studies within the Proposed Mining Area C Development Envelope and surrounds and information from these studies has informed impact assessments undertaken for this Proposal. All surveys were undertaken in accordance with relevant EPA guidelines at the time of survey. This comprehensive baseline has informed targeted surveys to address ecological knowledge gaps and changes in conservation status or survey guidelines. In summary, there have been 22 flora and vegetation surveys, 21 terrestrial vertebrate fauna surveys and eight SRE invertebrate fauna surveys undertaken wholly or partially within the Proposed Mining Area C Development Envelope. Many of these surveys overlap areas, enabling the review of previous results and the capture of baseline biodiversity data over an extended period. Species observations from all surveys are maintained within the BHP Billiton Iron Ore biodiversity data set, quality checked and assured on a regular basis consistent with changing taxonomy, and conservation status. Almost 2,750 troglofauna samples have been collected within the Proposed Mining Area C Development Envelope, and almost 1,300 stygofauna samples have been collected from groundwater catchments in which it occurs. The surveys are summarised in the EIAs and supporting documents provided in Appendix 4 – Appendix 11.

An overview of the impact assessment studies specifically undertaken for the Proposal is presented in Table 9 (noting that this is a subset of those listed above). The EIAs undertaken for the Proposal have been developed primarily using data collected by or on behalf of BHP Billiton Iron Ore. Information on species’ ecology and distribution has been supplemented by published species accounts and data available in the public domain and is considered accurate at the time of writing. Results from further studies may differ from those presented in this PER document, and BHP Billiton Iron Ore will continue to review information on Pilbara species as part of its adaptive management approach.

The cumulative EIAs undertaken for this Proposal relied on the data from a number of sources. The accuracy of the data not collected on behalf of BHP Billiton Iron Ore has not been verified; and unless there is evidence to the contrary, it has been assumed that it is accurate and collected in accordance with standard industry guidelines. BHP Billiton Iron Ore has made every effort to obtain relevant information and data available in the public domain at the time of referral but acknowledges that some information may have inadvertently been excluded.

Of note is that the validation of the conceptual groundwater model was limited due to lack of accessibility to monitoring points and datasets within the modelling domain and, in some cases, was limited to historic information only. Assumptions have been made about the influence of geology on groundwater where detailed data were not available.

The majority of data on Pilbara species were sourced from biological surveys undertaken for impact assessments undertaken in relation to mining environmental approvals. Therefore, there will be a bias towards the occurrence of species found on mining and exploration tenements. Biological surveys only provide a snapshot of the biological communities present at the time of survey; the absence of a record may not necessarily indicate that a species does not or will not occur within the survey area. This is unlikely to be a limitation for information within the Proposed Mining Area C Development Envelope as...
a considerable amount of biological survey work has been undertaken over a 20-year period; however, it restricts the ability to undertake a comprehensive cumulative impact assessment.

Mine planning and design are iterative processes that are subject to change over time as more information becomes available from exploration or operational activities. The EIAs that are presented in this PER were based on mine plans available prior to July 2016. For this reason, the impact assessment information is presented for both the Indicative Additional Impact Assessment Area and the Additional Development Envelope to allow for movement of pits, OSAs and infrastructure within the Proposed Mining Area C Development Envelope.

Impact assessments were undertaken based on EPA guidance documents and legislation published and current at the time of referral. The EPA checklist has been completed for terrestrial biodiversity issues in line with the ESD and is provided in Appendix 3.
### Table 9: Summary of impact assessment studies undertaken for the Proposal

<table>
<thead>
<tr>
<th>Factor</th>
<th>EPA Objective</th>
<th>Survey/Investigation</th>
<th>Summary</th>
<th>Study standard, guidance and limitations</th>
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<tbody>
<tr>
<td>Flora and vegetation</td>
<td>To protect flora and vegetation so that biological diversity and ecological integrity are maintained</td>
<td>Mining Area C – Southern Flank Flora and Vegetation Environmental Impact Assessment (Appendix 4).</td>
<td>This EIA study was carried out to review potential impacts on flora and vegetation arising from implementation of the Proposal and considered data collected during 22 flora and vegetation surveys undertaken wholly or partially within the Proposed Mining Area C Development Envelope. Data available from regional studies and information in publicly available databases were also considered.</td>
<td>EPA Guidance Statement 51. Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a).</td>
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<td></td>
<td>Flora and vegetation survey – Area C and Surrounds (Onshore Environmental, 2011) (Appendix 4).</td>
<td>This was a Level 2 Flora and Vegetation Survey undertaken in the Northern Flank and eastern areas of Mining area C. This report consolidates information from previous surveys undertaken at Mining Area C.</td>
<td>EPA Position Statement 2. Environmental Protection of Native Vegetation in Western Australia (EPA, 2000a).</td>
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<td>Level 2 Flora and Vegetation Survey South Flank (Onshore Environmental, 2012) (Appendix 4).</td>
<td>This was a Level 2 Flora and Vegetation Survey undertaken in the Southern Flank area.</td>
<td>EPA Position Statement 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002)</td>
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<td>Mining Area C Flora and Vegetation Environmental Impact Assessment (Onshore Environmental, 2015) (Appendix 4).</td>
<td>This EIA study was carried out to review potential impacts on flora and vegetation arising from mining within all deposits at Mining Area C. The document considered data from all surveys undertaken within the development envelope and surrounding areas, plus information available in public databases.</td>
<td>Technical Guide - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA &amp; DPaW, 2015).</td>
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<td>Coondewanna Flats Ecohydrological Study: Ecological Water Requirements of</td>
<td>This study was undertaken to determine the ecological water requirement of vegetation as part of BHP Billiton Iron Ore's eco-hydrogeological investigation of the Coondewanna Flats (the Flats), located southwest of Mining Area C. The purpose</td>
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<td>Factor</td>
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<tr>
<td>Vegetation</td>
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<td><em>Vegetation Report (Astron Environmental, 2014).</em></td>
<td>Of this work was to determine the eco-hydrological function of priority ecological communities (PECs) in order to inform ongoing management and monitoring of the Flats. The aim of management is to ensure the long term persistence of PECs at the Flats in response to changes in surface water and groundwater regimes associated with surrounding mining activities.</td>
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<tr>
<td>Terrestrial fauna (including short-range endemics)</td>
<td>To protect terrestrial fauna so that biological diversity and ecological integrity are maintained</td>
<td><em>Mining Area C Southern Flank Environmental Impact Assessment for Ghost Bat (Macrodema gigas) (Biologic, 2016b) (Appendix 5).</em></td>
<td>This study was an EIA of potential impacts to the ghost bat arising from implementation of the Proposal. The study considered work undertaken for BHP Billiton Iron Ore on ghost bat distribution, diet and cave attributes between 2011 and 2015 and the results from additional studies in 2015 and 2016 (Biologic, 2016b, below).</td>
<td><em>EPA Position Statement No. 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002a).</em> <em>EPA Guidance Statement No. 56. Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b).</em> <em>Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. (EPA and DEC, 2010).</em></td>
</tr>
</tbody>
</table>
| Hamersley Range Ghost Bat Population Study 2015/2016. (Biologic Environmental, Survey in prep). | | This survey was undertaken in conjunction with the University of Queensland and Murdoch University to:  
- Determine the presence of pregnant females within the Additional Development Envelope and surrounding BHP Billiton Iron Ore tenure; and  
- Determine genetic relatedness of ghost bats within the Additional Development Envelope, surrounding BHP Billiton Iron Ore tenure, and API and Fortescue Metal Group tenure located in the north-western Hamersley Range. | |
<p>| Mining Area C and Southern Flank Desktop Review of Vertebrate Fauna (Biologic, 2017) (Appendix 5). | | Desktop review of all terrestrial vertebrate fauna surveys undertaken within the Proposed Mining Area C Development Envelope, and including results from database searches. | |</p>
<table>
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<tr>
<th>Factor</th>
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<td>South Flank Targeted Fauna Survey (Biologic, 2016c) (Appendix 5).</td>
<td>This survey was undertaken to determine the presence, or likely presence, of the northern quoll, Pilbara olive python and northern brushtail possum within the Southern Flank area.</td>
<td>EPBC Act referral guidelines for the endangered northern quoll, <em>Dasyurus hallucatus</em> (DSEWPaC, 2011).</td>
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<td>Southern Flank Vertebrate Fauna Study (Biologic, 2011) (Appendix 5).</td>
<td>Level 2 vertebrate fauna survey undertaken within the Southern Flank area.</td>
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<td>South Flank 2010 Bat Survey Report (BatCall WA, 2011) (Appendix 5).</td>
<td>Targeted survey for conservation significant bat species within the Southern Flank area.</td>
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<td>Southern Flank Targeted Northern Quoll Survey (Biologic, 2013) (Appendix 5).</td>
<td>This survey was undertaken to determine the presence of the northern quoll within the Southern Flank area. The survey employed survey techniques and survey effort that was consistent with DSEWPaC guidelines.</td>
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<td>South Flank Baseline and Targeted SRE Fauna Survey (Biologic, 2016d) (Appendix 5).</td>
<td>This study was undertaken to:  - Address sampling gaps from the baseline studies;  - Complete habitat assessment across the Proposed Mining Area C Development Envelope and surrounds; and</td>
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<td>Determine the extent of habitat and population of the millipede <em>Antichiropus</em> ‘DIP007’.</td>
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<td><strong>Short Range Endemic Invertebrate Fauna Survey – South Flank</strong> (Biota, 2011) (Appendix 5).</td>
<td>Level 2 baseline survey of short-range endemic invertebrate fauna within the Southern Flank area.</td>
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<td><strong>South Flank Targeted Millipede Survey</strong> (Biota, 2013) (Appendix 5).</td>
<td>Targeted survey for short-range endemic <em>Antichiropus</em> millipede within the Southern Flank area and surrounds.</td>
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<td><strong>Mining Area C – Life of Project Environmental Management Plan Revision 6 Environmental Impact Assessment of Short-range Endemic Invertebrates</strong> (Biologic, 2015a) (Appendix 5).</td>
<td>This EIA study was carried out to review potential impacts on terrestrial invertebrate SREs arising from mining within all deposits at Mining Area C. The document considered data from all surveys undertaken within the development envelope and surrounding areas, plus information available in public databases.</td>
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<td><strong>Mining Area C Vertebrate Fauna Environmental Impact Assessment</strong> (Biota, 2015a) (Appendix 5).</td>
<td>This EIA study was carried out to review potential impacts on terrestrial vertebrate fauna arising from mining within all deposits at Mining Area C. The document considered data from all surveys undertaken within the development envelope and surrounding areas, plus information available in public databases.</td>
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<tr>
<td>Subterranean fauna</td>
<td>To protect subterranean fauna so that biological diversity and ecological</td>
<td><strong>Mining Area C, Southern Flank: Troglofauna Assessment</strong> (Bennelongia 2016a) (Appendix 6).</td>
<td>This EIA study was carried out to review impacts of implementation of the Proposal on troglofauna, considering the results of almost 2,750 samples collected within the Proposed Mining Area C Development Envelope and a troglofauna habitat assessment undertaken by BHP Billiton Iron Ore (BHP Billiton Iron Ore, 2016h).</td>
<td><strong>EPA EAG 12. Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia</strong> (EPA, 2013d); <strong>EPA Guidance Statement No. 54a. Sampling Methods and Survey Considerations for</strong></td>
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<td>integrity are maintained</td>
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<td><strong>Mining Area C, Southern Flank Stygofauna Assessment</strong> (Bennelongia, 2016b) (Appendix 6).</td>
<td>This EIA study was carried out to review impacts of implementation of the Proposal on stygofauna, considering the results of more than 1,000 samples within the Groundwater Assessment Area. The Groundwater Assessment Area was considered to be any additional areas that were modelled to experience groundwater drawdown of 2 m or more as a result of the Proposal.</td>
<td><strong>Subterranean Fauna in Western Australia</strong> (EPA, 2007).</td>
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<td><strong>Southern Flank Troglofauna Assessment</strong> (Bennelongia, 2016c).</td>
<td>Troglofauna sampling undertaken between March and May 2016 to determine distribution of potentially restricted species.</td>
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<td><strong>Southern Flank Stygofauna Assessment</strong> (Bennelongia, 2016d).</td>
<td>Stygofauna sampling undertaken between July and September 2016 to determine distribution of potentially restricted species.</td>
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<td><strong>South Flank Troglofauna Habitat Assessment</strong> (BHP Billiton Iron Ore, 2016h).</td>
<td>A geological review of subterranean fauna habitats to determine the known and inferred extent of potential troglofauna habitats in relation to likely pit areas within the Indicative Additional Impact Assessment Area.</td>
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<td><strong>Addendum for Modified Boundary: Mining Area C and Southern Flank Troglofauna Environmental Impact Assessment</strong> (Bennelongia, 2016e).</td>
<td>Review of impacts to troglofauna if the Modified Additional Impact Assessment Area was adopted.</td>
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<td><strong>Addendum based on Updated Habitat Assessment: Mining Area C and Southern Flank Troglofauna Environmental Impact</strong></td>
<td>Review of impacts to troglofauna considering outcomes of updated habitat assessment and considering restriction of impacts to proposed pit shell areas.</td>
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<td><strong>Assessment</strong></td>
<td>This EIA study was carried out to review potential impacts troglofauna arising from mining within all deposits at Mining Area C. The document considered data from all surveys undertaken within the development envelope and surrounding areas, plus information available in public databases.</td>
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<td><strong>Mining Area C, Life of Project: Troglofauna Assessment</strong> (Bennelongia, 2017).</td>
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<td><strong>Mining Area C, Life of Project: Stygofauna Assessment</strong> (Bennelongia, 2015a).</td>
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<td><strong>Mining Area C, Life of Project: Stygofauna Assessment</strong> (Bennelongia, 2015b).</td>
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<td>Hydrogeological Impact Assessment and Water Management Summary (BHP Billiton Iron Ore, 2016a).</td>
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<td>The assessment area encompassed the three identified environmental receptors in the area – Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis – and also included cumulative impact predictions and closure. This report summarises the outcomes of the modelling and impact assessment (during operations and post closure of the Proposal) undertaken by BHP Billiton Iron Ore in 2016.</td>
<td>As above plus Environmental and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area. Advice of the EPA to the Minister for Environment under Section 16(e) of the EP Act. EPA Report 1484. Perth, Western Australia. (EPA, 2013c). Limitations associated with the model include: • Assumptions in the 2016 mine plan (i.e. rate, sequence, timing and depth of pushbacks). • Assumptions in closure settings (particularly backfill properties and evaporation rates). Consultation with DoW as per details provided in Section 4.</td>
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<td>Coondewanna Flats Phase III Water Assessment (URS, 2014).</td>
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<td>The scope of this study was developed in consultation with Astron Environmental (2014a). This report presents the results and preliminary interpretations of hydrogeological data collected during site investigations conducted in April and May 2014. The aim of this investigation was to increase the level of knowledge of the surface water, groundwater and subsequent soil moisture in the Coondewanna Flats area.</td>
<td>Priority Ecological Communities for Western Australia Version 21 (DPaW, 2014).</td>
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<td>Coondewanna Flats Eco-Hydrological Review and Conceptual Model (AQ2, 2015).</td>
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<td>This report combines the assessment findings of the Astron Environmental (2014a) and URS (2014) studies for the Coondewanna Flats area to develop an integrated eco-hydrological model.</td>
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<td>Mining Area C Environmental Management Plan Revision 6 Surface Water Assessment (RPS Aquaterra, 2015).</td>
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<td>This study was undertaken in 2014 and finalised in 2015. The study included an environmental impact assessment review of potential impacts to surface water (during operations and post closure) from the</td>
<td>Operational Policy No.1.02 Policy on water conservation/efficiency plans (DoW, 2009). Pilbara Regional Water Plan 2010-2030 (DoW, 2010).</td>
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<td>Hydrogeological Assessment for Mining Area C (RPS Aquaterra, 2014).</td>
<td>This groundwater modelling and assessment was completed in 2014. The assessment area encompassed the three identified environmental receptors in the area: Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis and also included cumulative impact predictions and closure.</td>
<td>As above. Limitations associated with the model include: • Assumptions in the 2014 mine plan (i.e. rate, sequence, timing and depth of pushbacks). • Assumptions in closure settings (particularly backfill properties and evaporation rates).</td>
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<td>Mining Area C Hydrological Impact Assessment and Water Management Summary (BHP Billiton Iron Ore, 2016a).</td>
<td>This report summarises the outcomes of the modelling and impact assessment (during operations and post closure) undertaken by RPS Aquaterra in 2014.</td>
<td>As above.</td>
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<td>Inland waters environmental quality</td>
<td>To maintain the quality of groundwater and surface water, sediment and biota so that the environmental</td>
<td>Mining Area C Revised Proposal Surface Water Impact Assessment (MWH, 2016).</td>
<td>This study was undertaken in 2016. The study included an EIA review of potential impacts to surface water (during operations and post closure) of the implementation of the Proposal.</td>
<td>Water Quality Protection Guidelines – Mining and Mineral Processing (DoW, 2000) Limitation: This report was carried out based on the mine plan at the time the report was commissioned. As the mine plan evolves, surface water infrastructure will be revised and updated as required.</td>
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<td>Factor</td>
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|        | values, both ecological and social, are protected. | Hydrogeological Impact Assessment and Water Management Summary (BHP Billiton Iron Ore, 2016a). | The assessment area encompassed the three identified environmental receptors in the area – Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis – and also included cumulative impact predictions and closure. This report summarises the outcomes of the modelling and impact assessment (during operations and post closure of the Proposal) undertaken by BHP Billiton Iron Ore in 2016. | As above. Limitations associated with the model include:  
• Assumptions in the 2016 mine plan (i.e. rate, sequence, timing and depth of pushbacks).  
• Assumptions in closure settings (particularly backfill properties and evaporation rates).  
• Consultation with DoW as per details provided in Section 4. |
| Mining Area C Environmental Management Plan Revision 6 Surface Water Assessment (RPS Aquaterra, 2015). | Mining Area C Hydrological Impact Assessment for Mining Area C (RPS Aquaterra, 2014). | This study was completed in 2014.  
This was a desktop environmental impact assessment review of potential impacts to surface water (during operations and post closure) from the proposed EMP Revision 6 development at Mining Area C. | As above. Limitation: This report was carried out based on the mine plan at the time the report was commissioned.  
As the mine plan evolves, surface water infrastructure will be revised and updated as required. |
| Hydrogeological Assessment for Mining Area C (RPS Aquaterra, 2014). | Mining Area C Hydrological Impact Assessment and Water Management Summary (BHP Billiton Iron Ore, 2016a). | This groundwater modelling and assessment was completed in 2014.  
The assessment area encompassed the three identified environmental receptors in the area: Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis and also included cumulative impact predictions and closure. | Limitations associated with the model include:  
• Assumptions in the 2014 mine plan (i.e. rate, sequence, timing and depth of pits).  
• Assumptions in closure settings (particularly backfill properties and evaporation rates). |
| Heritage | To ensure that historical and cultural associations are not adversely affected. | A number of archaeological and ethnographical surveys have been carried out. | Surveys have covered the Proposed Mining Area C Development Envelope. | EPA Guidance Statement No. 41. Assessment of Aboriginal Heritage (EPA, 2004d).  
Consultation with the Traditional Owners (Banjima and Nyiyaparli people, as per details provided in Section 4. |
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<tr>
<td><strong>Rehabilitation and decommissioning closure</strong> (integrating factor)</td>
<td>To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.</td>
<td><strong>South Flank Iron Ore Project – Soil and Landform Assessment</strong> (Outback Ecology, 2012a)</td>
<td>This study was completed in 2012. The study was commissioned to undertake a soil and landform survey of the indicative disturbance area of the Proposal to provide baseline information and assist in the planning of soil resource management and future rehabilitation activities.</td>
<td><strong>Guidelines for Mining Proposals in Western Australia</strong> (DMP, 2016b). <em>Environmental Protection Bulletin No. 23: Guidance on the EPA’s Landforms Factor</em> Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA, 2006) Limitation: Assessment of AMD risk is based on material classification taken from resource or mining models produced by BHP Billiton Iron Ore. AMD classification within resource models is based on geochemical assays of drill-hole data.</td>
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<tr>
<td><strong>Landforms</strong></td>
<td>To maintain the variety, integrity, ecological functions and environmental values of landforms.</td>
<td><strong>South Flank Preliminary AMD Risk Assessment</strong> (BHP Billiton Iron Ore, 2016b).</td>
<td>This risk assessment was completed in 2016 and assessed the risk of AMD generation at all deposits at Southern Flank. The assessment focussed on source, pathways and receptors.</td>
<td><strong>Guidelines for Mining Proposals in Western Australia</strong> (DMP, 2016b). <em>Environmental Protection Bulletin No. 23: Guidance on the EPA’s Landforms Factor</em></td>
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**South Flank Preliminary AMD Risk Assessment** (BHP Billiton Iron Ore, 2016b).

This risk assessment was completed in 2016 and assessed the risk of AMD generation at all deposits at Southern Flank. The assessment focussed on source, pathways and receptors. This study was completed in 2012.

**South Flank Iron Ore Project – Soil and Landform Assessment** (Outback Ecology, 2012a).

This study was completed in 2012. The study was commissioned to undertake a soil and landform survey of the indicative disturbance area of the Proposal to provide baseline information and assist in the planning of soil resource management and future rehabilitation activities.

**Mining Area C Acid and Metalliferous Drainage Risk Assessment** (Klohn Crippen Berger, 2014).

This study was completed in 2014 and reviewed the potential impacts to key environmental receptors from potentially acid-forming materials (during operations and post closure) within the Mining Area C deposits.

**Mining Area C Baseline Soil and Landform Survey and Impact Assessment** (MWH Australia, 2015).

This baseline survey was undertaken in 2014. The report incorporates the results of the 2011 survey (Outback Ecology 2012).

**Mining Area C Assessment Study Area Soil and Landform Assessment** (Outback Ecology, 2012b).

This baseline survey was completed in 2011 and covered part of the proposed EMP Revision 6 development area.

**Mining Area C Acid and Metalliferous Drainage Risk Assessment** (BHP Billiton Iron Ore, 2016b).

This risk assessment was completed in 2016 and assessed the risk of AMD generation at all deposits at Southern Flank. The assessment focussed on source, pathways and receptors. This study was completed in 2012.

**South Flank Preliminary AMD Risk Assessment** (BHP Billiton Iron Ore, 2016b).

This risk assessment was completed in 2016 and assessed the risk of AMD generation at all deposits at Southern Flank. The assessment focussed on source, pathways and receptors. This study was completed in 2012.
<table>
<thead>
<tr>
<th>Factor</th>
<th>EPA Objective</th>
<th>Survey/investigation</th>
<th>Summary</th>
<th>Study standard, guidance and limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>South Flank Iron Ore Project – Soil and Landform Assessment</em> (Outback Ecology, 2012).</td>
<td>This study was completed in 2012. The study was commissioned to undertake a soil and landform survey of the indicative disturbance area of the Proposal to provide baseline information and assist in the planning of soil resource management and future rehabilitation activities. This baseline survey was completed in 2011 and covered the majority of the Additional Development Envelope.</td>
<td><em>Guidance Statement No. 6 – Rehabilitation of Terrestrial Ecosystems</em> (EPA, 2006) Limitation: Assessment of AMD risk is based on material classification taken from resource/ or mining models produced by BHP Billiton Iron Ore. AMD classification within resource models are is based on geochemical assays of drill hole data.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Area C EMP Revision 6 Landscape and Visual Impact Assessment</em> (Urbis, 2015).</td>
<td>This study was completed in January 2015. The study included data captured from predetermined vantage points in the vicinity of Mining Area C. It also utilised modelling to assess the impact (during operations and post closure) on viewsheds and landscape character types in the Pilbara region.</td>
<td></td>
</tr>
<tr>
<td>Terrestrial environmental quality</td>
<td></td>
<td><em>South Flank Preliminary AMD Risk Assessment</em> (BHP Billiton Iron Ore, 2016b).</td>
<td>This risk assessment was completed in 2016 and assessed the risk of AMD generation at all deposits at Southern Flank. The assessment focussed on source, pathways and receptors.</td>
<td><em>Commonwealth Department of Industry, Tourism and Resources [DITR] (2007) Leading Practice Sustainable Development Program for the Mining Industry - Managing Acid and Metalliferous Drainage.</em></td>
</tr>
</tbody>
</table>
|        |               | *Mining Area C Preliminary Acid and Metalliferous Drainage Risk Assessment* (Klohn Crippen Berger, 2014). | This study was completed in 2014. This study reviewed the potential impacts to key environmental receptors from potentially acid-forming materials within the Mining Area C deposits during operations and post closure. | *International Network for Acid Prevention (2012) Global Acid Rock Drainage Guide (GARD Guide).*
<table>
<thead>
<tr>
<th>Factor</th>
<th>EPA Objective</th>
<th>Survey/investigation</th>
<th>Summary</th>
<th>Study standard, guidance and limitations</th>
</tr>
</thead>
</table>
| Air quality (and atmospheric gases)         | To maintain air quality for the protection of the environment and human health and amenity. | Memorandum – Updated Air Quality Modelling for South Flank (PEL, 2016) (Appendix 9) | This study was completed in 2016. The modelling was undertaken to inform an impact assessment for potential air quality impacts resulting from the Proposal.  
  AMD classification within resource models are based on geochemical assays of drill hole data.                                                                                       | Air Quality Modelling Guidance Notes, Department of Environment, Government of Western Australia, March 2006.  
  National Greenhouse Accounts (NGA) Factors (Commonwealth Department of Climate Change and Energy Efficiency 2010).  
  Limitation: Modelling was undertaken based on the mine plan current at the time of modelling. Mine planning is an iterative process, and the plan is subject to change at any time. |
| Amenity                                     | To ensure that impacts to amenity are reduced to as low as reasonably practicable. | South Flank Project: Landscape and Visual Impact (360 Environmental, 2013)  
  South Flank Project: Landscape and Visual impact (Addendum) (BHP Billiton Iron Ore, 2016i) (Appendix 10). | The original study was undertaken in 2013. The impact assessment determined the potential impact of the Southern Flank mine as proposed in 2013 on visual amenity via photomontage analysis.  
  The addendum reviewed the original impact assessment in light of the changes to mine design in 2016.  
  Limitation: Impact assessments were undertaken based on the mine plan current at the time of assessment. Mine planning is an iterative process, and the plan is subject to change at any time. |                                                                                                                                                                                                                                         |
| Human health (noise)                       | To ensure that human health is protected.                                      | South Flank Environmental Noise (EAG 13 for the Consideration of Environmental Impacts from Noise (EPA, 2014b).) | This study was completed in 2016.  
  It included data captured from pre-determined vantage points in the vicinity of the proposed EMP Revision 6 development. The study also utilised modelling to assess the impact on viewsheds and landscape character types (during operations and post closure). |                                                                                                                                                                                                                                         |
<table>
<thead>
<tr>
<th>Factor</th>
<th>EPA Objective</th>
<th>Survey/Investigation</th>
<th>Summary</th>
<th>Study standard, guidance and limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>not adversely affected</td>
<td></td>
<td><strong>Assessment Document</strong> No: 1401562-1-200 (SVT, 2016) (Appendix 11).</td>
<td>The study utilised modelling to assess a range of potential development scenarios and determine noise levels at selected sensitive receptors within the regional area. This was inclusive of determining noise impacts from this Proposal and cumulatively with existing operations at Mining Area C.</td>
<td>Limitations: The modelling was carried out based on the mine plan at the time the report was commissioned. The financial year 2038 scenario was used as a high case for assessing potential impacts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Environmental Noise Assessment: Mining Area C</strong> (SVT, 2014).</td>
<td>This study was completed in 2014. This study utilised modelling to assess a range of potential development scenarios and determine noise levels at selected sensitive receptors within the regional area.</td>
<td>As above. Limitations: The modelling was carried out based on the mine plan at the time the report was commissioned. The Financial Year 2027 scenario was used as a high case for assessing potential impacts.</td>
</tr>
</tbody>
</table>
9. Identification of environmental factors

BHP Billiton Iron Ore has completed baseline studies (Table 9) and EIAs (Sections 11 and 12) to determine the potential environmental impacts and significance of the identified environmental factors against the EPA significance framework (EPA, 2013b).

9.1 Determining the environmental factors

In March 2016, BHP Billiton Iron Ore met with officers from the OEPA and discussed the results of the baseline studies, which assisted in further definition of this Proposal, the Proposed Mining Area C Development Envelope and the focus of key studies. The Environmental Scoping Document issued by the OEPA on 19 September 2016 provided an outline of preliminary key factors that are relevant to this Proposal. This PER document has been prepared in line with the ESD (OEPA, 2016).

The environmental factors, as defined in *EAG 8 for Environmental Factors and Objectives* (EAG 8) (EPA, 2013a) and EPA’s Statement of Environmental Principles, Factors and Objectives (EPA, 2016), were determined and include the preliminary key environmental factors detailed in Table 10, as well as other environmental factors that were considered in relation to this assessment but are not considered to be preliminary key environmental factors (these factors are discussed in Section 11 and Section 12 respectively).

Table 10: Preliminary key and other environmental factors

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Relevant Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Key Environmental Factors</td>
<td></td>
</tr>
<tr>
<td>Flora and Vegetation</td>
<td>Clearing of native vegetation, dewatering and potential alteration to surface water flows.</td>
</tr>
<tr>
<td>Terrestrial Fauna (Vertebrate Fauna including Short-range Endemics)</td>
<td>Clearing of habitat, dewatering, alterations and disruptions to surface water flows and pools, vehicle movement and waste disposal.</td>
</tr>
<tr>
<td>Subterranean Fauna (Stygofauna and Troglofauna)</td>
<td>Excavation for mining activities. Abstraction of groundwater for mining activities.</td>
</tr>
<tr>
<td>Hydrological Processes</td>
<td>Surface water diversions. Dewatering of groundwater for mining activities.</td>
</tr>
<tr>
<td>Inland Waters Environmental Quality</td>
<td>Construction and operation of Proposal including dewatering of groundwater for mining activities, discharge of excess water, waste landforms, storage and use of hazardous materials and hydrocarbons, and waste facilities (landfill, wastewater treatment plant). Post closure aspects, such as waste landforms and pit lakes, will be addressed under the Rehabilitation and Decommissioning factor.</td>
</tr>
<tr>
<td>Heritage</td>
<td>Clearing of native vegetation and excavation for mining activities. Dewatering of groundwater for mining activities. Alteration to hydrological processes.</td>
</tr>
<tr>
<td>Offsets (integrating factor)</td>
<td>Clearing of approximately 19,671.2 ha of native vegetation in Category 1 to 4 according to <em>Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment</em> (EPA &amp; DPaW, 2015) (equivalent to ‘Good’ to ‘Excellent’ condition or better) in the Hamersley IBRA subregion.</td>
</tr>
</tbody>
</table>
### EPA Environmental Factor | Relevant Aspects
--- | ---
**Other Environmental Factors**
Landforms | Alteration of the existing landforms but installation of mining landforms such as pits, OSA and infrastructure.
Terrestrial Quality | Use or exposure of potential harmful substances and generation of potential harmful waste material.
Air Quality | Particulate emissions from mobile equipment such as blasting and loading and hauling ore and from fixed plant such as crushing, screening and stockpiling ore.
Amenity | Visual amenity resulting from mine operations such as OSAs and pits.
Human Health | Noise from operation of mine infrastructure such as haul trucks, conveyors and ore crushing and screening.

#### 9.2 Environmental impact assessment studies and review of environmental factors

Following scope definition and consultation with the OEPA, environmental impact studies were undertaken to quantify the potential environmental impacts and determine the significance of the identified environmental factors against the EPA significance framework (EPA, 2013b). This document outlines the key findings of the studies and significance determination.

For each environmental factor, the following information is provided (Sections 11 and 12):

- Context, including a concise description of the relevant environmental values.
- Environmental aspects and the potential direct and indirect impacts resulting from the Proposal.
- A description of mitigation and management measures proposed.
- The regulation process required to ensure that potential impacts are managed.
- A statement of the outcome and justification to demonstrate that the EPA’s objective would be achieved.

BHP Billiton Iron Ore has applied the significance framework detailed in *EAG for Application of a Significance Framework in the Environmental Impact Assessment Process* (EPA, 2013b) during the assessment of this Proposal. The significance framework has been applied to determine the significance of both inherent and residual impacts, post application of the mitigation hierarchy. The evaluation of significance of inherent impacts informed proposed management measures and indicated where ministerial conditions may be required. The framework was then re-applied to determine significance of residual impacts to determine where offsets may apply.

BHP Billiton Iron Ore has considered the mitigation hierarchy in the *Western Australian Environmental Offsets Guidelines* (Government of Western Australia, 2014) and the EPA’s bulletin *Environmental Protection Bulletin No.1: Environmental Offsets* (EPA, 2014a), which describes how the EPA will consider offsets through the EIA process. The mitigation hierarchy steps comprise:

- **Avoid**: Avoidance is the primary and preferred strategy for managing significant impacts to the environment. Avoidance directly removes the potential impact to the environment. Avoidance
of impacts may involve comprehensive planning and suitable site selection, such as altering the location of infrastructure to avoid known locations of threatened ecological communities or of sensitive habitats. BHP Billiton Iron Ore considers impact avoidance as the preferred strategy for managing significant impacts to the environment through this Proposal.

- **Minimise:** After practicable avoid measures have been considered or implemented, mitigation measures to minimise the remaining significant impacts (if any) will be investigated and implemented to reduce impacts to an acceptable level.

- **Rehabilitate:** After practicable avoid and minimise measures have been considered or implemented, rehabilitation will be applied with the aim of reducing impacts to an acceptable level.

- **Offset:** If, after the first three steps of the mitigation hierarchy have been considered and applied, it is anticipated that there would be actual or reasonably foreseeable residual significant impacts to the environment, offset measures will be proposed, and BHP Billiton Iron Ore anticipates that these would become conditions of the MS.

BHP Billiton Iron Ore considers that the potential impacts for the preliminary key environmental factors can be appropriately managed through the implementation of specific and regional management plans and the application of Ministerial conditions. The management plans that are applicable to the implementation of this Proposal include:

- Mining Area C Closure Plan (Appendix 12);
- Conditional Environmental Management Plan (to be developed); and
- CPWRMP (Appendix 7).
10. Regional management approach

10.1 Adaptive management

Consistent with the regional management approach detailed in the recently published and released PER Strategic Proposal (BHP Billiton Iron Ore, 2016c), BHP Billiton Iron Ore uses adaptive management to enable the consideration of changing conditions and improvements in knowledge. This assists BHP Billiton Iron ore with overcoming future challenges to environmental management as results of evolving political, social and natural environments. It also provides the necessary flexibility to respond to changes in conservation significance; to the development of new technologies; and to improvements in the understanding of assets, values, species, threatening processes and impacts (e.g. climate change).

Adaptive management is a structured, iterative process of decision-making with the capacity to validate predicted impacts and to develop appropriate responses to emerging issues through monitoring of and adaptation to environmental, economic and social changes. An integral component to adaptive management is the application of the mitigation hierarchy (avoid, minimise, rehabilitate and offset).

Successful planning and execution in managing relevant environmental factors in the Pilbara requires a holistic, long-term view of broad scale of landscape focussed outcomes coupled with progressive operations-level activities. A key driver of this requirement is the regional scale and long life span of BHP Billiton Iron Ore’s proposed future mining activities in the Pilbara. This driver necessitates the use of a management approach that is both regional and adaptable over time. Where possible this Proposal has evaluated potential impacts on a regional scale, however, this is somewhat limited due to the availability of granularity in regional data. Management plans that have been, or will be, developed as part of the Proposal consider outcomes and adaptive management on a regional scale, for example the CPWRMP considers management on a catchment scale.

BHP Billiton Iron Ore’s adaptive management (Figure 11) uses a cycle of monitoring, reporting and implementing change where required. It allows an evaluation of the mitigation controls so that either they are progressively improved and refined or alternative solutions are adopted to ensure the outcome-based objectives are achieved. BHP Billiton Iron Ore’s adaptive management is underpinned by its corporate commitments, which collectively articulate BHP Billiton Iron Ore’s core values and minimum performance standards for environmental management and sustainability.
The five key steps of adaptive management are:

- **Define**: Conduct baseline and impact assessments (including cumulative impact assessments where required) to understand how the proposed operation or expansion may impact the environment (e.g. downstream impacts to environmental factors resulting from proposed mine dewatering). This information will be used to identify key risks and define acceptability criteria in accordance with BHP Billiton Iron Ore’s internal risk management frameworks and in consultation with key stakeholders. This step will also define outcome-based environmental objectives consistent with regulatory and internal requirements and set performance criteria to ensure the outcomes are met.

- **Plan**: Develop management plans that describe how the performance criteria or outcome-based objectives will be met through the application of the mitigation hierarchy, monitoring and reporting measures.

- **Implement and Monitor**: Implement management tools and monitor against performance criteria during construction and operations and into closure and rehabilitation. Conduct internal audits to verify management tools are being implemented in line with regulatory and internal standards.

- **Analyse and Learn**: Use monitoring data to verify models, validate assumptions and identify relevant internal and external changes (e.g. change in regulatory requirements, improved understanding, or advancements in technology) and address those changes where applicable. Review and assess data and information acquired to ensure that management tools, performance criteria or outcome-based objectives remain appropriate over the life of the operation and for closure.

- **Adapt and Share**: Report management performance and relevant metrics according to external and internal reporting requirements (e.g. AER, BHP Billiton Annual Sustainability Report). Where shortcomings in or improvement opportunities for the management approach are
identified, adapt the management approach. Implement and communicate the changes with a view to sharing learnings externally and contributing to improvements across the industry.

An integral component of adaptive management is the application of the mitigation hierarchy (avoid, minimise, rehabilitation, offset which is further discussed in Section 11.

10.2 Environmental governance hierarchy

BHP Billiton Iron Ore has an internal environmental governance hierarchy (Figure 12) that enables the business to meet its environmental objectives and legal compliance requirements and provides for continual improvement in environmental performance. The governance hierarchy has been developed in accordance with relevant international, national and state policies and agreements.

BHP Billiton’s environmental governance hierarchy comprises three tiers: Corporate level, Asset level (business, e.g. Iron Ore) and Operations (site level). At the Corporate level, BHP Billiton’s Corporate Charter – Our BHP Billiton Charter – identifies the values that underpin business activities. Measurable, minimum performance standards are defined in Our Requirements documents. These standards apply to all Assets and support the development and implementation of EMS. BHP Billiton’s Our Requirements Environment and Climate Change (BHP Billiton, 2016c) is the key guidance document for environmental management across all operations. BHP Billiton reports its corporate-wide sustainability performance in the BHP Billiton Annual Sustainability Report.

At the Asset level, BHP Billiton Iron Ore’s Health, Safety and Environmental Management System (referred to herein as the EMS), which includes regional strategies and plans, is the governance system that addresses environmental outcomes for the Pilbara region.

Site-specific management, monitoring and reporting is undertaken in a manner consistent with Corporate- and Asset-level governances. Management plans, procedures and registers are examples of the internal controls that underpin day-to-day operational activities. BHP Billiton Iron Ore publicly reports its environmental compliance performance in its AER in accordance with any environmental approval conditions.

Figure 12: BHP Billiton Iron Ore’s environmental governance hierarchy
10.3 Project environmental and Aboriginal heritage reviews

To support the documents identified in Figure 12, when considering land disturbance related activities, BHP Billiton Iron Ore has an internal Project Environmental and Aboriginal Heritage Review (PEAHR) process. The purpose of the process is to manage the implementation of environmental, Aboriginal heritage, land tenure and legal commitments prior to and during land disturbance. All ground disturbance activities will be required to meet the requirements of the PEAHR process, as well as relevant legislative and regulatory requirements, BHP Billiton Iron Ore’s Sustainable Development Policy and where practical and relevant industry standards, and codes of practice. Additionally, the PEAHR process provides a mechanism whereby technical and professional advice can be provided to the business regarding environmental aspects, land access and Aboriginal heritage planning and management issues. The PEAHR system consists of an electronic workflow process linked to a geographical information system. The objectives of the PEAHR process are to:

- identify the significant environmental, Aboriginal heritage and legal aspects of proposed activities;
- ensure that, through appropriate environmental, Aboriginal heritage and land access planning and management, BHP Billiton Iron Ore activities comply with all legal and other obligations;
- avoid, minimise and mitigate the number and nature of environmental, Aboriginal heritage and land tenure impacts and ensure adequate environmental performance of BHP Billiton Iron Ore operations; and
- provide a mechanism for continuous improvement.
11. Assessment of preliminary key environmental factors

This section discusses the potential environmental impacts associated with the Proposal for each preliminary key environmental factor, and includes information from surveys and the latest technical impact assessments completed in the Proposed Mining Area C Development Envelope. From this work, potential and cumulative impacts associated with the Indicative Additional Impact Assessment Area, additional disturbance within the Mining Area C EMP Revision 6 Impact Assessment Area and Additional Development Envelope have been defined. In response to these potential impacts, description of BHP Billiton Iron Ore’s management and mitigation is outlined.

11.1 Flora and vegetation

11.1.1 EPA objective

The EPA applies the following objective, according to Statement of Environmental Principles, Factors and Objectives (EPA, 2016), in its assessment of proposals that may affect flora and vegetation:

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

11.1.2 Relevant legislation, guidelines and policies

The discussion of the existing environment, impacts to and management of flora and vegetation in the Proposed Mining Area C Development Envelope has been compiled in consideration of relevant state legislation and EPA policies and guidance. Table 7 details the relevant EPA documents as identified in the Mining Area C – Environmental Scoping Document (OEPA, 2016) and their relevance to this Proposal. Other relevant legislation includes the EPBC Act and the Wildlife Conservation Act 1950 (WC Act).

11.1.3 Existing environment

11.1.3.1 Survey effort

Twenty flora and vegetation surveys were undertaken wholly or partially within the Proposed Mining Area C Development Envelope between 1997 and 2011; they comprise 11 Level 2 surveys (one or two seasons), two Level 1 surveys and seven targeted surveys (for conservation significant flora or weeds) (Table 11; Figure 13). All surveys undertaken post-2004 have been undertaken in accordance with the EPA’s (2004a) Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. In total, 782 quadrats have been surveyed within the Proposed Mining Area C Development Envelope (Figure 13). All areas within the Proposed Mining Area C Development Envelope that have been surveyed post-2004 have had a minimum of two seasons of survey, using a stratified approach such that all landforms and vegetation associations present have been sampled, and there is adequate geographic coverage. It is also noted that all Level 1 and Level 2 surveys undertaken for BHP Billiton Iron Ore include targeted searches for conservation significant species, and surveys undertaken post-2009 have been undertaken in accordance with BHP Billiton Iron Ore’s Flora and Vegetation survey guidelines which were developed in conjunction with DPaW to ensure consistency in approach for all surveys undertaken for the Company.

A further 26 flora and vegetation surveys have been undertaken on behalf of BHP Billiton Iron Ore in close proximity to the Proposed Mining Area C Development Envelope (but not overlapping it). These surveys are summarised in Appendix 4.
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### Table 11: Summary of flora and vegetation surveys undertaken wholly or partially within the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Report</th>
<th>Survey Type</th>
<th>Seasonal Conditions</th>
<th>Survey Area</th>
<th>Survey Date</th>
<th>Survey Effort</th>
<th>Experience of Personnel</th>
<th>Location of Survey</th>
<th>Conservation Significant Flora Recorded</th>
<th>Introduced (Weed) Taxa Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report</td>
<td>Survey Type / Seasonal Conditions</td>
<td>Survey Area</td>
<td>Survey Date</td>
<td>Survey Ha (No. quadrats)</td>
<td>Experience of Personnel</td>
<td>Location of Survey</td>
<td>Conservation Significant Flora Recorded</td>
<td>Introduced (Weed) Taxa Recorded</td>
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<tr>
<td>Southern Flank NVCP Extension Flora, Vegetation and Fauna Survey (ENV Australia, 2010a)</td>
<td>Level 1 Good</td>
<td>1,800 ha</td>
<td>16 - 20 November 2009, 2 December 2009</td>
<td>42 quadrats (50x50m)</td>
<td>Highly experienced Pilbara botanists accompanied with experienced Pilbara biologists</td>
<td>Within the Additional Development Envelope</td>
<td>Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)</td>
<td>*Cenchrus ciliaris, *Malvastrum americanum</td>
<td></td>
</tr>
<tr>
<td>Field Survey for Priority and Rare Flora Area C, Southern Flank (Pilbara Flora, 2008)</td>
<td>Targeted Good</td>
<td>4,351 ha</td>
<td>15 -20 May 2008</td>
<td>No quadrats, targeted searches</td>
<td>Experienced Pilbara botanists and biologist</td>
<td>Within the Additional Development Envelope</td>
<td>Eremophila magnifica subs. magnifica (P4)</td>
<td>*Bidens bipinnata</td>
<td></td>
</tr>
<tr>
<td>Area C – R Deposit Flora and Vegetation Assessment (ENV Australia, 2007)</td>
<td>Level 2 Poor</td>
<td>1,428 ha</td>
<td>24-30 October 2006</td>
<td>72 quadrats (50x50m)</td>
<td>Highly experienced Pilbara botanists</td>
<td>Southeast corner of the Current Approved Development Envelope</td>
<td>Eremophila magnifica subs. magnifica (P4)</td>
<td>*Bidens bipinnata, *Sesbania orientalis</td>
<td></td>
</tr>
<tr>
<td>Report</td>
<td>Survey Type / Seasonal Conditions</td>
<td>Survey Area</td>
<td>Survey Date</td>
<td>Survey Effort (No. quadrats)</td>
<td>Experience of Personnel</td>
<td>Location of Survey</td>
<td>Conservation Significant Flora Recorded</td>
<td>Introduced (Weed) Taxa Recorded</td>
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</tr>
<tr>
<td>Packsaddle Wastewater Treatment Plant</td>
<td>Level 1 Good</td>
<td>11 ha</td>
<td>13 July 2005</td>
<td>No quadrats completed; transects surveyed</td>
<td>Experienced Pilbara botanist and biologist</td>
<td>Adjacent to Packsaddle Village within Current Approved Development Envelope</td>
<td>Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)</td>
<td>*Malvastrum americanum</td>
<td></td>
</tr>
<tr>
<td>(Ecologia Environment, 2005)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Area C Deposits D, E and F Biological Survey</td>
<td>Level 2 Good</td>
<td>6,485 ha</td>
<td>21-24 May 2004</td>
<td>35 quadrats (100x100m)</td>
<td>Highly experienced Pilbara botanists</td>
<td>MAC pits within Proposed Mining Area C Development Envelope</td>
<td>None</td>
<td>*Bidens bipinnata, *Malvastrum americanum, *Oenothera hyalina, *Siganseckia orientalis</td>
<td></td>
</tr>
<tr>
<td>(Ecologia Environment, 2004a)</td>
<td></td>
<td></td>
<td></td>
<td>35 quadrats within Proposed Mining Area C Development Envelope</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packsaddle Range Biological Survey</td>
<td>Level 2 Good</td>
<td>5,093 ha</td>
<td>29-4 May 2004</td>
<td>52 quadrats (100x100m)</td>
<td>Highly experienced Pilbara botanists</td>
<td>Packsaddle Range along the northern extent of the Current Approved Development Envelope</td>
<td>None</td>
<td>*Bidens bipinnata, *Cenchrus ciliaris</td>
<td></td>
</tr>
<tr>
<td>(Ecologia Environment, 2004b)</td>
<td></td>
<td></td>
<td></td>
<td>48 quadrats within Proposed Mining Area C Development Envelope</td>
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</tr>
<tr>
<td>Mining Area C Rail Corridor Rare Flora Survey (Phase 2)</td>
<td>Targeted Good</td>
<td>7,768 ha</td>
<td>21-31 March 2002</td>
<td>No quadrats, targeted searches</td>
<td>Experienced Pilbara botanist</td>
<td>North-eastern sector of the Current Approved Development Envelope</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>(Biota, 2003)</td>
<td></td>
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</tr>
<tr>
<td>Mining Area C Rail Corridor Rare Flora Survey (Biota, 2002)</td>
<td>Targeted Poor</td>
<td>7,768 ha</td>
<td>12-18 November 2001</td>
<td>No quadrats, targeted searches</td>
<td>Experienced Pilbara botanist with field assistant</td>
<td>North-eastern sector of the Current Approved Development Envelope</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Mining Area C Village and Access Road Rare and Priority Flora</td>
<td>Targeted Good</td>
<td>11 ha</td>
<td>17 March 2002</td>
<td>No quadrats, targeted searches</td>
<td>Experienced Pilbara botanist and biologist</td>
<td>North-west sector of the Current Approved Development Envelope, dissecting Packsaddle Range</td>
<td>None</td>
<td>*Siganseckia orientalis</td>
<td></td>
</tr>
<tr>
<td>(Ecologia Environment, 2002)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area C to Yandi Rail Line Baseline Weed Survey (Ecologia Environment, 2001)</td>
<td>Targeted Poor</td>
<td>7,768 ha</td>
<td>16-17 October 2001</td>
<td>No quadrats, targeted searches</td>
<td>Field team not reported</td>
<td>North-eastern sector of the Current Approved Development Envelope</td>
<td>Not recorded</td>
<td>*Rumex vesicaria, *Argemone ochroleuca</td>
<td></td>
</tr>
<tr>
<td>Manillana Creek Western Access Corridor – Biological Assessment (HDM, 1999)</td>
<td>Level 2 Good</td>
<td>37,715 ha</td>
<td>23-30 April 1999</td>
<td>22 quadrats (100x100m)</td>
<td>Field team not reported</td>
<td>Southern extent of rail alignment within; north-west sector</td>
<td>None</td>
<td>*Bidens bipinnata, *Malvastrum americanum</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90 quadrats within Proposed Mining Area C Development Envelope</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Liability

BHP Billiton Iron Ore does not warrant that this map is free from errors or omissions. BHP Billiton shall not in any way be liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.

MINING AREA C - SOUTHERN FLANK
Location of Flora and Vegetation Surveys undertaken in the Proposed Mining Area C Development Envelope and Surrounds

- Marika Creek Western Access Corridor – Biological Assessment, HGM (1999)
- Southern Flanks Exploration Lease Flora and Vegetation Assessment, ENV (2003a)
- Southern Flanks NCFP Extension Flora and Fauna Survey, ENV (2010a)
- Field Survey for Priority and Rare Flora Area C Southern Flank, Pilbara Flora (2009a)
- Mining Area C Biological Survey, Ecology Environment (1998a)
- Flora and Vegetation Assessment Area C Mining Operations Environmental Management A, G, P1 and P3 Deposits, Woodman Environmental Consulting (2009a)
- Area C Separates D, E and F Biological Survey, Ecology Environment (2004a)
- Area C – R Deposit Flora and Vegetation Assessment, ENV (2007)
- Pilkington Range Biological Survey, Ecology Environment (2004a)
- Pilkington Water Treatment Plant, Ecology Environment (2003a)
- Area C and Surrounds Study Area, Level 3
- Flora and Vegetation Survey, Onshore Environmental (2012a)
- James to Area C Access Corridor Flora and Vegetation Survey, ENV (2012a)
- Level 2 Flora and Vegetation Survey Mulcharb Lakes, Onshore Environmental (2012)
- Southern Flanks to Joint Level 2 Flora and Vegetation Survey, ENV (2012)
- Level Two Flora and Vegetation Survey Southern Flank, Onshore Environmental (2012a)
Liability

BHP Billiton does not warrant that this map is free from errors or omissions. BHP Billiton shall not be in any way liable for loss, damage or injury to the user of this map or any person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.
11.1.3.2 Vegetation

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). Mining Area C is situated in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia as per Beard (1975), who broadly mapped the area as ranges and valley plains. The most common vegetation associations in the Proposed Mining Area C Development Envelope are *Eucalyptus leucophloia* (snappy gum) and *Triodia wiseana* (hard spinifex) tree steppe occurring on hills and tall woodlands of *Eucalyptus camaldulensis* (river red gum), *Eucalyptus victrix* (coolibah) and *Acacia aneura* (mulga) along drainage lines and in groves within the valley floors.

The original vegetation mapping undertaken by Beard (1975) was refined by Shepherd *et al.* (2002). There are two vegetation associations (as mapped by Shepherd *et al.* (2002)) in the Proposed Mining Area C Development Envelope:

- Hamersley 18: Low woodland; mulga (*Acacia aneura*); and
- Hamersley 82: Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*.

Onshore Environmental identified 34 vegetation associations in the Proposed Mining Area C Development Envelope (Onshore Environmental, 2017; Appendix 4). Twenty-four of these associations occur in the Additional Development Envelope, and 29 occur in the Indicative Additional Impact Assessment Area (Figure 14 and Table 12). Twenty-eight vegetation associations were mapped within the Approved Mining Area C (Northern Flank) Development Envelope, of which 21 occur within the Mining Area C Revision 6 EMP Impact Assessment Area (Onshore Environmental, 2015; Appendix 4).

At the complex level, vegetation within the Proposed Mining Area C Development Envelope is well represented and well reserved within the Pilbara bioregion. None of the vegetation associations are analogous with either Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) within the Pilbara. There are two PECs that occur within 20 km of the Proposed Mining Area C Development Envelope; the Coondewanna Flats PEC and the Weeli Wolli Spring PEC. These are discussed in detail in Sections 11.1.4.3.4 and 11.1.4.3.3.

Broadscale mapping at the vegetation association level occurs over a limited extent within the Pilbara, so inference at this fine scale is not possible. However, BHP Billiton Iron Ore has recently merged and collated vegetation association maps from 162 historical baseline surveys within their Pilbara tenure into a single consolidated map (Onshore Environmental, 2014 and subsequent revisions). The vegetation map represents a unique database on which to undertake preliminary impact assessment at the vegetation association level. The fine scale vegetation map covers 4,296 km² (429,623 ha), which represents 2.36% of the total Pilbara region. Based on this database, none of the vegetation associations within the Development Envelope are considered to be locally endemic or unique, and it is unlikely that any would be considered poorly reserved (D. Brearley, Onshore Environmental, pers. comm. 2017).

Fifteen vegetation associations were considered to have local significance (see Table 12) as they contain at least one conservation significant flora species. Four of these also comprised vegetation that is considered to be an 'Ecosystem at Risk' by Kendrick (2001).
<table>
<thead>
<tr>
<th>Map Code</th>
<th>Broad Floristic Formation</th>
<th>Vegetation Association</th>
<th>Ecosystem At Risk</th>
<th>Total Mapped</th>
<th>Proposed Mining Area C Development Envelope</th>
<th>Additional Development Envelope</th>
<th>Indicative Additional Impact Assessment Area</th>
<th>Mining Area C EMP Revision &amp; Impact Assessment Area</th>
<th>Cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP TwTa Ese AbPIApp</td>
<td>Hummock Grassland of <em>Triodia</em> wiseana and <em>Triodia</em> angusta with Open Mallee of <em>Eucalyptus socialis</em> subsp. <em>eucentrica</em> and Open Shrubland of <em>Acacia</em> bivenosa, <em>Petalostylis</em> labicheoides and <em>Acacia</em> pyrifolia var. <em>pyrifolia</em> on light brown clay loam on calcrite plains and rises.</td>
<td>n</td>
<td>10,246</td>
<td>29</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>FLOODPLAINS</td>
<td>Low Open Forest of <em>Acacia</em> aptaneura, <em>Acacia</em> pteraneura over Open Tussock Grassland of <em>Themeda triandra</em>, <em>Chrysopogon fallax</em> and <em>Eriachne benthamii</em> on red brown clay loam on floodplains.</td>
<td>n</td>
<td>10,214</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>FOOTSLOPES</td>
<td>Hummock Grassland of <em>Triodia</em> sp. <em>Shovelanna Hill</em> (S. van Leeuwen 3835) with Low Open Forest of <em>Corymbia</em> desertica subsp. <em>desertica</em> and <em>Hakea chordophylla</em> over Open Shrubland of <em>Acacia</em> ancinstrocarpa, <em>Acacia tumida</em> var. <em>pilbarensis</em> and <em>Eremophila longifolia</em> on red brown clay loam on unincised drainage lines and floodplains.</td>
<td>y</td>
<td>2,009</td>
<td>114</td>
<td>0</td>
<td>47</td>
<td>17</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>GORGES AND GULLIES</td>
<td>Hummock Grassland of <em>Triodia</em> sp. <em>Shovelanna Hill</em> (S. van Leeuwen 3835), <em>Triodia</em> pungens and <em>Triodia</em> wiseana with Low Open Woodland of <em>Eucalyptus leucophloia</em> subsp. <em>leucophloia</em> and *Open Shrubland of <em>Acacia</em> paraneura, <em>Acacia paraneura</em>, <em>Petalostylis</em> labicheoides and <em>Acacia ancinstrocarpa</em> on red brown clay loam on footslopes and low undulating hills.</td>
<td>n</td>
<td>6,687</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>38</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Low Open Forest of <em>Callicoma socialis</em> subsp. <em>eucentrica</em> and <em>Open Mallee of <em>Eucalyptus</em> leucophloia</em> subsp. <em>leucophloia</em> over Open Tussock Grassland of <em>Eriachne mucronata</em>, <em>Themeda</em> sp. Mt Barricade (M.E. Trudgill 2471) and <em>Cymbopogon ambiguus</em> and *Open Shrubland of <em>Triodia</em> pungens on orange brown clay loam on upper gorges.</td>
<td>n</td>
<td>584</td>
<td>15</td>
<td>11</td>
<td>15</td>
<td>0</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Low Woodland of <em>Corymbia</em> fimbriata, <em>Eucalyptus leucophloia</em> subsp. <em>leucophloia</em> and <em>Ficus brachypoda</em> over Open Shrubland of <em>Acacia hansenleyensis</em>, <em>Dodonea viscosa</em> subsp. <em>mucronata</em> and <em>Astronicha hamptoni</em> over Open Tussock Grassland of <em>Cymbopogon ambiguus</em>, <em>Eriachne mucronata</em> and <em>Themeda</em> sp. Mt Barricade on red brown clay loam along clifflines and gorges.</td>
<td>n</td>
<td>3,685</td>
<td>1,570</td>
<td>613</td>
<td>727</td>
<td>256</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Tussock Grassland of <em>Themeda triandra</em>, <em>Eriachne mucronata</em> and <em>Themeda</em> sp. Mt Barricade with Low Open Woodland of <em>Eucalyptus leucophloia</em> subsp. <em>leucophloia</em>, <em>Corymbia hansenleyana</em> and <em>Corymbia fimbriata</em> over High Shrubland of <em>Acacia tumida</em> var. <em>pilbarensis</em>, <em>Gossypium robinsonii</em> and <em>Petalostylis labicheoides</em> on red brown sandy loam in narrowly incised rocky drainage lines.</td>
<td>n</td>
<td>1,030</td>
<td>628</td>
<td>128</td>
<td>103</td>
<td>107</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
### Map Code | Broad Floristic Formation | Vegetation Association | Ecosystem At Risk | No. Cons. Sig. Flora | Total Mapped | Proposed Mining Area C Development Envelope | Additional Development Envelope | Indicative Additional Impact Assessment Area | Mining Area C EMP Revision | Cleared
---|---|---|---|---|---|---|---|---|---|---

#### HILL CRESTS AND UPPER HILL SLOPES

| TCtTwCs EtGh AarGooKe ve | Triodia Hummock Grassland | Hummock Grassland of Triodia pungens, Triodia wiseana and Triodia sp. Shovelanna Hill (S. van Leeuwen 3835) with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana over Low Shrubland of Acacia andis, Gomphothamnium oreophilum and Keraudrenia velutina subsp. elliptica on red brown loam on hills. | n | - | 5,277 | 130 | 0 | 0 | 103 | 27 |
| TCtTwAh EkkEgCh | Triodia Hummock Grassland | Hummock Grassland of Triodia wiseana with Shrubland of Acacia hamersleyensis and Open Mallee of Eucalyptus kingsmillii subsp. kingsmilli, Eucalyptus gamophylla and Corymbia hamersleyana (mallee form) on red brown loam and silky loam on hill crests. | n | - | 4,901 | 1,027 | 267 | 220 | 148 | 87 |
| TCtTwTsE EtGh Ah | Triodia Hummock Grassland | Hummock Grassland of Triodia wiseana, Triodia sp. Shovelanna Hill (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana over Open Shrubland of Acacia hamersleyensis on red brown clay loam on hill crests and upper hill slopes. | n | - | 8,049 | 83 | 24 | 58 | 20 | 5 |

#### HILL SLOPES AND UNDULATING LOW HILLS

| HSAaApr ErpAmArC odTwT | Acacia Low Woodland | Low Woodland of Acacia aptaneura and Acacia prinocarpa over Shrubland of Eremophila juinda subsp. pulcherrima, Acacia marramamba and Codonocarpus cotinifolius over Open Hummock Grassland of Triodia wiseana and Triodia pungens on red brown loam on hill slopes. | n | 2 | 715 | 529 | 170 | 473 | 0 | 51 |
| HSBtrTw El | Triodia Hummock Grassland | Hummock Grassland of Triodia brizoides and/or Triodia wiseana with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on steep hill slopes. | n | - | 12,977 | 2,143 | 229 | 293 | 859 | 139 |
| HSt tp AaApr ErpAmArS eg | Triodia Open Hummock Grassland | Open Hummock Grassland of Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on undulating hills. | n | - | 391 | 42 | 42 | 42 | 0 | 7 |
| HSt tp Etl SegGveh Gr | Triodia Hummock Grassland | Hummock Grassland of Triodia pungens with Scattered Low Trees of Eucalyptus leucophloia subsp. leucophloia and Scattered Shrubs of Senna glutinosa subsp. glutinosa, Grevillea wikami subsp. hispidula and Eremophila latrobi subsp. latrobi on skeletal orange brown loam on stony hill slopes. | n | - | 378 | 91 | 81 | 66 | 5 | 4 |
| HSt TsTv EtGh GvehSegg Ab | Triodia Hummock Grassland | Hummock Grassland of Triodia sp. Shovelanna Hill (S. van Leeuwen 3835) and Triodia wiseana with Very Open Mallee of Eucalyptus gamophylla over Open Shrubland of Grevillea wikami subsp. hispidula, Senna glutinosa subsp. glutinosa and Acacia bidendron on red brown sandy clay loam on hill slopes. | n | - | 1,032 | <1 | <1 | <1 | 0 | 0 |

#### MAJOR DRAINAGE LINES

<p>| MA ErEvy Ex ApysAbGoro TnEuaCyp | Eucalyptus Low Open Forest | Low Open Forest of Eucalyptus camaldulensis subsp. refugens, Eucalyptus victrix and Eucalyptus xerothermica over High Shrubland of Acacia prinocarpa var. prinocarpa, Acacia turville var. pulicaris and Gossypium robinsonii over Open Tussock Grassland of Themeda triandra, Eulalia aurea and Cymbopogon procures on red brown clay loam on major drainage lines. | y | 2 | 3,970 | 49 | 49 | 30 | 0 | &lt;1 |</p>
<table>
<thead>
<tr>
<th>Map Code</th>
<th>Broad Floristic Formation</th>
<th>Vegetation Association</th>
<th>Ecosystem At Risk</th>
<th>No. Cons. Sig. Flora</th>
<th>Total Mapped</th>
<th>Proposed Mining Area C Development Envelope</th>
<th>Additional Development Envelope</th>
<th>Indicative Additional Impact Assessment Area</th>
<th>Mining Area C EMP Revision &amp; Impact Assessment Area</th>
<th>Cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA AlpAppAs e Ecr ThmTlCy p</td>
<td>Acacia High Shrubland</td>
<td>High Shrubland of <em>Acacia tumida</em> var. <em>pilbarensis</em>, <em>Acacia pyrifolia</em> var. <em>pyrifolia</em> and <em>Acacia swartzioides</em> with Scattered Trees of <em>Eucalyptus caulescentis</em> subsp. <em>refulgens</em> over Open Tussock Grassland of <em>Themeda</em> sp. Mt Barricade (M.E. Trudgen 2471). <em>Themeda triandra</em> and Cymbopogon procerus on brown loam and gravels on major drainage channels.</td>
<td>y</td>
<td>-</td>
<td>255</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MEDIUM DRAINAGE LINES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME TpTl ExCoCh PiApygGor o</td>
<td>Tussock Hummock Grassland</td>
<td>Hummock Grassland of <em>Triodia pungens</em> and <em>Triodia longipes</em> with Low Woodland of <em>Eucalyptus xerothermica</em>, <em>Acacia ciliarisvaroidis</em> and <em>Corymbia hamersleyana</em> over High Shrubland of <em>Petalostylis labicheoides</em>, <em>Acacia pachyacra</em> var. <em>pyrifolia</em> and <em>Gossypium nubigenum</em> on red brown clay loam on medium drainage lines and surrounding floodplains.</td>
<td>n</td>
<td>3</td>
<td>10,915</td>
<td>1,857</td>
<td>516</td>
<td>534</td>
<td>375</td>
<td>67</td>
</tr>
<tr>
<td>ME TmlCy ChEll AmPliAni</td>
<td>Themeda Tussock Grassland</td>
<td>Open Tussock Grassland of <em>Themeda triandra</em>, <em>Anistida inaequiglumis</em> and Cymbopogon ambiguous with Low Open Woodland of <em>Corymbia hamersleyana</em> and <em>Eucalyptus leucoxylon</em> subsp. <em>leucophloia</em> over Open Shrubland of <em>Acacia monticola</em>, <em>Petalostylis labicheoides</em> and <em>Androcalva luteiflora</em> on red brown alluvium on minor and medium drainage lines.</td>
<td>n</td>
<td>2</td>
<td>1,584</td>
<td>207</td>
<td>68</td>
<td>72</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>ME TtChEua ExEvCh PkApAppy</td>
<td>Themeda Tussock Grassland</td>
<td>Tussock Grassland of <em>Themeda triandra</em>, <em>Chrysopogon fallax</em> and <em>Eulalia aurea</em> with Low Open Woodland of <em>Eucalyptus xerothermica</em>, <em>Eucalyptus victoria</em> and <em>Corymbia hamersleyana</em> and Shrubland of <em>Petulostylis labicheoides</em>, <em>Acacia pachyacra</em> and <em>Acacia pyrifolia</em> var. <em>pyrifolia</em> on red sandy loam on medium drainage lines.</td>
<td>n</td>
<td>-</td>
<td>1,775</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>ME TEuEte AppyApyPl EvCh</td>
<td>Themeda Tussock Grassland</td>
<td>Tussock Grassland of <em>Themeda triandra</em>, <em>Eulalia aurea</em> and <em>Enchame fenuiculmis</em> with High Shrubland of <em>Acacia pyrifolia</em> var. <em>pyrifolia</em>, <em>Acacia tumida</em> var. <em>pilbarensis</em> and <em>Petalostylis labicheoides</em> and Open Woodland of <em>Eucalyptus victrix</em> and <em>Corymbia hamersleyana</em> on red brown silty loam on medium drainage lines and flood plains.</td>
<td>n</td>
<td>-</td>
<td>851</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>12</td>
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<tr>
<td>MINOR DRAINAGE LINES</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI AlpPlAn TpTsChEll</td>
<td>Acacia Open Scrub</td>
<td>Open Scrub of <em>Acacia tumida</em> var. <em>pilbarensis</em>, <em>Petalostylis labicheoides</em> and <em>Acacia monticola</em> over Open Hummock Grassland of <em>Triodia pungens</em> and <em>Triodia</em> sp. Shovelarana Hill (S. van Leeuwen 3835) with Low Open Woodland of <em>Corymbia hamersleyana</em> and <em>Eucalyptus leucoxylon</em> subsp. <em>leucophloia</em> on red brown sandy loam on minor drainage lines.</td>
<td>n</td>
<td>3</td>
<td>5,671</td>
<td>1,763</td>
<td>561</td>
<td>698</td>
<td>425</td>
<td>134</td>
</tr>
<tr>
<td>MI PAlpAn ChEll TwTp</td>
<td>Petaostylis Shrubland</td>
<td>Shrubland of <em>Petalostylis labicheoides</em>, <em>Acacia tumida</em> var. <em>pilbarensis</em> and <em>Acacia monticola</em> with Low Open Woodland of <em>Corymbia hamersleyana</em> and <em>Eucalyptus leucoxylon</em> subsp. <em>leucophloia</em> on red brown sandy loam on minor drainage lines.</td>
<td>n</td>
<td>-</td>
<td>1,108</td>
<td>155</td>
<td>116</td>
<td>95</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>STONY PLAINS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP AaApr TmTtWp TcHcAvi</td>
<td>Acacia Low Open Forest</td>
<td>Low Open Forest of <em>Acacia apterana</em> and <em>Acacia pruinocarpa</em> over Open Hummock Grassland of <em>Triodia melvillei</em>, <em>Triodia wiseana</em> and <em>Triodia pungens</em> over Tussock Grassland of <em>Themeda triandra</em>, <em>Chrysopogon fallax</em> and <em>Anistida inaequiglumis</em> on red brown loam on plains.</td>
<td>y</td>
<td>2</td>
<td>7,717</td>
<td>389</td>
<td>209</td>
<td>212</td>
<td>26</td>
<td>102</td>
</tr>
<tr>
<td>SP AcacoAs ArDiDaCh f</td>
<td>Acacia Low Open Forest</td>
<td>Low Open Forest of <em>Acacia catarinulata</em> subsp. <em>occidentalis</em> and <em>Acacia apterana</em> over Very Open Tussock Grassland of <em>Themeda triandra</em>, <em>Digitaria ammobothra</em> and <em>Chrysopogon fallax</em> on red brown clay loam on lower stony plains.</td>
<td>y</td>
<td>1</td>
<td>89</td>
<td>68</td>
<td>68</td>
<td>43</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SP TpTb Eg PkAbaAnc</td>
<td>Triodia Hummock Grassland</td>
<td>Hummock Grassland of <em>Triodia pungens</em> and <em>Triodia basidewi</em> with Open Mallee of <em>Eucalyptus gamophylla</em> and Shrubland of <em>Petalostylis labicheoides</em>, <em>Acacia bivenosa</em> and <em>Acacia aniscinorca</em> on red brown loamy sand on stony plains and footslopes.</td>
<td>n</td>
<td>-</td>
<td>2,363</td>
<td>134</td>
<td>0</td>
<td>27</td>
<td>92</td>
<td>126</td>
</tr>
<tr>
<td>SP TpTm AaExAcao AaErhAadd s</td>
<td>Triodia Hummock Grassland</td>
<td>Hummock Grassland of <em>Triodia pungens</em> and <em>Triodia melvillei</em> with Low Open Woodland of <em>Acacia apterana</em>. <em>Eucalyptus xerothermica</em> and <em>Acacia catarinulata</em> subsp. <em>occidentalis</em> and Open Shrubland of <em>Acacia pachyacra</em>. <em>Eremophila forrestii</em> subsp. <em>forrestii</em> and <em>Acacia altaengens</em> on red brown clay loam or silty loam on stony plains and floodplains.</td>
<td>n</td>
<td>4</td>
<td>37,659</td>
<td>3,205</td>
<td>1,739</td>
<td>1,807</td>
<td>150</td>
<td>128</td>
</tr>
<tr>
<td>Map Code</td>
<td>Broad Floristic Formation</td>
<td>Vegetation Association</td>
<td>Ecosystem At Risk</td>
<td>No. Cons. Sig. Flora</td>
<td>Total Mapped</td>
<td>Proposed Mining Area C Development Envelope</td>
<td>Additional Development Envelope</td>
<td>Indicative Additional Impact Assessment Area</td>
<td>Mining Area C EMP Revision &amp; Impact Assessment Area</td>
<td>Cleared</td>
</tr>
<tr>
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<td>---------</td>
</tr>
<tr>
<td>SP</td>
<td>Triodia Hummock Grassland</td>
<td>Hummock Grassland of <em>Triodia</em> sp. Shovelanna Hill (S. van Leeuwen 3835), <em>Triodia</em> wiseana and <em>Triodia</em> pungens with Very Open Mallee of <em>Eucalyptus gamophylla</em> and <em>Eucalyptus trivalva</em> over Open Shrubland of <em>Acacia bivenosa</em>, <em>Acacia pachyacra</em> and <em>Acacia pruinocarpa</em> on red brown sandy loam and clay loam on stony plains.</td>
<td>n</td>
<td>3</td>
<td>5,257</td>
<td>1,150</td>
<td>455</td>
<td>564</td>
<td>342</td>
<td>38</td>
</tr>
<tr>
<td>OTHER</td>
<td>Unmapped</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1,952</td>
</tr>
</tbody>
</table>

*Note: NA = Not Applicable*
Vegetation Association

Not mapped

CP Tota Eae AllAgy
Hummock Grassland of Triodia wieana with Shrubland of Acacia hameromyxenia and Open Mallee of Eucalyptus kingiimillii subsp. kingiimillii, Eucalyptus guilfoyliae and Corymbia hameromyxenia (maide form) on red brown loam and silty loam on hill crests.

HC Tota Ee ElEch
Hummock Grassland of Triodia wieana with Shrubland of Acacia hameromyxenia and Open Mallee of Eucalyptus kingiimillii subsp. kingiimillii, Eucalyptus guilfoyliae and Corymbia hameromyxenia (maide form) on red brown loam and silty loam on hill crests.

HC Tota Tp EeCh
Hummock Grassland of Triodia wieana, Triodia sp. (Shovellana Hill (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill crests.

HS AaAp AmAamCh
Low Woodland of Acacia aptaneura and Acacia pruinocarpa over Shrubland of Eremophila jucunda subsp. pulcherrima, Acacia marnamomba and Corymbia hamerselyana over Low Open Woodland of Triodia wieana and Triodia pungens on brown red loam on upper hill slopes.

HS Tp El EllCh
Hummock Grassland of Triodia wieana and/or Triodia wieana with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on steep hill slopes.

HS AaAp EeFmrAmSp
Open Hummock Grassland of Triodia wieana with Low Open Woodland of Eucalyptus aptaneura and Acacia aptaneura over Open Shrubland of Eremophila fraxen, Acacia marnamomba and Sienna gluttonosa subsp. x luteaemn on red brown loam on undulating hills.

HS Tp El SegGrHn
Hummock Grassland of Triodia wieana with Scattered Low Trees of Eucalyptus leucophloia subsp. leucophloia and Scattered Shrubs of Sienna gluttonosa subsp. gluttina, Gossypium xanthophloia subsp. Sienna gluttonosa subsp. gluttina and Acacia bivenosa on red sand clay loam on hill slopes.

HS Tp Tp GmGn
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS TpEl Tp EeCh
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS Tp Tp El EeCh
Low Woodland of Acacia catenulata subsp. occidentalis and Acacia marramamba over Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS Tp Tp El ApAmCn
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS Tp Tp El ApAmCn
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS Tp Tp El ApAmCn
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS Tp Tp El ApAmCn
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.

HS Tp Tp El ApAmCn
Hummock Grassland of Triodia wieana, Triodia sp. (S. van Leeuwen 3835) and Triodia pungens with Low Open Woodland of Eucalyptus leucophloia subsp. leucophloia on brown sandy loam on hill slopes.
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MINING AREA C - SOUTHERN FLANK
Vegetation Associations in the Proposed Mining Area C Development Envelope

Vegetation Association
- Not mapped
- Cleared
- CP TwTa Ese
- FP AaApApt
- FP Ev Aa EuaErbTt
- FS TsTw TsTwTp
- GG CcolCf Ell ChCh
- MI PlAtpAm ChEll TwTp
- MA AaApr ErjpAmarCocf
- HS TsTw Eg GrwhSeggAb
- ME TtAriCya ChEll
- ME TtChfEua ExEvCh
- ME TtChfEuaExEvCh
- ME TtChfEuaExEvCh

Additional Development Envelope
- Mining Area C EMP Rev 6 Impact Assessment Area
- Indicative Additional Impact Assessment Area
- Great Northern Highway
- BHP Billiton Rail
- Vegetation Survey Sites

Spatial Data - Business Development
BHP BILLITON IRON ORE

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MINING AREA C - SOUTHERN FLANK
Vegetation Associations in the Proposed Mining Area C Development Envelope

- Proposed Mining Area C Development Envelope
- Approved Mining Area C (Northern Flank) Development Envelope
- Additional Development Envelope
- Mining Area C EMP Rev 6 Impact Assessment Area
- Indicative Additional Impact Assessment Area
- Vegetation Association

Great Northern Highway
BHP Billiton Rail

Map. This map has been compiled with data from numerous sources with different levels of Liability.

Scale: 1:95,000
Date: 3/05/2017
Prepared: M. LITTLE
Project No: ATMB2016/REV C
Reviewed: S. WILLIAMS
11.1.3.3 Vegetation condition

A majority of the vegetation in the Proposed Mining Area C Development Envelope, including the Additional Development Envelope, was considered to be in Good or better condition (Table 13 and Figure 15). Vegetation condition in the Indicative Additional Impact Assessment Area was generally rated as Pristine, Excellent or Very Good (Table 13).

Vegetation in areas of higher relief, with restricted access by stock and supporting less palatable plant species, retained higher condition scores in the range of Excellent to Pristine. This includes the northern fringe of the Proposed Mining Area C Development Envelope, the majority of uplands occurring south of the existing infrastructure and mining operations, and the deep rocky gorge habitats through the central sectors. Vegetation condition declines to Very Good or Good on drainage lines and flood plains, as well as on areas of Pack saddle Range where exploration activities have occurred or the impact of stock is greater. The major impact on lowland vegetation is the result of grazing by cattle, which has contributed to changes in native vegetation structure and composition, the introduction of weed species, and surface instability.

Table 13: Vegetation condition (based on Keighery, 1994) in the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Vegetation Condition</th>
<th>Proposed Mining Area C Development Envelope</th>
<th>Additional Development Envelope</th>
<th>Indicative Additional Impact Assessment Area</th>
<th>Mining Area C Revision 6 EMP Impact Assessment Area</th>
<th>Cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pristine</td>
<td>1,190</td>
<td>513</td>
<td>727</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Excellent</td>
<td>22,508</td>
<td>8,573</td>
<td>9,016</td>
<td>3,292</td>
<td>2,162</td>
</tr>
<tr>
<td>Very Good</td>
<td>5,936</td>
<td>589</td>
<td>658</td>
<td>3,344</td>
<td>1,131</td>
</tr>
<tr>
<td>Good</td>
<td>773</td>
<td>0</td>
<td>312</td>
<td>317</td>
<td>481</td>
</tr>
<tr>
<td>Unmapped</td>
<td>145</td>
<td>29</td>
<td>28</td>
<td>41</td>
<td>1,721</td>
</tr>
</tbody>
</table>

11.1.3.4 Flora

Four hundred and seventy-nine flora taxa (including varieties and subspecies) from 53 families and 166 genera have been recorded in the Proposed Mining Area C Development Envelope. Species representation was greatest among the Fabaceae, Poaceae, Malvaceae, Asteraceae, Amaranthaceae, Myrtaceae, Chenopodiaceae, Goodeniaceae, Scrophulariaceae and Solanaceae families, which is typical for the Pilbara bioregion. The most speciose genus was Acacia (51 taxa), followed by Senna (19 taxa), Sida (17 taxa), Eremophila (15 taxa), Ptilotus (14 taxa) and Triodia (11 taxa).

A search of the EPBC Act Protected Matters Database (DotE, 2016a) and the DPaW database (DPaW, 2016a) identified two Threatened flora species (both listed as Vulnerable) within a 50 km radius of the Proposed Mining Area C Development Envelope: *Lepidium catapycnon* (listed under the EPBC Act) and *Thryptomene wittweri* (listed under the EPBC Act and WC Act). *Lepidium catapycnon* is listed as a Priority 4 flora by DPaW. Neither species has been recorded in the Proposed Mining Area C Development Envelope nor is the habitat for *Thryptomene wittweri* considered to occur.

Fifty Priority flora have been recorded within 25 km of the Proposed Mining Area C Development Envelope (DPaW, 2016a) (Table 14). Ten of these have been recorded in the Proposed Mining Area C Development Envelope, and eight of these species occur in the Additional Impact Assessment Area (Table 14).
MINING AREA C - SOUTHERN FLANK
Vegetation Condition within the Proposed Mining Area C Development Envelope

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area

Vegetation Condition
- Pristine
- Excellent
- Very Good
- Good
- Not mapped
- Cleared

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Table 14: Conservation significant flora recorded in the Proposed Mining Area C Development Envelope and surrounds (species present in the Proposed Mining Area C Development Envelope are highlighted in grey)

<table>
<thead>
<tr>
<th>Species</th>
<th>Habitat</th>
<th>Recorded in ADE</th>
<th>Recorded in IAIAA</th>
<th>Recorded in MAC EMP R6</th>
<th>Habitat Present</th>
<th>Cons. Code*</th>
<th>Likelihood of Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acacia bromilowiana</em></td>
<td>Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>4</td>
<td>Recorded</td>
</tr>
<tr>
<td><em>Acacia daweana</em></td>
<td>Stony red loamy soils. Low rocky rises, along drainage lines.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Acacia effuse</em></td>
<td>Scree slopes of low ranges.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Acacia subtiliformis</em></td>
<td>Rocky calcrete plateau.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Adiantum capillus-veneris</em></td>
<td>Moist, sheltered sites in gorges and on cliff walls.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Amaranthus centralis</em></td>
<td>Alluvial plains and valleys, sandplains, rocky or gravelly hills and rises, and ephemeral watercourses and run-on areas.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Aristida lazaridis</em></td>
<td>Deep loam soils or sand.</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2</td>
<td>Recorded</td>
</tr>
<tr>
<td><em>Aristida jerichoensis var. subspinulifera</em></td>
<td>Hardpan plains.</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td><em>Barbula ehrenbergii</em></td>
<td>Iron rich weathered conglomerate on gorge walls.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td><em>Bothriochloa decipiens var. cloncurrensis</em></td>
<td>Woodlands on a range of soil types.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Calotis latiuscula</em></td>
<td>Rocky hillsides, floodplains, rocky creeks or river beds.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Calotis squamigera</em></td>
<td>Pebby loam.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Dampiera anonyma</em></td>
<td>Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite. Hill summits, upper slopes (above 1,000 m).</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Dampiera metallosum</em></td>
<td>Skeletal red-brown gravelly soil over banded ironstone. Steep slopes, summits of hills.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Eragrostis sp. Mt Robinson (S. van Leeuwen 4109)</em></td>
<td>Red-brown skeletal soils, ironstone. Steep slopes, summits.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td><em>Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)</em></td>
<td>Flat plain with thin soil underlain by partly consolidated colluvium.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>Species</td>
<td>Habitat</td>
<td>Recorded in ADE</td>
<td>Recorded in IAIAA</td>
<td>Recorded in MAC EMP R6</td>
<td>Habitat Present</td>
<td>Cons. Code*</td>
<td>Likelihood of Presence</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-------------------</td>
<td>------------------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><em>Eremophila forrestii</em> subsp. <em>viridis</em></td>
<td>Moderately to steeply sloping lower tip of hill spur. Soil: Red-brown very gravelly loam with gravel, pebble surface.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Eremophila magnifica</em> subsp. <em>magnifica</em></td>
<td>Skeletal soils over ironstone.</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4</td>
<td>Recorded</td>
</tr>
<tr>
<td><em>Eremophila magnifica</em> subsp. <em>velutina</em></td>
<td>Skeletal soils over ironstone. Summits. Rocky breakaways.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td><em>Eremophila sp.</em> Hamersley Range (K. Walker KW 136)</td>
<td>Rocky gullies and gorges. Steep rocky hill slopes and summits, high in the landscape.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Eremophila sp.</em> West Angelas (S. van Leeuwen 4086)</td>
<td>High in landscape, summit of hill, gently undulating to steep terrain, skeletal red gritty soil over massive banded iron of the Brockman Iron Formation.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Eremophila sp.</em> Snowy Mountain (S. van Leeuwen 3737)</td>
<td>Gently undulating to steep terrain, skeletal soil over banded iron of the Brockman Iron Formation.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td><em>Eucalyptus lucens</em></td>
<td>Ironstone. Rocky slopes and mountain tops, high in the landscape.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td><em>Fimbristylis sieberiana</em></td>
<td>Mud, skeletal soil pockets. Pool edges, sandstone cliffs.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Geijera salicifolia</em></td>
<td>Skeletal soils, stony soils. Massive rock scree, gorges.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Grevillea saxicola</em>[^a]</td>
<td>Orange/brown loam soils on steep breakaway and scree slopes (often with southerly aspects)</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td><em>Pleurocarpaea gracilis</em></td>
<td>Skeletal, brown gritty soil over ironstone. Hill summit.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td><em>Goodenia lyrata</em></td>
<td>Red sandy loam. Near claypan.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Goodenia sp.</em> East Pilbara (A.A. Mitchell PRP 727)</td>
<td>Red-brown clay soil, calcrete pebbles. Low undulating plain, swampy plains.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Hibiscus sp.</em> Gurinbiddy Range (M.E. Trudgen MET 15708)</td>
<td>Gullies and steep, rocky hill slopes.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Indigofera gilesei</em></td>
<td>Pebbly loam amongst boulders &amp; outcrops. Hills.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>Species</td>
<td>Habitat</td>
<td>Recorded in ADE</td>
<td>Recorded in IAIA</td>
<td>Recorded in MAC EMP R6</td>
<td>Habitat Present</td>
<td>Cons. Code*</td>
<td>Likelihood of Presence</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>------------------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Iotasperma sessilifolium</td>
<td>Cracking clay, black loam. Edges of waterholes, plains.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td>Lepidium catapycnon</td>
<td>Skeletal soils. Hillsides.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Moderate</td>
</tr>
<tr>
<td>Myriocephalus nudus</td>
<td>Moist areas, along rivers &amp; creeks, granite outcrops.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Low</td>
</tr>
<tr>
<td>Nicotiana umbratica</td>
<td>Shallow soils. Rocky outcrops.</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td>Oldenlandia sp. Hamersley Station</td>
<td>Cracking clay, basalt. Gently undulating plain with large surface rocks, flat crabholed plain.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
</tr>
<tr>
<td>Oxalis sp. Pilbara (M.E. Trudgen 12725)</td>
<td>Shaded gully on the lower slopes of a large hill, in the flowline in the gully. Soil: pebbly/gravelly red-brown loam amongst boulders.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>Pilbara trudgenii</td>
<td>Skeletal, red stony soil over ironstone. Hill summits, steep slopes, screes, cliff faces.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Low</td>
</tr>
<tr>
<td>Ptilotus mollis</td>
<td>Stony hills, scree slopes.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>4</td>
</tr>
<tr>
<td>Rhagodia sp. Hamersley (M. Trudgen 17794)</td>
<td>Floodplains, hardpan plains.</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td>Rhynchosia bungarensis</td>
<td>Pebbly, shingly coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>Rostellularia adscendens var. latifolia</td>
<td>Ironstone soils. Near creeks, rocky hills.</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td>Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)</td>
<td>Skeletal, brown stony soil over basalt. Summits of hills, steep hills.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>Low</td>
</tr>
<tr>
<td>Sida sp. Barlee Range (S. van Leeuwen 1642)</td>
<td>Skeletal red soils pockets. Steep slope.</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td>Sida sp. Hamersley Range (K. Newbey 10692)</td>
<td>-</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
</tr>
<tr>
<td>Stylidium weeliwolli</td>
<td>Gritty sand soil, sandy clay. Edge of watercourses.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>Low</td>
</tr>
<tr>
<td>Tetratheca fortiana</td>
<td>Shale pocket amongst ironstone.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td>Themeda sp. Hamersley Station (M.E. Trudgen 11431)</td>
<td>Red clay. Clay pan, grass plain.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>Species</td>
<td>Habitat</td>
<td>Recorded in ADE</td>
<td>Recorded in IAIAA</td>
<td>Recorded in MAC EMP R6</td>
<td>Habitat Present</td>
<td>Cons. Code*</td>
<td>Likelihood of Presence</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>-----------------</td>
<td>-------------------</td>
<td>------------------------</td>
<td>-----------------</td>
<td>------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td><em>Thryptomene wittweri</em></td>
<td>Skeletal red stony soils. Breakaways, stony creek beds.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>T, V</td>
<td>Low</td>
</tr>
<tr>
<td><em>Triodia</em> sp. Karjini (S. van Leeuwen 4684)</td>
<td>Summit and steep hill slopes, high in the landscape.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>Moderate</td>
</tr>
<tr>
<td><em>Triodia</em> sp. Mt. Ella (M.E. Trudgen 12739)</td>
<td>Light orange-brown, pebbly loam. Amongst rocks &amp; outcrops, gully slopes.</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>3</td>
<td>Recorded</td>
</tr>
<tr>
<td><em>Vittadinia</em> sp. Coondewanna Flats (S. van Leeuwen 4684)</td>
<td>Floodplains, hardpan plains.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>1</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

* Not identified in database search.
None of the native plant taxa recorded from the Proposed Mining Area C Development Envelope were considered to be range extensions, potentially new species, or locally endemic or restricted species. One introduced taxon (*Stylosanthes hamata*) represented a large range extension of approximately 400 km south-west of the nearest known occurrences. This record was restricted to the verge of Great Northern Highway and has subsequently been eradicated as part of BHP Billiton Iron Ore’s weed management program.

Twenty-three introduced (weed) species have been recorded in the Proposed Mining Area C Development Envelope during baseline surveys (Table 15 and Figure 16), none of which are listed under the *Biosecurity and Agriculture Management Act 2007* (WA). Twenty one species have been recorded in the Approved Mining Area C (Northern Flank) Development Envelope. The ulcardo melon and mimosa bush have been recorded in the Additional Development Envelope but not in the Approved Mining Area C (Northern Flank) Development Envelope.

A recent audit of weed management at Mining Area C has confirmed that no weeds listed under the *Biosecurity and Agriculture Management Act 2007* have been introduced to site since the commencement of operations. A population of pie melon (*Citrullus lanatus*) was recorded in operations areas and eradicated.

### 11.1.3.5 Existing impacts

Vegetation clearing has been undertaken in the Proposed Mining Area C Development Envelope under previously approved Part IV and Part V approvals. As of December 2016, a total of 5,482 ha have been cleared within the Proposed Mining Area C Development Envelope (Figure 7) as permitted via the following approvals and licences:

- **MS 491**: 4,792 ha
- Clearing under exemption (e.g. firebreaks): 31 ha
- **NVCP 2295**: 238 ha
- **NVCP CPS 4337**: 50 ha
- **NVCP CPS 4630**: 281 ha
- **NVCP CPS 4831**: 21 ha
- **NVCP CPS 5105**: 2 ha
- **Mining Act**: 45 ha
- **State Agreement**: 22 ha

This clearing has resulted in the removal of:

**Priority flora:**

- *Aristida jerichoensis var. subspinulifera* – approximately 129 individuals
- *Aristida lazarides* – approximately 7 individuals
- *Eremophila magnifica* subsp. *magnifica* – approximately 1 individual
- *Rhogodia* sp. Hamersley (M. Trudgen 17794) – approximately 5 individuals
- *Rostellularia adscendens var. latifolia* - approximately 15 individuals
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Weed Affected Areas

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank)
Development Envelope
Additional Development Envelope
BHPBIO Disturbance Footprint (Dec 2016)
BHP Billiton Rail
Rio Tinto Rail
Great Northern Highway

Species Observations (Weeds) outside Additional Development Envelope
Aerva javanica
Bidens bipinnata
Cenchrus ciliaris
Cenchrus setiger
Chloris barbata
Chloris virgata
Citrullus colocynthis
Citrullus lanatus
Conyza bonariensis
Cucumis myriocarpus
Cynodon dactylon
Datura leichhardtii
Digitaria ciliaris
Echinochloa colona
Euphorbia hirta
Flourensia cernua
Lactuca serriola
Malvastrumamericanum
Rumex crispus
Setaria viridis
Siggiewickia orientalis
Solanum nigrum
Sonchus oleraceus
Stylosanthes hamata
Vachellia farnesiana

Species Observations (Weeds) inside Additional Development Envelope
Bidens bipinnata
Cenchrus ciliaris
Malvastrumamericanum
Setaria viridis
Vachellia farnesiana

Liability
BHPBIO does not warrant that this map is free from errors or omissions. BHPBIO shall not be in any way liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.
### Table 15: Introduced flora species recorded in the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Weed Species</th>
<th>Proposed Mining Area C Development Envelope</th>
<th>Approved Mining Area C (Northern Flank) Development Envelope</th>
<th>Additional Development Envelope</th>
<th>Indicative Additional Impact Assessment Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bidens bipinnata (bipinnate beggartick)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cenchrus ciliaris (buffel grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cenchrus setiger (birdwood grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chloris barbata (purpletop chloris)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chloris virgata (feathertop Rhodes grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Citrullus colocynthis (colocynth)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Conyza bonariensis (flaxleaf fleabane)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Conyza sumatrensis (tall fleabane)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cucumis melo subsp. agrestis (ulcardo melon)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cynodon dactylon (couch grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Datura leichhardtii (native thornapple)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Digitaria ciliaris (summer grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Echinochloa colona (awnless barnyard grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Euphorbia hirta (asthma plant)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lactuca serriola (prickly lettuce)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Malvastrum americanum (spiked malvastrum)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rumex vesicaria (ruby dock)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Setaria verticillata (whorled pigeon grass)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sigesbeckia orientalis (indian weed)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Solanum nigrum (black berry nightshade)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sonchus oleraceus (common sowthistle)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tridax procumbens (tridax)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vachellia farnesiana (mimosa bush)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Vegetation condition:**

- Pristine - 7 ha
- Excellent – 2,162 ha
- Very Good – 1,131 ha
- Good – 461 ha
- Degraded/ unmapped\(^5\) - 1,721 ha

\(^5\) Area cleared prior to GIS mapping of vegetation association or condition
Vegetation associations:

Thirty-one vegetation associations have been subjected to clearing within the Proposed Mining Area C Development Envelope; six have been cleared by less than 1 ha, and 14 are considered to have local significance (Table 12). No vegetation association has had more than 10% of its mapped extent cleared within the Proposed Mining Area C Development Envelope. It is noted that GIS information is not available for some areas for which environmental assessments and clearing predate the collection of electronic vegetation association data in a format that could be consolidated into BHP Billiton Iron Ore’s regional vegetation association database.

The impacts of existing clearing to vegetation and flora within the Proposed Mining Area C Development Envelope are considered low.

11.1.4 Potential impacts

This section summarises potential direct and indirect impacts from mining within the Proposed Mining Area C Development Envelope, and specifically, impacts from those activities undertaken within the Indicative Additional Impact Assessment Area and the Mining Area C EMP Revision 6 Impact Assessment Area, and an assessment of potential cumulative impacts at a sub-regional or regional scale, as appropriate, and where information is available. The extents or boundaries used to assess the potential impacts of the Proposal and cumulative or regional extents vary for each factor. Table 16 details the areas assessed for the Flora and Vegetation factor.

Information has been summarised from flora and vegetation impact assessments undertaken in 2015 for update of the EMP Revision 6 (Onshore Environmental, 2015) and in 2016 for the Additional Impact Assessment Area (Onshore Environmental, 2017). Information from the 2015 impact assessments has been updated, where appropriate, in consideration of changes to species taxonomy, conservation listings or increased knowledge of species ecology or distribution. All supporting documents are provided in Appendix 4.

### Table 16: Impact Assessment Areas for flora and vegetation

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flora and Vegetation</td>
<td>Indicative Additional Impact Assessment Area and Additional Development Envelope. Mining Area C EMP Revision 6 Impact Assessment Area</td>
<td>Proposed Mining Area C Development Envelope, including Mining Area C EMP Revision 6 Impact Assessment Area and Indicative Additional Impact Assessment Area.</td>
<td>All areas within the Proposed Mining Area C Development Envelope. For Priority flora, this has also considered BHP Billiton Iron Ore and third-party footprints identified in BHP Billiton Iron Ore’s Strategic Proposal (BHP Billiton Iron Ore, 2016c).</td>
</tr>
</tbody>
</table>

11.1.4.1 Direct Impacts

11.1.4.1.1 Vegetation

Twenty-four of the 34 vegetation associations mapped in the Proposed Mining Area C Development Envelope occur in the Additional Development Envelope and 29 occur in Indicative Additional Impact Assessment Area. Twenty-eight vegetation associations were mapped within the Approved Mining Area C (Northern Flank) Development Envelope, of which 21 occur within the Mining Area C EMP Revision 6 Impact Assessment Area. Only two vegetation types have more than 30% of their total mapped area
within the Indicative Additional Impact Assessment Area (HS AaApr ErjpAmarCocf TwTp and SP AcaoAa ArabDiaChf; see Table 12). Both are considered to be locally significant vegetation, as one supports two conservation significant flora species and the second is considered to be an ‘Ecosystem at Risk’ by Kendrick (2001). Onshore Environmental (2017) considered impacts to these vegetation associations from clearing to be low. Impacts to all vegetation associations within the Indicative Additional Impact Assessment Area were considered to be low to very low (Onshore Environmental, 2017).

There are no vegetation associations within the Proposed Mining Area C Development Envelope that are considered to be PECs or TECs.

Fifteen vegetation associations in the Proposed Mining Area C Development Envelope are considered to have local conservation significance (Table 12 and Figure 17), as they are classified as an ‘Ecosystem at Risk’ by Kendrick (2001) or support one or more conservation significant flora species.

Ten are considered to have very low local conservation significance as they are well represented outside the Indicative Additional Impact Assessment Area and support Priority flora that occur in multiple vegetation associations in the Proposed Mining Area C Development Envelope and wider Pilbara IBRA bioregion. Impacts to these are therefore considered to be very low and are not discussed further.

The remaining five vegetation associations have been determined to have low local conservation significance (Appendix 4) and are discussed further below.

‘GG CcolCfEll ErmuThmbCya’

The vegetation association Low Open Forest of Callitris columellaris, Corymbia ferriticola and Eucalyptus leucophloia subsp. leucophloia over Open Tussock Grassland of Eriachne mucronata, Themeda sp. Mt Barricade (M.E. Trudgen 2471) and Cymbopogon ambiguus and Very Open Hummock Grassland of Triodia pungens on orange brown loam on upper gorges (GG CcolCfEll ErmuThmbCya) was considered locally significant as it supports one Priority 4 taxon (Acacia bromilowiana) which is restricted to this vegetation association. Only 2.6% of the mapped area6 for this vegetation association occurs within the Proposed Mining Area C Development Envelope (all within the Indicative Additional Impact Assessment Area) (Table 17). Significance of impact to this vegetation association type is therefore considered to be low (Onshore Environmental, 2017).

‘GG CfEllFib AhDovmAsha CyaErmuThmb’ and ‘GG TtErmuThmb EllChCf AtpGoroPl’

The vegetation association Low Woodland of Corymbia ferriticola, Eucalyptus leucophloia subsp. leucophloia and Ficus brachypoda over Open Shrubland of Acacia hammersleyensis, Dodonaea viscosa subsp. mucronata and Astrotichra hamptonii over Open Tussock Grassland of Cymbopogon ambiguus, Eriachne mucronata and Themeda sp. Mt Barricade (M.E. Trudgen 2471) on red brown loam along cliff lines and gorges (GG CfEllFib AhDovmAsha CyaErmuThmb) was considered locally significant as it supports four P3 flora taxa and one P4 flora taxon. Three of the P3 flora taxa are restricted to this vegetation association (Grevillea saxicola, Sida sp. Barlee Range (S. van Leeuwen 1642), Triodia sp. Mt Ella (M.E. Trudgen 12739)). Approximately 43% of its mapped area6 occurs within the Proposed Mining Area C Development Envelope (Table 17).

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6 BHP Billiton Iron Ore’s vegetation association database has been developed from the consolidation of 162 historical baseline surveys undertaken by multiple consultants at differing scales. The database has been developed to standardize as far as possible this mapping which can be utilised to undertake preliminary impact assessments at the vegetation association level. BHP Billiton Iron Ore’s vegetation association mapping covers approximately 4,300 km², which is about 2.4% of the total Pilbara region.
The vegetation association Tussock Grassland of *Themeda triandra*, *Eriachne mucronata* and *Themeda* sp. Mt Barricade (M.E. Trudgen 2471) with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia*, *Corymbia hamersleyana* and *Corymbia ferrticolia* over High Shrubland of *Acacia tumida* var. *pilbarenis*, *Gossypium robinsonii* and *Petalostylis labicheoides* on red brown sandy loam in narrowly incised rocky drainage lines (GG TtErmuThmb ElCh CfAtpGoroPl) was considered locally significant as it supports two P3 flora taxa and one P4 flora taxon. One of the P3 flora taxa (*Nicotiana umbratica*) is restricted to this vegetation association. Approximately 62% of its mapped area occurs within the Proposed Mining Area C Development Envelope.

The associations ‘GG CIElFib AhDovmAsa CyaErmuThmb’ and ‘GG TtErmuThmb ElChCf AtpGoroPl’ occur in gorges. While the composition of keystone species found within local gorges is relatively consistent, vegetation structure is spatially variable within this landform, i.e. vegetation structure occurring on sheer gorge walls differs to that on scree slopes, which differs to that along ephemeral drainage channels etc. Even at the fine-scale of mapping undertaken for BHP Billiton Iron Ore, these spatial differences are very difficult to delineate on a vegetation map and hence, the most representative vegetation structure present within the gorge landform is typically described and mapped. This has contributed to the under-representation of this vegetation association within the vegetation association mapping, and therefore impacts to these vegetation types are likely to be over-estimated. Significance of impact to these vegetation associations is considered to be low (Onshore Environmental, 2017).

‘HS AaApr ErjpAmarCocf TwTp’

The vegetation association Low woodland of *Acacia aptaneura* and *Acacia pruinocarpa* over Shrubland of *Eremophila jucunda* subsp. *pulcherrima*, *Acacia marramamba* and *Codonocarpus cotinifolius* over Open Hummock Grassland of *Triodia wiseana* and *Triodia pungens* on red brown loam on hill slopes (HS AaApr ErpjAmarCocf TwTp) was considered locally significant as it supports one P3 flora and one P4 flora taxon. Approximately 81% of its mapped area occurs within the Proposed Mining Area C Development Envelope (Table 17).

The association ‘HS AaApr ErjpAmarCocf TwTp’ occurred within a very long unburnt remnant where large *Acacia pruinocarpa* trees had established in association with a canopy of mulga. Fire was the major factor influencing the *in situ* structure of this association, which otherwise would have been representative of the surrounding vegetation (which had been burnt more recently). Fire was the major factor influencing the low representation of this association within BHP Billiton Iron Ore’s consolidated Pilbara mapping database. It is further noted that it does not occur in areas of unique or uncommon topography, and is considered highly unlikely to be uncommon in the landscape. Significance of impact to this vegetation association is therefore considered to be low (Onshore Environmental, 2017).

‘SP AcaoAa ArobDiaChf’

‘Valley floor mulga’ within the Hamersley subregion is considered to be an ‘Ecosystem at Risk’ by Kendrick (2001). Vegetation association ‘SP AcaoAa ArobDiaChf’ is equivalent to ‘valley floor mulga’ given its occurrence on stony plains in areas of lower relief. It also supports one Priority 3 flora taxon (*Rhagodia* sp. Hamersley (M. Trudgen 17794)). Less than 50% of its mapped area occurs within the Indicative Additional Impact Assessment Area (Table 17). Two Principal Botanists from Onshore Environmental have undertaken baseline flora and vegetation survey work within the Proposed Mining Area C Development Envelope on a regular basis since 2004 (Dr Darren Brearley and Dr Jerome Bull). Both botanists have also undertaken surveys across the wider Hamersley Range, including targeted survey work by helicopter within Karijini National Park. The botanists can confirm that vegetation supporting *Acacia catenulata* subsp. *occidentalis* and *Acacia aptaneura* is common on plains between Newman and Roy Hill (approximate range 150 km). It is also noted that seven other vegetation associations within BHP Billiton Iron Ore’s consolidated vegetation mapping database support *Acacia*
*catenulata* subsp. *occidentalis* and *Acacia aptaneura* as dominant upperstorey components, and are considered to be closely affiliated with ‘SP AcaoAa ArorbDiaChf’. As such, this vegetation association is not considered to be locally endemic or unique. Similarly, neither the vegetation association nor related ecosystem has been nominated as a PEC by DPaW since ‘valley floor mulga’ was identified as an ‘Ecosystem at Risk’ by Kendrick (2001) 16 years ago, suggesting a low level of perceived conservation significance. Onshore Environmental (2017) therefore considered the overall impact to be low.

There are 45 mulga dominant vegetation associations within BHP Billiton Iron Ore’s consolidated vegetation association mapping database that can be considered analogous with ‘valley floor mulga’ within the Hamersley subregion and therefore considered to be an ‘Ecosystem at Risk’ (Kendrick 2001). The fine scale definition of these vegetation associations has contributed to the inflated percentage of the ‘SP AcaoAa ArorbDiaChf’ represented within the Proposed Mining Area C Development Envelope. The diversity of mulga vegetation associations within the consolidated database reflects factors such as position in landscape and diversity of soil types, along with other factors including fire, frost and seasonality.

The distribution of mulga vegetation within the Pilbara is relatively well understood and has been defined through broad scale vegetation mapping (Heydenrych *et al*., 2015). Mulga is a dominant feature of vegetation within the southern Pilbara as far north as latitude 22 degrees south, where it is replaced by *Acacia xiphophylla* in the Chichester Ranges. Mulga extends broadly from the Fortescue Valley into the Hamersley Range, and south into the Ashburton Botanical District. It is found in drainage basins and valley floors typical of the Fortescue Valley, the elevated washplains of Coondewanna Flats and Wanna Munna Flats (and Southern Flank/Mining Area C), footslope pediments of West Angelas, and steep hill slopes and breakaways of Mt Barricade, Mt Robinson and Parmelia Hill. Mulga vegetation dominates the drive northwest from Newman through the Hamersley Range, and is well represented within Karijini National Park. Mulga vegetation is known to extend as far north as BHP Billiton Iron Ore’s Roy Hill tenements, where extensive stands in excellent condition have been observed. It is noted that vegetation mapping has not been completed for the Roy Hill tenements, and hence is not represented within BHP Billiton Iron Ore’s consolidated Pilbara mapping database. However, vegetation at the Roy Hill tenements includes associations that are closely affiliated with mulga represented around Southern Flank and Mining Area C.

There is one vegetation association within the Proposed Mining Area C Development Envelope that contains species that are considered to be groundwater dependent. The vegetation association Low Open Forest of *Eucalyptus camaldulensis* subsp. *refulgens*, *Eucalyptus victrix* and *Eucalyptus xerothemica* over High Shrubland of *Acacia pyriformia* var. *pyriformia*, *Acacia tumida* var. *pilbarensis* and *Gossypium robinsonii* over Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Cymbopogon procerus* on red brown clay loam on major drainage lines (MA EcrEvEx ApyAtpGoro TtEuaCyp). This vegetation association occurs along Pebble Mouse Creek within the Additional Development Envelope and approximately 30 ha occur within the Indicative Additional Impact Assessment Area. *Eucalyptus camaldulensis* subsp. *refulgens* is considered to be a facultative phreatophyte which utilises groundwater sources in an opportunistic fashion or during times of limited water supply and/or drought like conditions (Astron, 2010). Facultative phreatophytes are susceptible to extended periods of water stress and have good physiological and/or morphological adaptations to reduce their water demands during drought-like conditions. Regional groundwater levels in the vicinity of this section of Pebble Mouse Creek exceed 40 m in depth. It is therefore considered very unlikely that this vegetation association will be accessing groundwater that is subject to drawdown for mining operations. Impacts to this vegetation association are therefore considered low.
### Table 17: Impact assessment for locally significant vegetation associations in the Proposed Mining Area C Development Envelope (from Onshore Environmental, 2017)

<table>
<thead>
<tr>
<th>Vegetation Association</th>
<th>Characteristics Defining Local Significance</th>
<th>Proportion of Consolidated Mapping Area in all Proposed Disturbance Areas (%)</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG CcolCfEll ErmuThmbCya</td>
<td>Supports one P4 flora, which is restricted to this vegetation association.</td>
<td>2.6</td>
<td>Low</td>
</tr>
<tr>
<td>GG CfEllFib AhDovmAsha CyaErmuThmb</td>
<td>Supports four P3 flora and one P4 flora taxon. Three of the P3 flora are restricted to this vegetation association.</td>
<td>20.5</td>
<td>Low</td>
</tr>
<tr>
<td>GG TtErmuThmb EIIChCf AtpGoroPI</td>
<td>Supports two P3 flora and one P4 flora taxon. One of the P3 flora is restricted to this vegetation association.</td>
<td>14.1</td>
<td>Low</td>
</tr>
<tr>
<td>HS AaApr ErjpAmarCof TwTp</td>
<td>Supports one P3 flora and one P4 flora taxon.</td>
<td>73.0</td>
<td>Low</td>
</tr>
<tr>
<td>HS TtTwTp EIICh AhiAaa</td>
<td>Supports one P2, two P3 flora and one P4 flora taxon.</td>
<td>8.8</td>
<td>Very Low</td>
</tr>
<tr>
<td>FS Ts CdHc AancAiGrwh</td>
<td>Supports one P2 and three P3 flora taxa.</td>
<td>2.9</td>
<td>Very Low</td>
</tr>
<tr>
<td>SP AaApr TmTwTp TtChfAri</td>
<td>'Valley floor mulga' which is considered an 'ecosystem at risk.' Supports one P2 and two P3 flora taxa.</td>
<td>2.9</td>
<td>Very Low</td>
</tr>
<tr>
<td>SP AcaoAa ArobDiaChf</td>
<td>'Valley floor mulga' which is considered an 'ecosystem at risk.' Supports one P3 flora taxa.</td>
<td>48.3</td>
<td>Low</td>
</tr>
<tr>
<td>SP TpTm AaExAcao ApaErffAads</td>
<td>Supports one P2, two P3 flora and one P4 flora taxon.</td>
<td>5.5</td>
<td>Very Low</td>
</tr>
<tr>
<td>SP TtTwTp EgEt AbApaApr</td>
<td>Supports three P3 flora taxa.</td>
<td>18.9</td>
<td>Very Low</td>
</tr>
<tr>
<td>FP TtEua ExAa AprAtpErlo</td>
<td>'Valley floor mulga' which is considered an 'ecosystem at risk.' Supports one P2 and one P3 flora taxon.</td>
<td>2.9</td>
<td>Very Low</td>
</tr>
<tr>
<td>MI AtpPlAm TpTs ChEll</td>
<td>Supports one P2, one P3 flora and one P4 flora taxon.</td>
<td>15.9</td>
<td>Very Low</td>
</tr>
<tr>
<td>ME TtAriCya ChEll AmPlAnl</td>
<td>Supports one P3 flora and one P4 flora taxon.</td>
<td>4.8</td>
<td>Very Low</td>
</tr>
<tr>
<td>ME TpTlo ExAciCh PlAppypGoro</td>
<td>Supports three P3 flora taxa.</td>
<td>5.6</td>
<td>Very Low</td>
</tr>
<tr>
<td>MA EcrEvEx AppypAtpGoro TtEuaCyp</td>
<td>Major ephemeral watercourse which is considered an 'ecosystem at risk.' Supports two P3 flora taxa.</td>
<td>1.4</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

*Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area*
MINING AREA C - SOUTHERN FLANK
Impacts to Conservation Significant Vegetation within the Proposed Mining Area C Development Envelope

BHP BILLITON IRON ORE

Hora 119°5'0"E
Horz 22°55'0"S

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Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

Local Conservation Significant Vegetation
- Cleared:
  - FP TtEua ExAa AprApaEts
  - FS Ts CaCicAacCicGorh
  - GG CoGorh TtEuaFib TtEuaFib
  - CG CcOrh TtEuaFib TtEuaFib
  - AlpGorh FbApaTtEua
  - AtpGoro PlTtEua
  - HSp TtEuaFib TtEuaFib

- HS TtEua FbApa TtEuaFib
  - MA TtEua FbApa TtEuaFib
  - TtEuaFib
  - ME TtEuaFib TtEuaFib
  - ME TtEuaFib TtEuaFib

- HS TtEua TtEua FbApa TtEuaFib
  - TtEua FbApa TtEuaFib
  - ExAa Aa Aa
  - TtEuaFib TtEua
  - TtEuaFib TtEua

- HS TtEuaFib TtEuaFib
  - TtEuaFib TtEuaFib
  - TtEuaFib TtEuaFib
  - TtEuaFib TtEuaFib
  - TtEuaFib TtEuaFib

Kilometres
Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994
Obligate phreatophytic vegetation refers to vegetation that is completely or highly dependent on groundwater sources to survive, and within the vicinity of the Proposed Mining Area C Development Envelope the only obligate phreatophyte species is silver cadjeput, *Melaleuca argentea*. There are no vegetation associations within the Proposed Mining Area C Development Envelope that contain this species. It does occur within the Weeli Wolli PEC (including Ben’s Oasis). Impacts to this community associated with groundwater drawdown are discussed in Section 11.1.4.3.3.

**11.1.4.1.2 Conservation significant flora**

Ten conservation Priority flora taxa have been recorded within the Proposed Mining Area C Development Envelope (Table 14). Eight of these have been recorded in the Indicative Additional Impact Assessment Area, and six have been recorded within the Mining Area C Revision 6 EMP Impact Assessment Area (Table 14). These species are discussed further below.

**Acacia bromilowiana** (Priority 4). *Acacia bromilowiana* has been recorded as one population in the Proposed Mining Area C Development Envelope where it occurred in upper reaches of a gorge in the Indicative Additional Impact Assessment Area (Figure 18). The plants in this location provided an estimated 1% foliage cover (Table 18). It has also been recorded from just outside the southern boundary of the Proposed Mining Area C Development Envelope, occurring as more than 100 plants and providing up to 10% cover from seven point locations on the northern slopes of Mount Robinson (Onshore Environmental, 2012). Regionally, *Acacia bromilowiana* has been recorded from 63 locations across the southern third of the Pilbara (BHP Billiton Iron Ore, 2016j).

The impact of direct clearing of the single *Acacia bromilowiana* population associated with the Proposal is considered to be very low, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Aristida jerichoensis** subsp. **subspinulifera** (Priority 3). Five populations of *Aristida jerichoensis* subsp. *subspinulifera*, containing approximately 2,559 plants, have been recorded primarily within the northwest and western boundaries of the Proposed Mining Area C Development Envelope on stony plains and floodplains (Figure 18). Two of these populations, containing approximately 790 plants, occur in the Indicative Additional Impact Assessment Area (Table 18). Two populations containing approximately 161 plants occur within the Mining Area C EMP Revision 6 Impact Assessment Area.

The species has been recorded extensively west of the Proposed Mining Area C Development Envelope in BHP Billiton Iron Ore exploration leases and also occurs in large numbers in New South Wales and Queensland, with smaller populations in the Northern Territory, South Australia and Western Australia (outside of the Proposed Mining Area C Development Envelope) (BHP Billiton Iron Ore, 2016j).

The impact of direct clearing within four of the five populations of *Aristida jerichoensis* subsp. *subspinulifera* in the Proposed Mining Area C Development Envelope is considered to be low as more than 60% of known individuals within the Proposed Mining Area C Development Envelope occur outside proposed disturbance areas and it occurs commonly outside this area in Western Australia and other Australian states. It is considered very unlikely that implementation of the Proposal will result in a change to its conservation status.
Table 18: Number of records and number of plants (or estimated % ground cover) for Priority flora taxa occurring in the Proposed Mining Area C Development Envelope, Indicative Additional Impact Assessment Area and Mining Area C Revision 6 EMP Impact Assessment Area

<table>
<thead>
<tr>
<th>Vegetation Association</th>
<th>No. Populations in Proposed Mining Area C Development Envelope</th>
<th>No. Plants in Proposed Mining Area C Development Envelope</th>
<th>No. Populations in Indicative Additional Impact Assessment Area</th>
<th>No. Plants in Indicative Additional Impact Assessment Area</th>
<th>No. Populations in Mining Area C EMP Revision 6 Impact Assessment Area</th>
<th>No. Plants in Mining Area C EMP Revision 6 Impact Assessment Area</th>
<th>No. Plants Cleared (up to December 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia bromilowiana (P4)</td>
<td>1</td>
<td>1% cover</td>
<td>1</td>
<td>1% cover</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aristida jerichoensis var. subspinulifera (P3)</td>
<td>5</td>
<td>2,559</td>
<td>2</td>
<td>790</td>
<td>2</td>
<td>161</td>
<td>129</td>
</tr>
<tr>
<td>Aristida lazaridis (P2)</td>
<td>3</td>
<td>2,977</td>
<td>2</td>
<td>2,114</td>
<td>3</td>
<td>660</td>
<td>7</td>
</tr>
<tr>
<td>Eremophila magnifica subsp. magnifica (P4)</td>
<td>10</td>
<td>676</td>
<td>3</td>
<td>196</td>
<td>3</td>
<td>83</td>
<td>1</td>
</tr>
<tr>
<td>Grevillea saxicola (P3)</td>
<td>1</td>
<td>55</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nicotiana umbratica (P3)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)</td>
<td>16</td>
<td>302</td>
<td>14</td>
<td>225</td>
<td>7</td>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>Rostellularia adscendens var. latifolia (P3)</td>
<td>9</td>
<td>325</td>
<td>5</td>
<td>69</td>
<td>3</td>
<td>228</td>
<td>15</td>
</tr>
<tr>
<td>Sida sp. Barlee Range (S. van Leeuwen 1642) (P3)</td>
<td>1</td>
<td>47</td>
<td>1</td>
<td>47</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)</td>
<td>1</td>
<td>2-10% cover</td>
<td>1</td>
<td>2-10% cover</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
MINING AREA C - SOUTHERN FLANK
Impacts to Conservation Significant Flora populations in the Proposed Mining Area C Development Envelope

Conservation Significant Flora
- Aristida lazaridis (P2)
- Aristida jerichoensis var. subspinulifera (P3)
- Grevillea saxicola (P3)
- Nicotiana umbrosa (P3)
- Rostellularia adscendens var. latifolia (P3)
- Sida sp. Barlee Range (S. van Leeuwen 1942) (P3)
- Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)
- Acacia bromilowiana (P4)
- Emophipila magnifica subsp. magnifica (P4)

Significant Flora Populations
- Aristida lazaridis (P2)
- Aristida jerichoensis var. subspinulifera (P3)
- Grevillea saxicola (P3)
- Nicotiana umbrosa (P3)
- Rostellularia adscendens var. latifolia (P3)
- Sida sp. Barlee Range (S. van Leeuwen 1942) (P3)
- Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)
- Acacia bromilowiana (P4)
- Emophipila magnifica subsp. magnifica (P4)

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**Aristida lazaridis** (Priority 2). *Aristida lazaridis* has been recorded from three populations, containing almost 3,000 plants, in the Proposed Mining Area C Development Envelope (Figure 18 and Table 18). Two populations occur entirely or partially within the Indicative Additional Impact Assessment Area. It is estimated that 2,114 plants occur in the Indicative Additional Impact Assessment Area. Three populations containing approximately 600 plants occur within the Mining Area C EMP Revision 6 Impact Assessment Area. It also occurs extensively on lowland areas in adjacent BHP Billiton Iron Ore tenure (see Onshore Environmental, 2017; Appendix 4).

In Western Australia, *Aristida lazaridis* occurs in the Pilbara and Kimberley Interim Biogeographical Regionalisation for Australia (IBRA) bioregions, including Karijini National Park (BHP Billiton Iron Ore, 2016j). It also occurs in the Northern Territory and Queensland (BHP Billiton Iron Ore, 2016j).

The impact of direct clearing of *Aristida lazaridis* in the Proposed Mining Area C Development Envelope is considered to be low given the retention of a large number of populations in adjacent BHP Billiton Iron Ore tenure. It is considered very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Eremophila magnifica** subsp. *magnifica* (Priority 4). *Eremophila magnifica* subsp. *magnifica* has been recorded from ten populations, containing approximately 676 plants, in the Proposed Mining Area C Development Envelope (Figure 18). It was associated with rocky gorge sites, cliff faces and steep rocky slopes predominantly throughout the central sector. Three of the eight populations, containing a total of approximately 196 plants, occur in the Indicative Additional Impact Assessment Area (Table 18). Four populations, containing approximately 83 plants, occur within the Mining Area C EMP Revision 6 Impact Assessment Area.

*Eremophila magnifica* subsp. *magnifica* is widespread throughout the eastern two-thirds of the Hamersley IBRA subregion (BHP Billiton Iron Ore, 2016j; Onshore Environmental, 2017, see Appendix 4).

The impact of direct clearing of *Eremophila magnifica* subsp. *magnifica* in the Proposed Mining Area C Development Envelope is considered to be low as a number of populations will be retained within the Proposed Mining Area C Development Envelope and it occurs more widely in the Hamersley IBRA subregion. It is considered very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Rhagodia sp. Hamersley** (M. Trudgen 17794) (Priority 3). *Rhagodia sp. Hamersley* (M. Trudgen 17794) was recorded from 15 populations, containing approximately 302 plants (Figure 18 and Table 18), in the north-western, western and southern sectors of the Proposed Mining Area C Development Envelope where it occurred predominantly on floodplains. Fourteen populations, containing a total of approximately 225 plants, occur wholly or partly in the Indicative Additional Impact Assessment Area (Table 18). Seven populations containing approximately 28 plants occur within the Mining Area C EMP Revision 6 Impact Assessment Area.

*Rhagodia sp. Hamersley* (M. Trudgen 17794) has been frequently recorded in the eastern half of the Hamersley IBRA subregion and extends into the Fortescue IBRA subregion and Gascoyne IBRA bioregion (BHP Billiton Iron Ore, 2016j).

The impact of direct clearing of *Rhagodia sp. Hamersley* (M. Trudgen 17794) in the Proposed Mining Area C Development Envelope is considered to be low, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.
**Rostellaria adscendens var. latifolia (Priority 3)**. *Rostellaria adscendens var. latifolia* was recorded from nine populations, containing approximately 325 plants (Figure 18), in the northeast and southeast sectors of the Proposed Mining Area C Development Envelope where it occurred primarily in broad medium drainage lines. Plants occurred as scattered individuals or populations of up to a maximum of 82 plants. Five populations, containing approximately 69 plants, occur in the Indicative Additional Impact Assessment Area (Table 18). Three populations containing approximately 228 plants occur within the Mining Area C EMP Revision 6 Impact Assessment Area.

*Rostellaria adscendens var. latifolia* occurs throughout the eastern half of the Hamersley IBRA subregion and extends into the Fortescue IBRA subregion. It is also widespread and common across the Northern Territory, South Australia, New South Wales, and Queensland (BHP Billiton Iron Ore, 2016j) and there are a number of records in Karijini National Park (Onshore Environmental, 2017; see Appendix 4).

The impact of direct clearing of *Rostellaria adscendens var. latifolia* in the Proposed Mining Area C Development Envelope is considered to be low, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Sida sp. Barlee Range (S. van Leeuwen 1642) (Priority 3)**. *Sida* sp. Barlee Range (S. van Leeuwen 1642) was recorded from one population, containing approximately 47 plants (Figure 18), in the Proposed Mining Area C Development Envelope. All plants occurred at the base of cliffs and on steep hill slopes. This population occurs in the Indicative Additional Impact Assessment Area.

*Sida* sp. Barlee Range (S. van Leeuwen 1642) occurs extensively throughout the southern Pilbara and northern Gascoyne IBRA bioregions, with five records occurring in Karijini National Park (BHP Billiton Iron Ore, 2016j). It has also been reported in low numbers from BHP Billiton Iron Ore’s neighbouring tenements west and east of the Proposed Mining Area C Development Envelope.

The impact of direct clearing of the one population of *Sida* sp. Barlee Range (S. van Leeuwen 1642) in the Proposed Mining Area C Development Envelope is considered to be low, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Triodia sp. Mt Ella (M.E. Trudgen 12739) (Priority 3)**. *Triodia* sp. Mt Ella (M.E. Trudgen 12739) was recorded on red brown loam on stony slopes and upper plains from one population in the southern sector of the Proposed Mining Area C Development Envelope, providing ground coverage of between 2% to 10% (Table 18 and Figure 18). This population occurs in the Indicative Additional Impact Assessment Area.

*Triodia* sp. Mt Ella (M.E. Trudgen 12739) is known from 395 records throughout the south-eastern sector of the Pilbara IBRA bioregion and extending marginally into the Gascoyne bioregion. It has been recorded with increasing frequency in the Hamersley IBRA subregion in recent years and occurs at BHP Billiton Iron Ore’s neighbouring tenements and in Rio Tinto Iron Ore’s West Angelas tenement.

The impact of direct clearing of the one population of *Triodia* sp. Mt Ella (M.E. Trudgen 12739) in the Proposed Mining Area C Development Envelope is considered to be low, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

11.1.4.2 Indirect impacts of the Proposal

**Alteration to surface water.** The Proposal has the potential to impact surface water resources and thus flora and vegetation by:

- changing local surface water flow patterns;
- affecting surface water runoff volumes and quality;
- increasing the risk of erosion and sedimentation; or
- contamination from chemicals or hydrocarbons.

Surface water modelling predicted that there would be a net loss in surface water runoff from the natural hydrological cycle. However, these changes are not considered to be significant to the overall hydrological system at a regional scale, particularly in comparison to the large natural seasonal variations in catchment runoff (MWH, 2016). It is therefore concluded that changes to the surface hydrology are unlikely to have any significant impact on downstream flora and vegetation. Changes to surface water as a result of the Proposal are discussed further in Section 11.4.7.

The alteration of existing surface water regimes by project infrastructure may impact on susceptible downstream vegetation, most notably mulga-dominated vegetation associations situated on floodplains. Three vegetation associations in the Proposed Mining Area C Development Envelope (predominantly in the northwest and southern fringe) and the Indicative Additional Impact Assessment Area support mulga vegetation on stony plains and floodplains. While all three vegetation associations are susceptible to altered surface water flows, their extent is relatively small (321 ha in the Indicative Additional Impact Assessment Area), and it is unlikely that these communities will be impacted by the Proposal.

Proposed changes to surface hydrology are not likely to result in any significant alteration to the composition or structure of existing vegetation associations. While downstream vegetation is likely to be at highest risk from impacts associated with reduced surface water flows, increased sediment loading, and contamination, the potential impacts are determined to be not significant because the vegetation associations do not support high-risk species and are well represented regionally.

### Alteration to groundwater

The Proposal has the potential to impact groundwater resources available to flora as a result of drawdown of water levels from dewatering and water supply abstraction. The lowering of groundwater levels during mine dewatering activities results in a propagation of drawdown and modification of the hydrological conditions away from the orebody aquifers and more regionally towards Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis.

Groundwater-dependent vegetation is associated with the Weeli Wolli Spring PEC, and potential impacts to this receptor are discussed in Section 11.1.4.3.3. The Coondewanna Flats PEC is not considered to be groundwater dependent; however, injection of surplus water into the Juna Downs Managed Aquifer Recharge (MAR) borefield north of the Coondewanna Flats PEC has the potential to develop local groundwater mounding, bringing groundwater closer to tree root zones which may potentially result in waterlogging of trees. This is discussed further in Section 11.1.4.3.4 and references therein.

### Fire

Wildfire resulting from lightning strike is a natural phenomenon to which arid zone vegetation is well adapted, with many plant taxa reliant on heat and smoke to break seed dormancy and stimulate germination (Fox, 1978). However, increased access to previously remote areas can increase the frequency of fire through accidental occurrences and arson.

Vegetation associations that are more sensitive to fire include those associated with deep gorge habitats and dense mulga stands on floodplains. There is a mosaic of fire ages evident across the Proposed Mining Area C Development Envelope, with vegetation condition assessment confirming the majority of vegetation remains in Good or better condition despite this.
Fire is a natural occurrence in vegetation associations in the Proposed Mining Area C Development Envelope, and the increased risk posed by implementation of the Proposal is manageable and not considered a significant risk to vegetation or flora.

**Introduced species.** Domestic stock, such as cattle, are significant vectors for weed species in lowland areas of the Pilbara, including the Proposed Mining Area C Development Envelope. Vegetation condition typically declines across these lowlands due to alteration of native vegetation structure and composition, including a higher loading of introduced weed species. Increased vehicular access combined with disturbance (such as clearing for roads and other infrastructure) also has the potential to introduce or spread weed species.

Existing operations at Mining Area C have managed the introduction of weed species effectively through various strategies associated with prevention (quarantine) and control (targeted spray programs and progressive rehabilitation). Implementation of the Proposal is not expected to significantly increase the risk of weed invasion and spread, provided current management processes are maintained. These management processes will also be employed in implementation of the Proposal. As a result of the proven success of BHP Billiton Iron Ore’s existing processes, a significant increase in the risk of weed invasion and spread is unlikely to occur.

**Dust.** Dust associated with iron ore mining in the Pilbara is generally chemically inert (Butler, 2009; Turner, 2013), so any potential impacts on plants are likely to be physical, including leaf abrasion, blocking of stomata and increased absorption of incident radiation, which in turn can elevate leaf temperature and negatively impact on photosynthetic processes and transpiration loss. These physical effects tend to be proportional to the amount of dust that vegetation is exposed to, the plant structures and the size of the dust particles (i.e. the higher the dust loading and the smaller the particle size, then the higher the risk) (Grierson, 2015).

In the Pilbara, dust generated by mining activities is likely to be both short-lived and transported for relatively short distances of 100 to 200 m, mainly at the time of service track construction (Grierson, 2015). Long-term observations of vegetation in close proximity to other mine sites across the Hamersley Range have demonstrated repeatedly the overall resilience of vegetation to extremely high levels of dust exposure. Plants coloured orange with dust for several years survive quite well, in part because plants in arid environments mainly grow in response to high rainfall and have very low metabolic rates outside of these periods. Growth periods thus also coincide with when (i) foliage is washed clean by rainfall and (ii) the lowest level of dust emissions due to damping down of the environment.

There is low risk of increased dusting to the vegetation forming the two subtypes of the Coondewanna Flats PEC, situated outside the southwest corner of the Proposed Mining Area C Development Envelope. Studies in the Pilbara on a range of species suggest that dust is unlikely to impact vegetation (Grierson, 2015); it is therefore considered unlikely that there will be dust impacts to the PEC.

### 11.1.4.3 Regional cumulative impacts

#### 11.1.4.3.1 Vegetation

Based on the original mapping by Beard (1975) that was more recently refined by Shepherd et al. (2002), there are two vegetation associations represented in the Proposed Mining Area C Development Envelope: Hamersley 18 and Hamersley 82. Less than 2% of the total extent for each vegetation association mapped by Beard (1975) and later refined by Shepherd et al. (2002) are represented in the Proposed Mining Area C Development Envelope, and less than 5% occurs in cumulative BHP Billiton Iron Ore or third-party disturbance areas (Table 19). Using Beard’s (1975) regional vegetation
association mapping, the cumulative impact to vegetation communities is considered unlikely to be significant.

The Proposal will be developed and operated as part of the existing Mining Area C operation, which was approved under MS 491. The Indicative Additional Impact Assessment Area intersects similar vegetation associations to those represented in the Approved Mining Area C (Northern Flank) Development Envelope, and none are of elevated conservation significance. All vegetation associations (and land systems) that may be disturbed by this Proposal are well represented in the Pilbara bioregion. Therefore, no significant cumulative impacts to vegetation are predicted.

**Table 19: Current pre-European extent of vegetation associations that occur in the Proposed Mining Area C Development Envelope (Shepherd et al., 2002), the area represented in the Proposed Mining Area C Development Envelope, cumulative BHP Billiton Iron Ore disturbance footprint, and cumulative third-party disturbance footprint (percentages are a proportion of the current pre-European extent for each vegetation association)**

<table>
<thead>
<tr>
<th>Vegetation Association</th>
<th>Current Pre-European Extent (ha)</th>
<th>Proposed Mining Area C Development Envelope (ha)</th>
<th>Cumulative BHP Billiton Iron Ore Disturbance (ha)</th>
<th>Cumulative Third-Party Disturbance (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamersley 18</td>
<td>770,898</td>
<td>13,167 (1.7%)</td>
<td>35,994 (4.7%)*</td>
<td>4,878 (0.6%)</td>
</tr>
<tr>
<td>Hamersley 82</td>
<td>5,602,479</td>
<td>22,864 (0.4%)</td>
<td>54,590 (1.0%)*</td>
<td>15,594 (0.3%)</td>
</tr>
</tbody>
</table>

*This correlates with the area assessed for the BHP Billiton Strategic Proposal*

**11.1.4.3.2 Flora**

Mapping of confirmed locations for each of the eight Priority flora species represented in the Indicative Additional Impact Assessment Area confirmed broadly similar distributional patterns extending between Newman and Tom Price (Appendix 4).

A regional assessment of cumulative impacts to Priority flora was undertaken for BHP Billiton Iron Ore’s Strategic Proposal in early 2016 (BHP Billiton Iron Ore, 2016c). Potential cumulative impacts to those conservation significant species present within the Proposed Mining Area C Development Envelope are shown in Table 20. The data used for the assessment have been compiled from BHP Billiton Iron Ore’s corporate database and DPaW’s WA Herb and Threatened and Priority Flora List databases. The assessment used the best available information to determine cumulative impacts; however it was noted that there were a number of limitations to the assessment, including inaccuracy of data and erroneous records (which were where noted removed or corrected), currency of data (due to delays in submission and loading of data), and a bias of data collected from BHP Billiton Iron Ore and other mining company tenements (BHP Billiton Iron Ore, 2016c). These limitations were not unique to this assessment, and would be relevant to any cumulative impact assessment undertaken for the region. The cumulative impact from the Proposal and other proposed disturbance by BHP Billiton Iron Ore and third parties was considered unlikely to significantly reduce the representation of the ten taxa recorded in the Proposed Mining Area C Development Envelope.

**11.1.4.3.3 Weeli Wolli Spring PEC**

The Weeli Wolli Spring area is recognised as having multiple ecological values that collectively contribute to its DPaW listing as a Priority 1 Ecological Community. The community is described by DEC (2009a) as being:
‘...dominated by a fringing forest or tall woodland of Silver paperbark (Melaleuca argentea) and River Red Gum (Eucalyptus camaldulensis) over trees of Coolibah (E. victrix) and a dense shrub layer dominated by an assortment of wattles, in particular Pilbara Jam (Acacia citrinoviridis). The presence of permanent water and very moist sediment also provides suitable habitat for many sedges and herbs.”

Table 20: Potential cumulative impact to the ten Priority flora occurring in the Proposed Mining Area C Development Envelope (summarised from BHP Billiton Iron Ore, 2016j)

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of Records</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pilbara Area</td>
</tr>
<tr>
<td>Acacia bromilowiana (P4)</td>
<td>63</td>
</tr>
<tr>
<td>Aristida jerichoensis var. subspinulifera (P3)</td>
<td>227</td>
</tr>
<tr>
<td>Aristida lazaridis (P2)</td>
<td>203</td>
</tr>
<tr>
<td>Eremophila magnifica subsp. magnifica (P4)</td>
<td>548</td>
</tr>
<tr>
<td>Grevillea saxicola (P3)</td>
<td>97</td>
</tr>
<tr>
<td>Nicotiana umbratica (P3)</td>
<td>19</td>
</tr>
<tr>
<td>Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)</td>
<td>1309</td>
</tr>
<tr>
<td>Rostellularia adscendens var. latifolia (P3)</td>
<td>253</td>
</tr>
<tr>
<td>Sida sp. Barlee Range (S. van Leeuwen 1642) (P3)</td>
<td>130</td>
</tr>
<tr>
<td>Triodia sp. Mt Ella (M.E. Trudgen 12739) (P3)</td>
<td>394</td>
</tr>
</tbody>
</table>

There are several species of conservation interest, including one named after the spring (the Priority 2 Stylidium weeliwolli). This area supports the obligate phreatophyte Melaleuca argentea, which is highly sensitive to groundwater drawdown. Eucalyptus camaldulensis and E. victrix are considered to be facultative phreatophyte species.

A detailed assessment of hydrological impacts to the Weeli Wolli springs is provided in Section 11.4, and key aspects relating to flora and vegetation are summarised here.

The previously forecast residual drawdown at Weeli Wolli Spring presented in the EMP Revision 6 model was around 1.6 m at GWB0018 in 2054 (see Section 11.4). This drawdown is predicted to occur following closure of Hope Downs 1 (see Figure 2) and is attributed to the combined impacts of dewatering at Hope Downs 1 and Mining Area C (Northern Flank). Maximum drawdown at GWB0018 was modelled to be between 6 and 7 m in 2026 and coincides with the conclusion of Hope Downs dewatering.

Dewatering at Southern Flank is predicted to contribute between 0.2 and 0.5 m of drawdown at GWB0018 in 2054. This drawdown is modelled to occur following the end of aquifer replenishment and mitigation actions at Hope Downs 1. Cumulative groundwater drawdown from the Mining Area C combined operations and Rio Tinto Iron Ore’s Hope Downs 1 dewatering activities shows a far greater change, whereby water levels are significantly reduced in the lower catchment of the spring area. This drawdown, which shows a range of 3 to 14 m, is associated predominantly with abstraction from Hope
Downs 1. The timing and success of Hope Downs 1 closure plans to recover groundwater levels will be the key influence on groundwater level and potential for a continued impact at Weeli Wolli Spring.

Following closure of Hope Downs 1 the combined cumulative impacts show a range of 1 – 2.5 m drawdown at 2054 with a median drawdown of 1.75 m which is close to the previously assessed change of 1.6 m. Residual drawdown in the upper end of this range (>2 m) has potential to reduce water availability to *Melaleuca argentea* (if unmitigated) and may result in the population contracting east toward the spring. If this reduction occurs, it is predicted that the distribution of *Melaleuca argentea* will be smaller to that which occurred prior to development of the Hope Downs 1 mine. It is noted that this community has been significantly altered by drawdown and discharge associated with the Hope Downs 1 mine and there is limited information available on the baseline conditions of this community. Adaptive management measures such as aquifer recharge (as outlined in the CPWRMP) will be implemented to mitigate any impacts to an acceptable level.

11.1.4.3.4 Coondewanna Flats PEC

A number of studies addressing aspects of the ecohydrology of Coondewanna Flats have been completed in the past decade, and more recently a considerable volume of monitoring data has been collected. These studies have included a hydro-environmental assessment, monitoring of regional bores, analysis of tree water chemistry and leaf water potential, and development of an ecohydrological conceptual model (Appendix 7). A summary of key components of the conceptual ecohydrological model is as follows:

- It is an internally draining system relying on surface water runoff from the surrounding catchments.
- Surface water flows typically reach the Coondewanna Flats three out of every four years to replenish the soil moisture in the unsaturated zone, even when groundwater recharge does not occur. Groundwater is generally 20 m below ground level (mbgl).
- The vegetation communities are considered unlikely to rely on groundwater as:
  - There is abundant water in the soil profile to support the community for extended periods of time.
  - The depth to groundwater is beyond the range commonly associated with groundwater dependence.
  - Soil matric-potential and soil water chemistry indicate plant water abstraction from 0 to 5 mbgl and 6 to 15 mbgl.
  - Measured predawn leaf water potentials for all species are negative. Changes in leaf water potential have reflected changes in soil moisture and matric pressure.
- The estimated soil-water reservoir could sustain the vegetation community for a drought period of approximately nine years.

It is therefore considered very unlikely that any drawdown of groundwater levels below the Coondewanna Flats PEC will impact the community. Increased dust loading is also unlikely to cause an impact (see Section 11.1.4.2). Nevertheless, should subsequent studies indicate that the Coondewanna Flats PEC is groundwater dependent, mitigation measures such as managed aquifer recharge will be implemented.

Section 11.4.7 details potential changes to the surface water catchment for Coondewanna Flats. While there is a 6.9% reduction in total catchment size when the Proposal is implemented, this is considered unlikely to affect the size and frequency of surface water flows reaching Coondewanna Flats as the
majority of flows originate from the northern parts of the catchment that sits outside the Proposed Mining Area C Development Envelope.

Groundwater mounding from injection of water at the Juna Downs MAR borefield has potential to cause groundwater to intersect the tree root zone. Modelling shows that at the proposed injection rates the groundwater level is expected to increase from 22 mbgl to 16 mbgl (BHP Billiton Iron Ore, 2016a). At this level, reduction in root mass is considered unlikely and negative direct (loss of vegetation) or indirect (fragmentation) impacts to the Coondewanna Flats PEC are not expected.

11.1.5 Mitigation and residual impacts

BHP Billiton Iron Ore has carried out a review of the Western Australian Government’s ‘Mitigation Process’, which is detailed in section 3 of the WA Environmental Offsets Guideline (Government of Western Australia, 2014). The four steps are:
- avoid;
- minimise;
- rehabilitate; and
- offset.

Following consideration of all data gathered during baseline surveys, additional targeted surveys and the outcomes of EIAs, BHP Billiton Iron Ore have concluded that impacts to flora and vegetation are not considered significant at a species or population level.

However, BHP Billiton Iron Ore have revised its indicative Proposal designs to ensure that they address the first two steps of the mitigation process, i.e. the designs have ‘avoided’ or ‘minimised’ impacts. The key drivers for revision of the Proposal design was related to other key factors where predicted impacts (pre-mitigation) were considered significant without mitigation, specifically for ghost bat cave avoidance and avoidance of suitable troglofauna habitat. This holistic approach was used to ensure that the overall impact of the Proposal was minimised. Sections 11.2.5 and 11.3.4 provide details of mitigation applied to reduce impacts to ghost bat and troglofauna habitat. As a consequence of the application of mitigation for those aspects, it is likely that impacts to flora and vegetation will be reduced.

The original referral to the OEPA in May 2016 estimated clearing of 19,800 ha, of which 5,942 ha was located in the current Mining Area C EMP Revision 6 Impact Assessment Area. The 19,800 ha of native vegetation clearing was subsequently amended under s43A of the EP Act, with the Consent to a Change to Proposal during Assessment granted by the EPA in April 2017. The revised clearing to be assessed under this Proposal is 19,671.2 ha.

Following implementation of the steps outlined in the Mitigation Process (Government of Western Australia, 2014), native vegetation clearing may be reduced to 15,693 ha (Table 21). BHP Billiton Iron Ore commit to, where practical, restricting disturbance to within the Indicative Modified Impact Assessment Area during detailed mine planning and design and during operations. This results in a potential 20% reduction in proposed clearing at the time of submission of this PER document. Despite the likely impact being less than originally proposed, a total of 19,800 ha of disturbance is still requested to provide flexibility in approach and to ensure that suitable offsets outcomes can be achieved.

Table 21: Summary of clearing before and after mitigation

<table>
<thead>
<tr>
<th>Area</th>
<th>Original Referral (ha)</th>
<th>Following Mitigation (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pits and OSAs</td>
<td>13,000</td>
<td>8,932</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>729.2</td>
<td>819</td>
</tr>
<tr>
<td>Additional disturbance at Mining Area C</td>
<td>5,942</td>
<td>5,942</td>
</tr>
<tr>
<td>Total</td>
<td>19,671.2</td>
<td>15,693</td>
</tr>
</tbody>
</table>
MINING AREA C - SOUTHERN FLANK
Impacts to flora and vegetation following mitigation

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment
Indicative Additional Impact Assessment Area
Modified Indicative Additional Impact Assessment
BHP Billiton Rail
Great Northern Highway

Significant Flora Populations
- Aristida lazaridis (P2)
- Aristida jerichoensis var. subspinulifera (P3)

Significant Vegetation Association
- Grevillea saxicola (P3)
- Nicotiana umbratica (P3)
- Rhagodia sp. Hamersley (M. Trudgen 17794) (P3)
- Rostellularia ascendentis var. latifolia (P3)
- Sida sp. Barlee Range (S. van Leeuwen 1642) (P3)
- Tribodia sp. Mt Ella (M.E. Trudgen 12739) (P3)
- Acacia bromiliwiana (P4)
- Eremophila magnifica subs. magnifica (P4)

BHP BILLITON IRON ORE

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The impact to two Priority flora species recorded in the Indicative Additional Impact Assessment Area may also be reduced. An evaluation of the change of impacts to flora and vegetation with implementation of the modified Indicative Additional Impact Assessment Area is provided in Appendix 4. Actions that may be taken to reduce potential impacts to flora and vegetation are summarised in Figure 19 and Table 22. The residual impact to flora and vegetation as a result of implementation of the Proposal are not considered significant at a species or population level. However, there will be a net loss of vegetation rated Good or above and therefore financial offsets will apply.

Table 22: Actions that may be taken to reduce impacts to flora and vegetation

<table>
<thead>
<tr>
<th>Action Taken</th>
<th>Step in the ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
</table>
| Modification of Indicative Additional Impact Assessment Area | Avoid                            | If clearing is restricted to within the Modified Indicative Additional Impact Assessment Area it will reduce the impact to the following conservation species and vegetation associations:  
  - *Rhagodia* sp. Hamersley – impacts reduced from 11 populations to 4 populations.  
  - *Rostellularia adscendens* var. *latifolia* – impacts reduced from 5 populations to 4 populations.  
  If clearing is restricted to the Modified Indicative Additional Impact Assessment Area it will result in a reduction in the impact to two vegetation associations considered to be ‘Ecosystems at Risk.’ There will be a slight increase of clearing of the third vegetation association (SP AcaoAa ArobDiaChf) by 4 ha. |
| Modification of Indicative Additional Impact Assessment Area | Avoid                            | If clearing is restricted to within the Modified Indicative Additional Impact Assessment Area it will reduce the clearing of vegetation of Very Good or higher condition as follows:  
  - Excellent – clearing reduced from 9,016 ha to 8,081 ha  
  - Very Good – clearing reduced from 658 ha to 469 ha  
  (Note there will be an increase of approximately 55 ha to clearing of vegetation in Pristine condition.) |
| Modification of Indicative Additional Impact Assessment Area | Minimise                         | If clearing is restricted to within the Modified Indicative Additional Impact Assessment Area it will reduce fragmentation of a number of locally significant vegetation associations and those that had more than 50% of their total mapped area in the Indicative Additional Impact Assessment Area. |
| Ongoing Rehabilitation                                    | Rehabilitate                     | BHP Billiton Iron Ore undertakes progressive rehabilitation and ongoing performance assessment in areas where mining operations have been completed and further disturbance is unlikely. Further details are outlined in the Mine Closure Plan (Appendix 12) |

11.1.6 Proposed management approach

11.1.6.1 Internal management approach

The proposed management plan provisions for flora and vegetation due to groundwater change are outlined in Table 57 and Table 58. They include trigger criteria, response actions, monitoring and reporting. It is proposed that these management approaches will be formalised through regulation of an Environmental Management Plan via the Ministerial Statement and BHP Billiton Iron Ore’s standard
Pilbara-wide Health, Safety and Environment system, including the PEAHR process (see Section 10.3) which is based on application of the mitigation heirachy (i.e. avoid, minimise, rehabilitate).

### 11.1.6.2 Regulatory management

Impacts to flora and vegetation will be managed by an environmental management plan regulated through the MS.

### 11.1.6.3 Summary and predicted outcome

Table 23 summarises impacts to flora and vegetation previously assessed under MS 491, additional changes likely to occur following implementation of the Proposal, and the cumulative extent in the Proposed Mining Area C Development Envelope.

In consideration of the outcomes of the EIA and proposed management measures, BHP Billiton Iron Ore propose that flora and vegetation representation, diversity, viability and ecological integrity at the species, population and community level can be maintained. BHP Billiton Iron Ore are therefore confident that the EPA objective for flora and vegetation can be met and that residual impacts to vegetation representation, diversity, viability and ecological integrity at the species, population and community level are not significant. BHP Billiton Iron Ore recognise that there will be a net loss of good or above rated vegetation and populations of conservation significant flora and therefore consider that financial offsets are applicable to address this net loss (see Section 11.8).

<table>
<thead>
<tr>
<th>Indicative Additional Impact Assessment Area</th>
<th>Mining Area C EMP Revision 6 EMP Impact Assessment Area</th>
<th>Cumulative Extent in Proposed Mining AREA C Development Envelope (without Mitigation)</th>
<th>Cumulative Extent in Proposed Mining Area C Development Envelope (with Mitigation)</th>
</tr>
</thead>
</table>
| Eight species or priority flora recorded in the Indicative Additional Impact Assessment Area:  
  - *Acacia bromilowiana* (P4)  
  - *Aristida jerichoensis var. subspinulifera* (P3)  
  - *Aristida lazaridis* (P2)  
  - *Eremophila magnifica subsp. magnifica* (P4)  
  - *Rhapodia sp.* Hamersley (M. Trudgen 17794) (P3)  
  - *Rostellularia adscendens var. latifolia* (P3)  
  - *Sida* sp. Barlee Range (S. van Leeuwen 1642) (P3)  
  - *Triodia sp.* Mt Ella (M.E. Trudgen 12739) (P3) | Six Priority flora present within the Approved Mining Area C (Northern Flank) Development Envelope. Six species recorded within the EMP Revision 6 Assessment Area:  
  - *Aristida jerichoensis var. subspinulifera* (P3)  
  - *Aristida lazaridis* (P2)  
  - *Eremophila magnifica subsp. magnifica* (P4)  
  - *Nicotiana umbratica* (P3)  
  - *Rhapodia sp.* Hamersley (M. Trudgen 17794) (P3)  
  - *Rostellularia adscendens var. latifolia* (P3) | Ten Priority flora in the Proposed Mining Area C Development Envelope:  
  - *Acacia bromilowiana* (P4)  
  - *Aristida jerichoensis var. subspinulifera* (P3)  
  - *Aristida lazaridis* (P2)  
  - *Eremophila magnifica subsp. magnifica* (P4)  
  - *Grevillea saxicola* (P3)  
  - *Nicotiana umbratica* (P3)  
  - *Rhapodia sp.* Hamersley (M. Trudgen 17794) (P3)  
  - *Rostellularia adscendens var. latifolia* (P3)  
  - *Sida* sp. Barlee Range (S. van Leeuwen 1642) (P3)  
  - *Triodia sp.* Mt Ella (M.E. Trudgen 12739) (P3) | Ten Priority flora in the Proposed Mining Area C Development Envelope:  
  - *Acacia bromilowiana* (P4)  
  - *Aristida jerichoensis var. subspinulifera* (P3)  
  - *Aristida lazaridis* (P2)  
  - *Eremophila magnifica subsp. magnifica* (P4)  
  - *Grevillea saxicola* (P3)  
  - *Nicotiana umbratica* (P3)  
  - *Rhapodia sp.* Hamersley (M. Trudgen 17794) (P3)  
  - *Rostellularia adscendens var. latifolia* (P3)  
  - *Sida* sp. Barlee Range (S. van Leeuwen 1642) (P3)  
  - *Triodia sp.* Mt Ella (M.E. Trudgen 12739) (P3) |
### 11.2 Terrestrial fauna

#### 11.2.1 EPA objective

The EPA applies the following objective, according to the *Statement of Environmental Principles, Factors and Objectives* (EPA, 2016), in its assessment of proposals that may affect terrestrial fauna:

> To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

#### 11.2.2 Relevant legislation, guidelines and policies

The discussion of the existing environment, impacts and management of terrestrial fauna in the Proposed Mining Area C Development Envelope has been compiled in consideration of relevant state legislation and EPA policies and guidance. Table 7 details the relevant EPA documents as identified in
the Mining Area C – Environmental Scoping Document (OEPA, 2016) and their relevance to this Proposal.

11.2.3 Existing environment

11.2.3.1 Survey effort

Twenty-one vertebrate fauna surveys were undertaken wholly or partially in the Proposed Mining Area C Development Envelope between 1997 and 2016; these comprised seven Level 2 surveys (one or two seasons), five Level 1 surveys and nine targeted surveys (for conservation fauna) (the results of key surveys are shown in Table 24 and locations of survey areas and sites are shown in Figure 20). Targeted surveys for the ghost bat (*Macroderma gigas*) were undertaken in the area containing Mining Area C and Southern Flank between 2010 and 2016 (BatCall WA, 2011, Biologic, 2013, Biologic, 2015b). The following targeted surveys for conservation significant species recorded during baseline surveys or considered likely to occur based on available habitat or regional records have been undertaken within the Additional Development Envelope: northern quoll (*Dasyurus hallucatus*) surveys were undertaken 2012 and 2015 (Biologic, 2013, Biologic, 2016); and surveys for Pilbara olive python (*Laisis olivaceus barroni*) and northern brushtail possum (*Trichosurus vulpecula arnhemensis*) were undertaken in 2015 (Biologic, 2016).

All surveys undertaken post-2004 have been undertaken in accordance with the EPA Guidance Statement 56: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b) and all surveys undertaken post-2010 have been in accordance with the EPA and DEC’s (2010) Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. Where appropriate, surveys for species listed under the Federal Environment Protection and Biodiversity Conservation Act 1999 have considered survey guidelines recommended by the Federal Department of the Environment and Energy (e.g. Commonwealth of Australia, 2010). All areas within the Proposed Mining Area C Development Envelope that have been surveyed for environmental approvals post-2004 have had a minimum of two seasons of survey using a stratified approach such that all landforms and fauna habitats present have been sampled, and to ensure there was adequate geographic coverage. It is also noted that all Level 1 and Level 2 surveys undertaken for BHP Billiton Iron Ore include targeted searches for conservation significant species, and surveys undertaken post-2009 have been undertaken in accordance with BHP Billiton Iron Ore’s Vertebrate Fauna survey guidelines (BHP Billiton Iron Ore, 2016k) which were developed in conjunction with DPaW to ensure consistency in approach for all surveys undertaken for the Company.

A summary of survey information from all Level 2 and targeted surveys is provided in Table 24. Survey effort for all terrestrial fauna surveys undertaken wholly or partially within the Proposed Mining Area C Development Envelope is summarised in Table 25.

A further 18 vertebrate fauna surveys have been undertaken on behalf of BHP Billiton Iron Ore within 10 km of the Proposed Mining Area C Development Envelope (but not overlapping it), which provides contextual information for the area for use in impact assessment.
Table 24: Summary of Level 2 and targeted surveys undertaken within the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Survey</th>
<th>Consultant</th>
<th>Core Area C Biological Study</th>
<th>Area C Deposits D, E and F Biological Survey</th>
<th>Area C-R Deposit fauna Assessment</th>
<th>Area C Mining Operation Environmental Management Plan (Revision 4)</th>
<th>Area C-R Deposit: Bat Assessment</th>
<th>South Flank 2010 Bat Survey</th>
<th>Area C and Surround Fauna Study</th>
<th>South Flank Bat Assessment Survey</th>
<th>Central Pilbara Ghost Bat Assessment</th>
<th>South Flank Targeted Nictu Quoll Survey</th>
<th>BHP Billion - Iron Ore C Southern Flank – Public Environmental Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Single Phase Level 2</td>
<td>Single Phase Level 2</td>
<td>Targeted Survey</td>
<td>Single Phase Level 2</td>
<td>Single Phase Level 2</td>
<td>Targeted Reconnaissance Survey for Bats</td>
<td>Two Phase Level 2</td>
<td>Two Phase Level 2</td>
<td>Targeted Bat Survey</td>
<td>Targeted Bat Survey</td>
<td>Targeted Bat Survey</td>
<td>Targeted Bat Survey</td>
</tr>
<tr>
<td>No. of trapping sites</td>
<td>11</td>
<td>6</td>
<td>0</td>
<td>4 full sites, 2 Elliott only sites.</td>
<td>4 full sites, 1 Funnel / Elliott only site</td>
<td>0</td>
<td>0</td>
<td>12 Sites. 5 run both Phases, 3 run first Phase only, 5 run second Phase only</td>
<td>10 Sites, two Phases</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Trapping site configuration</td>
<td>CALM Pilbara grid</td>
<td>Linear transect or Grid. Varied, inconsistent.</td>
<td>N/A</td>
<td>2 pot trap, 2 funnel, 10 Elliott, 5 Cages</td>
<td>Linear transect or Grid. Varied, inconsistent.</td>
<td>N/A</td>
<td>N/A</td>
<td>Linear transect. 5 Bucket, 5 PVC, 20 Funnel, 20 Elliott, 2 Cage</td>
<td>Linear transect. 5 Bucket, 5 PVC, 20 Funnel, 20 Elliott, 2 Cage</td>
<td>N/A</td>
<td>N/A</td>
<td>20 Cage or large Elliott traps</td>
</tr>
<tr>
<td>Nights trapped</td>
<td>Average of 5.9, range from 5 to 7</td>
<td>7</td>
<td>N/A</td>
<td>3 (3 sites), 4 (1 site)</td>
<td>Average of 5.6, range 4–7</td>
<td>N/A</td>
<td>N/A</td>
<td>6</td>
<td>6–8</td>
<td>N/A</td>
<td>N/A</td>
<td>14</td>
</tr>
<tr>
<td>Cage nights</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
<td>100</td>
<td>48</td>
<td>N/A</td>
<td>N/A</td>
<td>216</td>
<td>280</td>
<td>N/A</td>
<td>N/A</td>
<td>3535</td>
</tr>
<tr>
<td>Elliott nights</td>
<td>1180</td>
<td>840</td>
<td>N/A</td>
<td>185</td>
<td>590</td>
<td>N/A</td>
<td>N/A</td>
<td>2160</td>
<td>2800</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Funnel nights</td>
<td>0</td>
<td>336</td>
<td>N/A</td>
<td>280</td>
<td>149</td>
<td>N/A</td>
<td>N/A</td>
<td>2160</td>
<td>2800</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Bucket nights</td>
<td>265</td>
<td>210</td>
<td>N/A</td>
<td>0</td>
<td>85.5</td>
<td>N/A</td>
<td>N/A</td>
<td>540</td>
<td>700</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>PVC Pipe nights</td>
<td>265</td>
<td>210</td>
<td>N/A</td>
<td>0</td>
<td>85.5</td>
<td>N/A</td>
<td>N/A</td>
<td>540</td>
<td>700</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Pot nights</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
<td>280</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Total Trap nights</td>
<td>1710</td>
<td>1596</td>
<td>N/A</td>
<td>845</td>
<td>958</td>
<td>N/A</td>
<td>N/A</td>
<td>5616</td>
<td>7280</td>
<td>N/A</td>
<td>N/A</td>
<td>3035</td>
</tr>
</tbody>
</table>

7 Small 500 ml ‘pots’ employed as a means of potentially trapping small sub-fossorial taxa.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diurnal search (hrs)</td>
<td>62.5</td>
<td>39.3</td>
<td>Not stated (searched 10 gullies and gorges)</td>
<td>23</td>
<td>5</td>
<td>Not stated</td>
<td>N/A</td>
<td>51.2</td>
<td>152</td>
<td>N/A</td>
<td>N/A</td>
<td>320</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>Nocturnal search (hrs)</td>
<td>10</td>
<td>20</td>
<td>Not stated</td>
<td>5</td>
<td>0</td>
<td>N/A</td>
<td>48</td>
<td>48</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>80</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Bird surveys (hrs)</td>
<td>44</td>
<td>35</td>
<td>N/A</td>
<td>18.5</td>
<td>22</td>
<td>N/A</td>
<td>N/A</td>
<td>35.3</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
<td>40</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Bird survey method</td>
<td>1 hr set-time period survey, 2 x AM, 1 x mid-day, 1 x PM</td>
<td>20 min set time period</td>
<td>N/A</td>
<td>Opportunistic</td>
<td>30 or 60 min set time period</td>
<td>N/A</td>
<td>N/A</td>
<td>20 min set time period</td>
<td>20 min set time period</td>
<td>N/A</td>
<td>N/A</td>
<td>20 min set time period</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Bat recording (nights)</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>23</td>
<td>22</td>
<td>20</td>
<td>N/A</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Bat recording (hrs)</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>5.3</td>
<td>0</td>
<td>Unknown</td>
<td>8</td>
<td>&gt;180</td>
<td>&gt;180</td>
<td>160</td>
<td>N/A</td>
<td>0</td>
<td>&gt;180</td>
</tr>
<tr>
<td></td>
<td>No. Caves Assessed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>47</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Bat survey method</td>
<td>Mist nets</td>
<td>ANABATTM</td>
<td>ANABATTM II, cave searches</td>
<td>ANABATTM</td>
<td>Conducted by Specialized Zoological</td>
<td>ANABATTM SD-1, gully searches, Harp trap, cave entrance examination using video or barrier</td>
<td>ANABATTM II, cave searches</td>
<td>ANABATTM SD-1, gully searches</td>
<td>ANABATTM II and ANABATTM SD-1, gully searches</td>
<td>Animal counts, still camera, video camera, SM2 Songmeter, cave searches</td>
<td>Cave assessment, nocturnal count, video camera, motion detecting camera, SM2</td>
<td>N/A</td>
<td>SM2, cave searches</td>
</tr>
<tr>
<td></td>
<td>Limitations</td>
<td>No cage traps used. Pre-ANABATTM and pre-funnel trap use. Single Phase only. Sites 6 and 11 Elliott traps only.</td>
<td>The cool winter weather is likely to have reduced the number of reptile species recorded.</td>
<td>Fire on 24th November. Sites 1, 3, 4 and 6 affected. Pot traps instead of bucket or pipe. Pot traps not used at Sites 1 and 10.</td>
<td>South-west of survey area was burnt. Trap line configuration and layout varied considerably between sites. Trap line number</td>
<td>Bat survey only</td>
<td>Bird survey only</td>
<td>Bat survey only</td>
<td>Bat survey only</td>
<td>Bird surveys inconsistent between sites.</td>
<td>Prevailing dry conditions may have reduced capture rates.</td>
<td>Not all areas of caves able to be surveyed due to safety or access restrictions</td>
<td>Not all areas of caves able to be surveyed due to safety or access restrictions</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey</td>
<td>Mining Area C Biological Survey</td>
<td>Area C: Deposits D, E and F Biological Survey</td>
<td>Area C Expansion Deposits E and F Assessed</td>
<td>Area C R Targeted Fauna Assessment</td>
<td>Area C Mining Operation Environment Assessment P3 Deposits: Terrestrial Fauna Assessment</td>
<td>Area C Mining Operation Environment Assessment P3 Deposits: Bat Survey and Assessment</td>
<td>South Flank 2010 Bat Survey</td>
<td>Area C and Surrounds Fauna Survey</td>
<td>Southern Flank Vertebrate Fauna Assessment</td>
<td>South Flank Bat Assessment Survey</td>
<td>Central Pilbara Ghost Bat Assessment</td>
<td>Central Pilbara Ghost Bat Assessment: 2014</td>
<td>South Flank Targeted Fauna Survey</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------</td>
<td>-------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------------------------├───</td>
<td>---------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------------</td>
<td>----------------------------------------</td>
<td>---------------------------------</td>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td>Site 6 consisted of Elliotts around a pebble mound. Very limited trapping. Casual bird observations.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td>Australian Bustard is listed as recorded in the appendices, but text specifically says that it was not recorded.</td>
<td>Pit traps are not discriminated so a ratio of 50:50 is assumed. Bat survey conducted by Specialized Zoological (separate report).</td>
<td>Hair trap sites and camera traps were used. Extensive searches of gully systems and gorges for caves suitable for Ghost Bat and Pilbara Leaf-nosed Bat.</td>
<td>Hair trap sites and camera traps were used. Extensive searches of gully systems and gorges for caves suitable for Ghost Bat and Pilbara Leaf-nosed Bat.</td>
<td>24 nights of still camera recording, 4 nights of video camera recording, mn. 48 nights of guano sheets.</td>
<td>24 nights of still camera recording, 4 nights of video camera recording, mn. 48 nights of guano sheets.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24 nights of still camera recording, 4 nights of video camera recording, mn. 48 nights of guano sheets.
Liability
BHP does not warrant that this map is free from errors or omissions. BHP shall not in any way be liable for loss, damage or injury to the user of this map or any other person or organization consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.
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MINING AREA C - SOUTHERN FLANK
Location of Survey Sites and Level 2 Vertebrate Fauna Survey Boundaries undertaken in the Proposed Mining Area C Development Envelope and surrounds

- Proposed Mining Area C Development
- Approved Mining Area C (Northern Flank) Development Envelope
- Additional Development Envelope
- Mining Area C EMP Rev 6 Impact Assessment
- Indicative Additional Impact Assessment Area
- Level 2 Vertebrate Fauna Survey
- Great Northern Highway
- BHP Billiton Rail

Area C Deposits O, E and F Biological Survey, Ecologia (2004b)
Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment, Specialised Zoological (2008)
Area C and Surrounds Vertebrate Fauna Survey, Biologic (2011)

- Mining Area C Biological Survey, Ecologia
- Mining Area C R Deposit Fauna Assessment, ENV (2007)
- Mudlark Vertebrate Fauna Study, Biologic (2016)
- Packsaddle Range Biological Survey, Ecologia (2004a)
- South Flank Targeted Fauna Survey, Biologic (2016)
- South Flank Targeted Northern Quoll Survey, Biologic (2013)
- South Flank to Jinidi Level 2 Vertebrate Fauna Survey, Biologic (2012)
- Southern Flank Vertebrate Fauna Study, Biologic (2011)

- Mudlark Vertebrate Fauna Study, Biologic (2016)
- Packsaddle Range Biological Survey, Ecologia (2004a)
- South Flank Targeted Fauna Survey, Biologic (2016)
- South Flank Targeted Northern Quoll Survey, Biologic (2013)
- South Flank to Jinidi Level 2 Vertebrate Fauna Survey, Biologic (2012)
- Southern Flank Vertebrate Fauna Study, Biologic (2011)

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994
Table 25: Summary of survey effort for terrestrial vertebrate fauna surveys undertaken wholly or partially within the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Trap/ Survey Type</th>
<th>Trap/ Survey Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cage trap</td>
<td>4,739 trap nights</td>
</tr>
<tr>
<td>Elliott trap</td>
<td>13,355 trap nights</td>
</tr>
<tr>
<td>Funnel trap</td>
<td>11,325 trap nights</td>
</tr>
<tr>
<td>Pit trap</td>
<td>6,401 trap nights</td>
</tr>
<tr>
<td>Diurnal search</td>
<td>&gt;751.3 person hours</td>
</tr>
<tr>
<td>Nocturnal search</td>
<td>211 person hours</td>
</tr>
<tr>
<td>Bird survey</td>
<td>194.8 person hours</td>
</tr>
<tr>
<td>Bat survey</td>
<td>101 recording nights/ &gt;721.3 recording hours</td>
</tr>
</tbody>
</table>

Eight short-range endemic (SRE) invertebrate surveys have been undertaken wholly or partially within the Proposed Mining Area C Development Envelope (Table 26; Figure 21). Four completed baseline SRE sampling (collecting all SRE fauna), one undertook both baseline and targeted millipede Antichiropus ‘DIP007’ sampling, one undertook targeted millipede Antichiropus ‘DIP007’ sampling and two completed habitat assessments only (Table 26). All surveys undertaken post-2009 have been undertaken in accordance with the EPA’s (2009) Guidance Statement 20: Sampling of Short Range Endemic Fauna for Environmental Impact Assessment in Western Australia and BHP Billiton Iron Ore’s survey guidance for SREs (BHP Billiton Iron Ore, 2015c) which were developed in conjunction with DPaW and the Western Australian Museum to ensure consistency of survey approach across surveys.

Table 26: SRE fauna and habitat survey effort within the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Survey Area</th>
<th>Author</th>
<th>Survey Dates</th>
<th>Survey Type</th>
<th>SRE Sites</th>
<th>Targeted SRE Sites</th>
<th>Habitat Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area C: A, D, P1 and P3 Deposits</td>
<td>Outback Ecology 2008</td>
<td>April &amp; June 2008</td>
<td>Baseline</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area C: A, D, P1 and P3 Deposits</td>
<td>Outback Ecology 2009</td>
<td>April 2009</td>
<td>Habitat Assessment</td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Area C and Surrounds</td>
<td>Biota 2011a</td>
<td>Feb. &amp; June 2010</td>
<td>Baseline</td>
<td>36</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>South Flank</td>
<td>Biota 2013a</td>
<td>April/ May 2012</td>
<td>Targeted Antichiropus DIP007</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mudlark</td>
<td>Biota 2013b</td>
<td>March &amp; July 2011, &amp; Feb. 2012</td>
<td>Baseline</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Area C</td>
<td>Biologic 2015</td>
<td>Sept. 2014</td>
<td>Habitat Assessment</td>
<td></td>
<td></td>
<td>85</td>
</tr>
<tr>
<td>South Flank</td>
<td>Biologic 2016d</td>
<td>May 2016</td>
<td>Baseline &amp; Targeted A. DIP007</td>
<td>13</td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>

| Totals                                   | 90                      | 43                 | 260             |
Overall, the extent of SRE fauna sampling and habitat assessments within the Proposed Mining Area C Development Envelope can be regarded as sufficient for the purposes of mapping SRE habitats and fauna distributions for the impact assessment, and to meet the requirements of current EPA guidance (Biologic, 2016a). All baseline surveys have used a stratified approach to ensure that all landforms and fauna habitats present have been sampled, and that there is adequate geographic coverage.

11.2.3.2 Habitats

All major fauna habitats present in the Proposed Mining Area C Development Envelope have been sampled during baseline surveys and scored High, Medium or Low using criteria including habitat suitability for conservation significant species and the diversity or uniqueness of the faunal community that it supports. Vertebrate fauna habitat maps were developed by Biologic (2014a) based on a combination of Onshore Environmental’s vegetation mapping at Mining Area C and Southern Flank (Onshore Environmental, 2014) and findings of previous vertebrate fauna surveys that overlap the Proposed Mining Area C Development Envelope.

Nine major fauna habitats occur in the Proposed Mining Area C Development Envelope (Table 27 and Figure 22). There are no habitat types restricted to the Proposed Mining Area C Development Envelope. It is noted that some areas within the Proposed Mining Area C Development Envelope have been cleared or assessed prior to development of fauna habitats (denoted as ‘Unmapped’).

In addition to the major fauna habitats, significant habitat features, such as caves and waterholes, have been recorded across the proposed Mining Area C Development Envelope as part of baseline studies and targeted surveys (e.g. Biologic 2011, 2016c). Visual inspection of caves, nocturnal observations, SongMeter 2 (SM2) bat detectors, scat collection sheets and infrared video recorders were used to evaluate the level of use of the caves by ghost bats during latter surveys, and the relative importance of each cave was determined based on roost suitability (day, night or maternity) and usage.

Sixty-three caves have been recorded in the Proposed Mining Area C Development Envelope. Thirty-three caves suitable for use by ghost bats have been recorded in the Additional Development Envelope and 18 caves in the Mining Area C EMP Revision 6 Impact Assessment Area. These are shown in Figure 26 and discussed in further detail in Section 11.2.4.1.2

Only one semi-permanent waterhole has been recorded in the Proposed Mining Area C Development Envelope, and it occurs in the Additional Development Envelope (Figure 22).

The Coondewanna Flats PEC occurs immediately adjacent to the western boundary of the Proposed Mining Area C Development Envelope. While this PEC is recognised for its unique flora values, Lake Robinson (a component of the PEC) is a large ephemeral water body that provides habitat for water birds during periods of inundation.

The habitats in the Proposed Mining Area C Development Envelope have been classified into seven SRE habitat zones based on landform features, drainage features and vegetation features that influence SRE occurrence (Figure 23 and Table 28). Each zone contains one or several SRE habitat types. The methods and assumptions of this classification system are described in Biologic (2011) (see Appendix 5).
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MINING AREA C - SOUTHERN FLANK
Location of short-range endemic fauna surveys undertaken in the Proposed Mining Area C Development Envelope and surrounds

Proposed Mining Area C Development Envelope
- Approved Mining Area C (Northern Flank) Development Envelope
- Additional Development Envelope
- Mining Area C EMP Rev 6 Impact Assessment Area
- Indicative Additional Impact Assessment Area
- BHP Billiton Rail
- Great Northern Highway

A Survey of the Short Range Endemic Invertebrate Fauna of South Flank to Jinidi, Biota (2013)
- Area C Deposit A, D, P1 and P3 SRE Habitat Assessment, Outback Ecology (2009)
- Area C Habitat Assessment EMP Rev 6 EIA, Biologic (2014)
- Area C and Surrounds Short Range Endemic Invertebrate Fauna Survey, Biota (2011)
- Short Range Endemic Fauna Survey - South Flank, Biota (2011)
- South Flank Baseline and Targeted SRE Invertebrate Fauna Survey, Biologic (2016)
- South Flank Targeted Millipede Survey, Biota (2011)
- Targeted Survey for Short Range Endemic Invertebrate Fauna of Area C West, Biota (2013)

Scale @ A4: 1:180,000
Prepared: M. LYTTLE
Project No: A780/034 REV B
Date: 30/03/2017
Checked: B. BARNETT
Revision: Rev B
Reviewed: S. WILLIAMSON
Figure: 21a

Kilometres
Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

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MINING AREA C - SOUTHERN FLANK

Location of short-range endemic fauna survey sites undertaken in the Proposed Mining Area C Development Envelope and surrounds

- Proposed Mining Area C Development Envelope
- Approved Mining Area C (Northern Flank) Development Envelope
- Additional Development Envelope
- Mining Area C EMP Rev 6 Impact Assessment Area
- Indicative Additional Impact Assessment Area
- BHP Billiton Rail
- Great Northern Highway
- Short-range Endemic Survey Boundary
- Targeted Survey for Short Range Endemic Invertebrate Fauna Survey of Area C West, Biota (2013)
- A Survey of the Short Range Endemic Invertebrate Fauna of South Flank to Jinidi, Biota (2013)
- Area C Habitat Assessment EIA, Biologic (2014)
- South Flank Baseline and Targeted SRE Invertebrate Fauna Survey, Biologic (2015)
- South Flank Targeted Millipede Survey, Biota (2011)
- Area C Deposit A, D, P1 and P3 SRE Survey, Outback Ecology (2009)
- Area C Deposit A, D, P1 and P3 SRE habitat Assessment, Outback Ecology (2009)
- Short Range Endemic Fauna Survey - South Flank, Biota (2011)
- Area C and Surrounds Short Range Endemic Invertebrate Fauna Survey, Biota (2011)
- Targeted Survey for Short Range Endemic Invertebrate Fauna of Area C West, Biota (2013)
- A Survey of the Short Range Endemic Invertebrate Fauna of South Flank to Jinidi, Biota (2013)
- Area C Habitat Assessment EIA, Biologic (2014)
- South Flank Baseline and Targeted SRE Invertebrate Fauna Survey, Biologic (2015)
- South Flank Targeted Millipede Survey, Biota (2011)
- Area C Deposit A, D, P1 and P3 SRE Survey, Outback Ecology (2009)
### Table 27: Fauna habitats in the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Distinguishing Characteristics</th>
<th>Total Area Mapped (ha)*</th>
<th>Proposed MAC Develop Envelope</th>
<th>Additional Develop Envelope</th>
<th>Indicative Additional Impact Assess Area</th>
<th>MAC EMP Rev 6 Impact Assess Area</th>
<th>Cleared (as of Dec 2016)</th>
<th>Habitat Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorge/Gully</td>
<td>Gorges and gullies are rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open (but not as open as Drainage Area or Valleys). Caves and rock pools are most often encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.</td>
<td>4,900</td>
<td>1,564</td>
<td>450</td>
<td>457</td>
<td>393</td>
<td>43</td>
<td>High - Gorge/Gully habitats provide habitat for Pilbara olive python, northern quoll, Pilbara flat-headed blindsnake and Pilbara barking gecko. This habitat type also contains caves that support the local population of ghost bats and cliff face habitats suitable for peregrine falcons.</td>
</tr>
<tr>
<td>Crest/Slope</td>
<td>These fauna habitats tend to be more open and structurally simple than other fauna habitats and are dominated by varying species of spinifex. Common features of these habitats are rocky substrates, often with exposed bedrock, and skeletal red soils. Some Crest/Slope habitats within the Proposed Mining Area C Development Envelope are dissected by rocky gullies. This habitat is usually dominated by <em>Eucalyptus</em> woodlands, <em>Acacia</em> and <em>Grevillea</em> scrublands and <em>Triodia</em> low hummock grasslands. Dolerite Hills are also a part of this habitat type in some sections of</td>
<td>191,987</td>
<td>18,696</td>
<td>5,170</td>
<td>5,916</td>
<td>4,391</td>
<td>1,571</td>
<td>Medium - Provides habitat for the western pebble-mound mouse, which is largely restricted to this habitat type.</td>
</tr>
<tr>
<td>Habitat Type</td>
<td>Distinguishing Characteristics</td>
<td>Total Area Mapped (ha)*</td>
<td>Proposed MAC Develop Envelope</td>
<td>Additional Develop Envelope</td>
<td>Indicative Additional Impact Assess Area</td>
<td>MAC EMP Rev 6 Impact Assess Area</td>
<td>Cleared (as of Dec 2016)</td>
<td>Habitat Value</td>
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<td>---------------</td>
</tr>
<tr>
<td>Minor Drainage Line</td>
<td>These are characterised by sloping sides vegetated with hummock-forming grasses and valley bases dominated by thick Acacia species. Rocky outcropping is common throughout these valleys, and crumbling breakaways form boulder piles in some locations. Previously mapped as Valley in the EMP Revision 6.</td>
<td>11,170</td>
<td>2,886</td>
<td>1,041</td>
<td>1,272</td>
<td>471</td>
<td>156</td>
<td>Low – No conservation significant species restricted to or largely reliant on this habitat type.</td>
</tr>
<tr>
<td>Major Drainage Lines</td>
<td>This habitat is created by episodic rainfall that scours the landscape when draining. Mature river red gums and coolibahs over river pools and open, sandy or gravelly riverbeds characterise this habitat type. The eucalypt species (<em>E. victix</em> and <em>E. camaldulensis</em>) typically contain a number of significant tree hollows used by parrots and owls for roosting and nesting. In ungrazed areas, the vegetation adjacent to the main channel or channels is denser, taller and more diverse than adjacent terrain and can include reed beds around pools.</td>
<td>13,148</td>
<td>63</td>
<td>38</td>
<td>20</td>
<td>&lt;0.1</td>
<td>4</td>
<td>High - Suitable habitat for migratory bird species, including the rainbow bee-eater, as well as a locally high diversity of bird species. Provides potential breeding and foraging sites for the grey falcon and peregrine falcon. Provides habitat and dispersal opportunities for the Pilbara olive python and Pilbara flat-headed blindsnake.</td>
</tr>
<tr>
<td><strong>Habitat Type</strong></td>
<td><strong>Distinguishing Characteristics</strong></td>
<td><strong>Total Area Mapped (ha)</strong></td>
<td><strong>Area (ha)</strong></td>
<td><strong>Habitat Value</strong></td>
<td></td>
<td></td>
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<td>---------------</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stony Plain</strong></td>
<td>These are erosional surfaces of gently undulating plains, ridges and associated foot slopes. They are characterised by open shrubland of mixed acacias and other shrubs (particularly <em>Petalostylis labicheoides</em>) and open spinifex (<em>Triodia pungens</em>) grasslands with abundant coarse fragments up to the size of stones. Trees are mixed, consisting of <em>Eucalyptus xerothermica</em> in association with <em>Acacia aneura</em> and <em>Corymbia hamersleyana</em>. Previously mapped as Stony/Sand Plain in some areas in EMP Revision 6.</td>
<td>47,452</td>
<td>1,607, 1,494, 1,132, 0</td>
<td>Low - Habitat is widespread in the Pilbara region and does not exclusively support any conservation significant species in the Proposed Mining Area C Development Envelope.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mulga</strong></td>
<td>This habitat includes woodlands and other ecosystems in which mulga (<em>Acacia aneura</em>) is dominant, either as the principal acacia or mixed with others. It consists of groves on stony soils with tussock grasses and occasionally spinifex.</td>
<td>38,525</td>
<td>1,203, 629, 849, 149</td>
<td>Medium - Mulga habitat supports the Pilbara flat-headed blindsnake and also supports a relatively unique and diverse faunal assemblage, with numerous species restricted to this habitat type.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sand Plain</strong></td>
<td>Sand Plain habitat is characterised by relatively deep sandy soils supporting dense spinifex grasslands and sparse shrubs. This habitat transitions into patches of mulga in places.</td>
<td>54,862</td>
<td>1,108, 279, 394, 110</td>
<td>Medium - Supports a diverse fauna community, particularly fossorial species, which are usually restricted to this habitat type. (Note that, at a regional scale, this habitat is considered to have high...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitat Type</td>
<td>Distinguishing Characteristics</td>
<td>Total Area Mapped (ha)*</td>
<td>Proposed MAC Develop Envelope</td>
<td>Additional Develop Envelope</td>
<td>Indicative Additional Impact Assess Area</td>
<td>MAC EMP Rev 6 Impact Assess Area</td>
<td>Cleared (as of Dec 2016)</td>
<td>Habitat Value</td>
</tr>
<tr>
<td>------------------------------</td>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Drainage Area/ Floodplain</td>
<td>Characterised by low and sparse vegetation compared to Major Drainage Lines. Consisted of Acacia low woodland sometimes with scattered Eucalyptus xerothermica and Corymbia hamersleyana. The understorey generally lacks density and often consists solely of sparse tussock grassland, often of <em>Cenchrus ciliaris</em> where it has been introduced. The substrate can be sandy in places but generally consists of a loam gravel or stone. Previously mapped as Stony/Sand Plain in some areas in the EMP Revision 6.</td>
<td>36,863</td>
<td>2,284</td>
<td>575</td>
<td>668</td>
<td>469</td>
<td>93</td>
<td>Medium – Provides suitable habitat for a number of conservation significant species, including the Pilbara flat-headed blindsnake. Pilbara olive python may use this habitat during dispersal.</td>
</tr>
<tr>
<td>Hardpan Plain</td>
<td>Gently inclined alluvial plains with shallow loams. Typically covered by low scattered woodlands of mulga in groves arranged at right angles to the direction of sheet water flow. In areas where the hardpan is close to the surface and soil depth is insufficient to support trees, an open scrub may persist.</td>
<td>6,121</td>
<td>13</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Low – May provide habitat for water birds when inundated. No significant species are expected to be reliant on this habitat.</td>
</tr>
<tr>
<td>Unmapped</td>
<td></td>
<td>NA</td>
<td>1,128</td>
<td>28</td>
<td>29</td>
<td>1,011</td>
<td>3,261</td>
<td>NA</td>
</tr>
</tbody>
</table>
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Vertebrate Fauna Habitats and Key Habitat Features within the Proposed Mining Area C Development Envelope

Scale @ A4: 1:150,000
Prepared: M. LYTTLE
Project No: A780/036 REV B
Date: 30/03/2017
Checked: B. BARNETT
Revision: Rev B
Reviewed: S. WILLIAMSON

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 impact Assessment Area
Indicative Additional Impact Assessment Area

Vertebrate Fauna Habitat Locations
- Cave
- Waterhole
- Artificial Ghost Bat Roost
- BHP Billiton Rail
- Great Northern Highway

Vertebrate Fauna Habitat
- Cleared
- Not mapped
- Drainage Area/Floodplain
- Gorge/Gully
- Hardpan Plain
- Hillcrest/Hillslope
- Major Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Sand Plain
- Stony Plain

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Table 28: SRE habitat zones in the Proposed Mining Area C Development Envelope

<p>| Habitat Zone                      | Distinguishing Characteristics                                                                                                                                                                                                                                                                                                                                 | Habitat Suitability Rank*                                                                 | Proposed MAC Develop Envelope | Additional Development Envelope Area | Area (ha) Indicative Additional Impact Assessment Area | Mining Area C EMP Rev 6 Impact Assessment Area | Cleared |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|-----------------------------------------------|-----------------------------------------------|---------|
| <strong>Major gorge/gully systems</strong>    | Comprises a series of massive, deeply incised gorge/deep gully/ chasm systems occurring only in the more mountainous areas. They feature interconnected rocky habitats, such as gorges/deep gullies, ridges/breakaways, scattered rocky outcrops/boulder piles, and wide expanses of shallow/open gullies leading down the steep, open faces. | 5 – High (south facing) 4 – Moderate/ High (north facing) | 903                             | 449                                 | 378                                 | 239                                           | 19                                           |         |
| <strong>River gorges</strong>                 | Comprises deeply incised low to moderate gorges carved by moderate or major drainage lines, where the base of the gorge is relatively flat, and the vertical or near vertical faces offer consistent shade. It forms in highly mountainous areas, usually at the base of steep slopes, or in deeply incised rolling hills. The habitat types in this zone may include gorges/deep gullies, drainage lines, drainage foci, and ridges/breakaways in areas where one face is more deeply incised than another. | 5 - High | 128                             | 0                                  | 0                                  | 18                                            | 15                                           |         |
| <strong>Shallow open gullies/ridges</strong>  | Comprises all other gully/valley systems and moderate to tall ridgelines that are not considered to be major gorge/gully systems or river gorges. The dominant habitat types in this zone are shallow/ open gullies and ridges/breakaways, which vary from moderate-low to high suitability, depending on slope, aspect, the abundance of rocky outcropping, and vegetation structure and density. At the landscape scale, this zone forms a reasonably well-connected network. | 3 - Moderate | 3,124                            | 769                                 | 1,087                               | 353                                           | 78                                           |         |</p>
<table>
<thead>
<tr>
<th>Habitat Zone</th>
<th>Distinguishing Characteristics</th>
<th>Habitat Suitability Rank</th>
<th>Proposed MAC Develop Envelope</th>
<th>Additional Development Envelope Area</th>
<th>Area (ha) Indicative Additional Impact Assessment Area</th>
<th>Mining Area C EMP Rev 6 Impact Assessment Area</th>
<th>Cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill slopes/crests</td>
<td>Comprises the remaining rocky habitats on open slopes and hill crests that do not feature major outcrops, ridges, or gullies. Such areas generally have skeletal soils and open vegetation (often Triodia hummock grassland with scattered Corymbia/Eucalyptus spp.) that can provide pockets of protection from exposure. Steeper, south-facing hill slopes can also provide some protection.</td>
<td>1 – Low; however, they can contain suitable microhabitats.</td>
<td>15,752</td>
<td>5,170</td>
<td>5,701</td>
<td>2,762</td>
<td>1,104</td>
</tr>
<tr>
<td>Drainage areas</td>
<td>Comprises drainage lines and foci and vegetation groves associated with the major and minor drainage lines. These areas are dominated by dense shrubland and groves/thickets of Acacia (A. aneura (mulga) and other species) and Eucalyptus/Corymbia species; therefore, the majority of SRE habitats are based on vegetation and detritus. Slope and aspect are more or less irrelevant to SRE suitability here; instead, the density and structure of vegetation influences the complexity of detrital microhabitats and the amount of shelter available. Isolation is generally low, as the groves and drainage line habitats form an interconnected network of vegetation-based habitats along the course of the drainage line and floodplains.</td>
<td>2 – Moderate/ Low</td>
<td>3,706</td>
<td>887</td>
<td>1,096</td>
<td>1,147</td>
<td>165</td>
</tr>
<tr>
<td>Habitat Zone</td>
<td>Distinguishing Characteristics</td>
<td>Habitat Suitability Rank*</td>
<td>Proposed MAC Develop Envelope</td>
<td>Additional Development Envelope Area</td>
<td>Area (ha)</td>
<td>Mining Area C EMP Rev 6 Impact Assessment Area</td>
<td>Cleared</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
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<td>-----------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Mulga woodland</td>
<td>Comprises mulga groves that occur on open plains. These areas are distinguished from the surrounding shrubland/grassland of the open plains by providing more shade and a greater abundance of leaf litter and detrital microhabitats. Mulga groves in the Proposed Mining Area C Development Envelope tend to occur on deep clay-loam soils that provide optimal burrowing habitats for many mygalomorph spiders and scorpions. This zone generally occurs in large or well-connected patches and shares many habitat similarities with the Drainage areas.</td>
<td>2 – Moderate/ Low</td>
<td>1,029</td>
<td>628</td>
<td>729</td>
<td>98</td>
<td>64</td>
</tr>
<tr>
<td>Open plains</td>
<td>Comprises the remaining open, flat habitats on detrital or alluvial plains that do not feature significant groves/thickets, drainage features, or rocky outcrops. Moderately dense shrubland on the plains can provide patches of detrital microhabitats throughout; however, the low levels of habitat complexity, shelter, and isolation generally make these areas unsuitable for SRE species.</td>
<td>1 - Low</td>
<td>4,262</td>
<td>1,774</td>
<td>1,745</td>
<td>771</td>
<td>275</td>
</tr>
<tr>
<td>Unmapped</td>
<td></td>
<td>NA</td>
<td>1,646</td>
<td>28</td>
<td>7</td>
<td>1,605</td>
<td>3,762</td>
</tr>
</tbody>
</table>

* From Biologic (2016a); see Appendix 5.
MINING AREA C - SOUTHERN FLANK
Short-range Endemic Habitat Zones within the Proposed Mining Area C Development Envelope

BHP BILLITON IRON ORE

Scale @ A4: 1:150,000
Prepared: M. LYTTLE
Project No: A780037 REV B
Date: 30/03/2017
Checked: B. BARNETT
Revision: Rev B
Reviewed: S. WILLIAMSON

MINING AREA C - SOUTHERN FLANK
Short-range Endemic Habitat Zones within the Proposed Mining Area C Development Envelope

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area
BHP Billiton Rail
Great Northern Highway

Short-range Endemic Habitats
- Not mapped
- Cleared
- Hill slopes/crests
- Open Plains
- Drainage Areas
- Mulga Woodland
- Shallow Open Gullies/Ridges
- Major Gorge/Gullies
- River Gorge

Projected: Transverse Mercator
Datum: GDA 1994
Coordinate System: Central Project Grid (CPG94)

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11.2.3.3 Existing impacts

Clearing has been undertaken in the Proposed Mining Area C Development Envelope under previously approved Part IV and Part V approvals. As of December 2016, 5,482 ha have been cleared. Less than 50 ha of vertebrate fauna habitats classified as High habitat value have been cleared to date (Table 27). The habitat that has been subjected to the highest amount of clearing is the Crest/Slope habitat. This habitat is considered to have Medium value for vertebrate fauna, which is based on it being the preferred habitat type for the Priority 4 western pebble-mound mouse. Less than 35 ha of SRE habitat mapped as high suitability for SREs have been cleared as of December 2016. It is noted, however, that 3,762 ha of unmapped habitat has also been cleared.

11.2.3.4 Fauna community

Two hundred and forty vertebrate fauna species have been recorded during surveys that overlap the Proposed Mining Area C Development Envelope, comprising 30 native and eight introduced mammals, 108 birds, 86 reptiles and eight amphibians. Database searches and literature reviews suggest that approximately 300 species may occur in the area.

The baseline survey that correlates geographically with the Additional Development Envelope recorded 161 vertebrate fauna species, comprising 26 native and seven introduced mammals, 68 birds, 58 reptiles and two amphibians (Biologic, 2011). A summary of all surveys undertaken in the Proposed Mining Area C Development Envelope and species lists from each of these surveys is provided in Appendix 5.

Eleven conservation significant species have been recorded in the Proposed Mining Area C Development Envelope. A further two species are considered to possibly occur, based on a Naturemap database search undertaken in January 2017 (DPaW, 2017) and other records housed in BHP Billiton Iron Ore’s internal database. Information on these species is provided in Section 11.2.4.1.2.

Thirteen species have been recorded from invertebrate taxonomic groups known to contain SRE species within the Proposed Mining Area C Development Envelope. A number of juvenile or female specimens have also been collected from these groups that have not been identified to species level due to lack of morphological characteristics or suitability to undertake genetic studies (classified as ‘sp indet.’). The groups recorded were: millipedes (Myriapoda); selenopid spiders (Selenopidae); pseudoscorpions (Pseudoscorpiones); mygal spiders (Mygalomorphae) and slaters (Isopods).

Twelve confirmed or potential SRE species have been recorded in the Mining Area C EMP Revision 6 Impact Assessment Area. Four confirmed and one potential SRE invertebrate taxa have been recorded in the Additional Development Envelope with the four confirmed SRE species also being recorded within the Indicative Additional Impact Assessment Area. These species are discussed in detail in Section 11.2.4.1.

11.2.4 Potential impacts

This section summarises potential direct and indirect impacts from mining within the Proposed Mining Area C Development, and specifically, impacts from those activities undertaken within the Indicative Additional Impact Assessment Area and the Mining Area C EMP Revision 6 Impact Assessment Area, and an assessment of potential cumulative impacts at a sub-regional or regional scale, as appropriate, and where information is available. The extents or boundaries used to assess the potential impacts of the Proposal and cumulative or regional extents vary for each factor. Table 29 details the areas assessed for the terrestrial fauna factor.

Information has been summarised from terrestrial vertebrate and SRE invertebrate fauna impact assessments undertaken in 2015 for update of the EMP Revision 6 (Biologic, 2015a; Biota, 2015) and
in 2016 for the Additional Impact Assessment Area (Biologic 2016a, b), and information from a terrestrial vertebrate fauna desktop review undertaken in 2017 (Biologic, 2017). Information from the 2015 impact assessments has been updated, where appropriate, in consideration of changes to species taxonomy, conservation listings or increased knowledge of species ecology or distribution. All supporting documents are provided in Appendix 5.

### Table 29 – Impact Assessment Areas for Terrestrial Fauna

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. including Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial Fauna (vertebrate fauna and SRE invertebrates).</td>
<td>Indicative Additional Impact Assessment Area and Additional Development Envelope. Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>Proposed Mining Area C Development Envelope, including Mining Area C EMP Revision 6 Impact Assessment Area and Indicative Additional Impact Assessment Area.</td>
<td>All areas within the Proposed Mining Area C Development Envelope. For conservation significant fauna this has considered BHP Billiton Iron Ore and third-party footprints identified in BHP Billiton Iron Ore’s Strategic Proposal (BHP Billiton Iron Ore, 2016c). An assessment of ghost bats has been undertaken across the eastern Hamersley IBRA subregion.</td>
</tr>
</tbody>
</table>

### 11.2.4.1 Direct impacts

#### 11.2.4.1.1 Habitats

Vegetation clearing to accommodate development is the most direct impact likely to affect native fauna as it causes direct alteration of the land surface, making it unsuitable as habitat for most species. Implementation of the Proposal will result in the removal of native vegetation, rocks and soil; and the loss of individual fauna, in particular small ground-dwelling mammals and reptiles.

Nine major vertebrate fauna habitats occur in the Proposed Mining Area C Development Envelope, with all of these also occurring in the Indicative Additional Impact Assessment Area (Table 30). Seven of these occur within the Mining Area C EMP Revision 6 Impact Assessment Area, although one of these seven covers less than 0.1% of it.

The most common habitat in the Proposed Mining Area C Development Envelope is the Crest/Slope habitat, comprising approximately 61% of the total area and 53% of the Additional Development Envelope. It also comprises more than half of the Indicative Additional Impact Assessment Area (55%; Table 30). The Crest/Slope habitat is considered to have Medium conservation value, which is based on the fact that it is the primary habitat for the western pebble-mound mouse. Crest/Slope habitat is extremely common in the Hamersley IBRA subregion, with almost 192,000 ha mapped across BHP Billiton Iron Ore tenure alone. Removal of this habitat type is not considered to be significant at a local or regional scale.

The two fauna habitats classified to have high conservation value to vertebrate fauna are Gorge/Gully and Major Drainage Line. Gorge/Gully comprises less than 5% of the Additional Development Envelope and Indicative Additional Impact Assessment Area (Table 30). It is classified as having High value to vertebrate fauna as it provides habitat for a number of conservation significant species in the Pilbara, including the Pilbara olive python and northern quoll. Almost one third of the total mapped area of this habitat type occurs within the Proposed Mining Area C Development Envelope; however, it is also common in surrounding third party tenure to the north and in Karijini National Park to the west. Impacts
to this habitat type are considered moderate as these habitats generally contain caves which ghost bats use as roosts.

The Major Drainage Line habitat comprises less than 1% of the Additional Development Envelope and the Indicative Additional Impact Assessment Area, and less than 0.1 ha occurs in the Mining Area C EMP Revision 6 Impact Assessment Area (Table 30). Impacts to this habitat type are not considered to be significant at a local or regional scale.

**Table 30: Area of major vertebrate fauna habitats in the Impact Assessment Areas**

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Habitat Classification</th>
<th>Total Area Mapped (ha)</th>
<th>Proposed Mining Area C Development Envelope (ha) (Proportion of Total Area Mapped)</th>
<th>Indicative Additional Impact Assessment Area (ha) (Proportion of Total Area Mapped)</th>
<th>EMP Revision 6 Impact Assessment Area (ha) (Proportion of Total Area Mapped)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorge/Gully High</td>
<td>High</td>
<td>4,282</td>
<td>1,564 (32%)</td>
<td>457 (9%)</td>
<td>393 (8%)</td>
</tr>
<tr>
<td>Crest/Slope Medium</td>
<td>Medium</td>
<td>191,807</td>
<td>18,696 (10%)</td>
<td>5,916 (3%)</td>
<td>4,391 (2%)</td>
</tr>
<tr>
<td>Minor Drainage Line</td>
<td>Low</td>
<td>11,170</td>
<td>2,886 (26%)</td>
<td>1,272 (11%)</td>
<td>471 (4%)</td>
</tr>
<tr>
<td>Major Drainage Line</td>
<td>High</td>
<td>13,148</td>
<td>63 (&lt;1%)</td>
<td>20 (&lt;1%)</td>
<td>&lt;0.1 (0%)</td>
</tr>
<tr>
<td>Stony Plain Low</td>
<td>Low</td>
<td>47,452</td>
<td>1,607 (3%)</td>
<td>1,132 (2%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Mulga Medium</td>
<td>High</td>
<td>38,525</td>
<td>1,203 (3%)</td>
<td>849 (2%)</td>
<td>149 (&lt;1%)</td>
</tr>
<tr>
<td>Sand Plain Medium</td>
<td>Medium</td>
<td>54,862</td>
<td>1,108 (2%)</td>
<td>394 (&lt;1%)</td>
<td>110 (&lt;1%)</td>
</tr>
<tr>
<td>Drainage Area/Floodplain Medium</td>
<td>36,863</td>
<td>2,284 (6%)</td>
<td>668 (2%)</td>
<td>469 (1%)</td>
<td></td>
</tr>
<tr>
<td>Hardpan Plain Low</td>
<td>Low</td>
<td>6,121</td>
<td>13 (&lt;1%)</td>
<td>2 (&lt;1%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Unmapped</td>
<td>NA</td>
<td>NA</td>
<td>1,128</td>
<td>29</td>
<td>1,011</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>404,981</strong></td>
<td><strong>30,552 (7%)</strong></td>
<td><strong>10,739 (3%)</strong></td>
<td><strong>6,994 (1%)</strong></td>
</tr>
</tbody>
</table>

Seven SRE habitat zones have been identified in the Proposed Mining Area C Development Envelope. Six of these occur within the Indicative Additional Impact Assessment Area and all occur within the Mining Area C Revision 6 Impact Assessment Area (Table 28 and Table 31). Three of the habitats (Major gorge/gully systems, River gorges and Hill slopes/crests (*Antichiropus* ‘DIP007’ habitat)) are considered to have high suitability for SRE fauna. Approximately 4,239 ha of High suitability SRE habitats occur in the Indicative Additional Impact Assessment Area (a majority of this is habitat for *Antichiropus* ‘DIP007’) and 612 ha of High suitability SRE habitats occur in the Mining Area C EMP Revision 6 Impact Assessment Area (Table 31). Biologic (2015a, 2016) considered that removal of these habitats will likely have a moderate to high impact on SRE fauna.

**Table 31: Area of SRE habitat zones in impact assessment areas**

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Habitat Classification</th>
<th>Proposed Mining Area C Development Envelope (ha)</th>
<th>Additional Development Envelope (ha)</th>
<th>Indicative Additional Impact Assessment Area (ha)</th>
<th>EMP Revision 6 Impact Assessment Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major gorge/gully systems</td>
<td>5 – High</td>
<td>903</td>
<td>450</td>
<td>378</td>
<td>239</td>
</tr>
<tr>
<td>River gorges</td>
<td>5 – High</td>
<td>128</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
</tbody>
</table>
### Habitat Type

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Habitat Classification</th>
<th>Proposed Mining Area C Development Envelope</th>
<th>Additional Development Envelope</th>
<th>Indicative Additional Impact Assessment Area</th>
<th>EMP Revision 6 Impact Assessment Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill slopes/crests (Antichiropus 'DIP007' habitat)</td>
<td>5 – High</td>
<td>7,038</td>
<td>3,518</td>
<td>3,861</td>
<td>355</td>
</tr>
<tr>
<td>Hill slopes/crests (non-Antichiropus 'DIP007' habitat)</td>
<td>1 – Low</td>
<td>8,714</td>
<td>1,652</td>
<td>1,840</td>
<td>2,407</td>
</tr>
<tr>
<td>Shallow open gullies/ridges</td>
<td>3 – Moderate</td>
<td>3,124</td>
<td>768</td>
<td>1,087</td>
<td>353</td>
</tr>
<tr>
<td>Drainage areas</td>
<td>2 – Moderate/Low</td>
<td>3,706</td>
<td>887</td>
<td>1,096</td>
<td>1,148</td>
</tr>
<tr>
<td>Mulga woodland</td>
<td>2 – Moderate/Low</td>
<td>1,029</td>
<td>629</td>
<td>729</td>
<td>98</td>
</tr>
<tr>
<td>Open plains</td>
<td>1 - Low</td>
<td>4,262</td>
<td>1,774</td>
<td>1,745</td>
<td>771</td>
</tr>
</tbody>
</table>

#### 11.2.4.1.2 Conservation significant species

Eleven vertebrate fauna species of conservation significance have been recorded in the Proposed Mining Area C Development Envelope, of which nine have been recorded in the Indicative Additional Impact Assessment Area and eight have been recorded within the Mining Area C EMP Revision 6 Impact Assessment Area (Table 32). A further three species were identified in the database search as occurring within the area and are considered to potentially occur (Table 32).

Four confirmed SRE species, comprising two millipedes and two mygalomorph spiders, have been recorded within the Indicative Additional Impact Assessment Area. A juvenile mygalomorph spider from the Barychelidae family has also been recorded in the Additional Development Envelope and is considered to be a potential SRE (Table 33). Excluding Antichiropus ‘DIP007’, all of the confirmed SRE species have been recorded outside of the Proposed Mining Area C Development Envelope.

Within the Mining Area C EMP Revision 6 Impact Assessment Area three additional confirmed SRE species have been recorded; a millipede, mygalomorph spider and a selenopid spider (Table 33).

Impacts to all conservation significant species recorded or potentially occurring within the Proposed Mining Area C Development Envelope are discussed further below.

**Northern quoll (Dasyurus hallucatus).** The northern quoll is listed as Endangered under the EPBC Act and WC Act, primarily because of the impact of cane toads on populations in the Northern Territory and Queensland and the perceived threat associated with the arrival of cane toads in Western Australia. In addition to this, the northern quoll is susceptible to predation by feral cats, dogs, dingoes and foxes; and reduced population sizes mean they are also vulnerable to other threatening processes, such as habitat loss associated with mining developments and inappropriate fire regimes (Woinarski et al., 2014).
Table 32: Conservation significant vertebrate fauna species recorded in the Proposed Mining Area C Development Envelope or considered to possibly occur

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Conservation Status</th>
<th>Records in the Proposed Mining Area C Development Envelope</th>
<th>Records in the Additional Development Envelope Area</th>
<th>Records in the Indicative Additional Impact Assessment Area</th>
<th>Records in the Mining Area C Revision 6 Impact Assessment Area</th>
<th>Records within 20 km of the Proposed Mining Area C Development Envelope</th>
<th>Locality Records in the Pilbara Area (from BHP Billiton Iron Ore, 2016J).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern quoll <em>Dasyurus hallucatus</em></td>
<td>EPBC Act Endangered WC Act Schedule 2</td>
<td>Scat records from two locations (Biologic, 2011; Biota 2012)</td>
<td>One record</td>
<td>No records</td>
<td>No records</td>
<td>Scats recorded approximately 5 km northwest and a male quoll observed 5 km east.</td>
<td>1,605</td>
</tr>
<tr>
<td>Pilbara leaf-nosed bat <em>Rhinonicterus aurantia</em></td>
<td>EPBC Vulnereble WC Act Schedule 3</td>
<td>Recorded from two locations</td>
<td>One record</td>
<td>One record</td>
<td>One record</td>
<td>One record 6 km north-west, one record 17 km to the south-east.</td>
<td>347</td>
</tr>
<tr>
<td>Pilbara olive python <em>Liasis olivaceus barroni</em></td>
<td>EPBC Act Vulnerable WC Act Schedule 3</td>
<td>Recorded from four locations</td>
<td>Two records</td>
<td>Two records</td>
<td>One record</td>
<td>One record 8 km west, one record 10 km south, one record 1 km southeast, one record 15 km southeast, three records at BHP Billiton Iron Ore’s Jinidi project (20 km east), six records at BHP Billiton Iron Ore’s Yandi project (15 to 20 km north), three records along Weeli Wolli Creek (20 km east).</td>
<td>185</td>
</tr>
<tr>
<td>Species Name</td>
<td>Conservation Status</td>
<td>Records in the Proposed Mining Area C Development Envelope</td>
<td>Records in the Additional Development Envelope Area</td>
<td>Records in the Indicative Additional Impact Assessment Area</td>
<td>Records in the Mining Area C Revision 6 Impact Assessment Area</td>
<td>Records within 20 km of the Proposed Mining Area C Development Envelope</td>
<td>Locality Records in the Pilbara Area (from BHP Billiton Iron Ore, 2016J).</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------</td>
<td>-----------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ghost bat</td>
<td>EPBC Act Vulnerable WC Act Schedule 3</td>
<td>Recorded from 96 locations; 63 caves recorded^2</td>
<td>54 records; 36 caves recorded</td>
<td>49 records; 33 caves</td>
<td>18 caves</td>
<td>Recorded from 171 locations; 35 caves recorded in BHP Billiton Iron Ore tenure.</td>
<td>997</td>
</tr>
<tr>
<td>Grey falcon</td>
<td>WC Act Schedule 3</td>
<td>Recorded from five locations</td>
<td>Three records</td>
<td>Three records</td>
<td>One record 16 km southwest.</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Rainbow bee-eater</td>
<td>EPBC Act Migratory WC Act Schedule 5</td>
<td>Recorded from five locations</td>
<td>One record</td>
<td>No records</td>
<td>Recorded from multiple locations (in excess of 50) from north, south, east and west of the Proposed Mining Area C Development Envelope boundary.</td>
<td>(1958)</td>
<td></td>
</tr>
<tr>
<td>Peregrine falcon</td>
<td>WC Act Schedule 7</td>
<td>Recorded from two locations</td>
<td>No records</td>
<td>No records</td>
<td>Recorded from two locations approximately 11 km west and northwest, and one location at Weeli Wolli Creek approximately 13 km east.</td>
<td>207</td>
<td></td>
</tr>
<tr>
<td>Species Name</td>
<td>Conservation Status</td>
<td>Records in the Proposed Mining Area C Development Envelope</td>
<td>Records in the Additional Development Envelope Area</td>
<td>Records in the Indicative Additional Impact Assessment Area</td>
<td>Records in the Mining Area C Revision 6 Impact Assessment Area</td>
<td>Records within 20 km of the Proposed Mining Area C Development Envelope</td>
<td>Locality Records in the Pilbara Area (from BHP Billiton Iron Ore, 2016J).¹</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>-----------------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fork-tailed swift  <em>Apus pacificus</em></td>
<td>EPBC Act Migratory WC Act Schedule 5</td>
<td>Recorded from five locations.</td>
<td>No records</td>
<td>No records</td>
<td>Recorded from four locations in BHP Billiton Iron Ore's Jinidi project approximately 20 km east of the Proposed Mining Area C Development Envelope boundary.</td>
<td>(37)</td>
<td></td>
</tr>
<tr>
<td>Pilbara flat-headed blind-snake  <em>Anilios ganei</em></td>
<td>DPaW Priority 1</td>
<td>Recorded from four locations</td>
<td>One record</td>
<td>One record</td>
<td>One record approximately 4 km south, and one record approximately 19 km southeast.</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Pilbara barking gecko  <em>Underwoodisaurus seorsus</em></td>
<td>DPaW Priority 2</td>
<td>Recorded from six locations</td>
<td>Recorded from three locations</td>
<td>Recorded from three locations</td>
<td>Three records south (200 m, 11 km and 17 km from the Proposed Mining Area C Development Envelope boundary), one record 20 km southwest, one record 8 km west, and one record 6 km east.</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Western pebble-mound mouse  <em>Pseudomyx chapmani</em></td>
<td>DPaW Priority 4</td>
<td>113 recorded locations</td>
<td>48 records</td>
<td>31 records</td>
<td>36 records</td>
<td>More than 1,000 recorded locations from north, south, east and west of the Proposed Mining Area C Development Envelope boundary.</td>
<td>3,396</td>
</tr>
<tr>
<td>Species Name</td>
<td>Conservation Status</td>
<td>Records in the Proposed Mining Area C Development Envelope</td>
<td>Records in the Additional Development Envelope Area</td>
<td>Records in the Indicative Additional Impact Assessment Area</td>
<td>Records in the Mining Area C Revision 6 Impact Assessment Area</td>
<td>Records within 20 km of the Proposed Mining Area C Development Envelope</td>
<td>Locality Records in the Pilbara Area (from BHP Billiton Iron Ore, 2016).1</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------------</td>
<td>-----------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>-----------------------------------------------------------</td>
<td>-----------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Common greenshank <em>Tringa nebularia</em></td>
<td>EPBC Act Migratory</td>
<td>No records</td>
<td>No records</td>
<td>No records</td>
<td>No records</td>
<td>Identified in Naturemap search (40 km radius; DEC, 2016).3</td>
<td>(145)</td>
</tr>
<tr>
<td>Northern brushtail possum <em>Trichosurus vulpecula arnhemensis</em></td>
<td>WC Act Schedule 3</td>
<td>No records</td>
<td>No records</td>
<td>No records</td>
<td>No records</td>
<td>One record (scat) approximately 2 km west of the Proposed Mining Area C Development Envelope boundary.</td>
<td>214</td>
</tr>
<tr>
<td>Short-tailed mouse <em>Leggadina lakedownensis</em></td>
<td>DPaW Priority 4</td>
<td>No records</td>
<td>No records</td>
<td>No records</td>
<td>No records</td>
<td>Two record approximately 20 km west northwest of the Proposed Mining Area C Development Envelope boundary.</td>
<td>158</td>
</tr>
</tbody>
</table>

1. Caves recorded have been assessed for use by the ghost bat in Section 11.2.4.1.2
2. Numbers in parentheses were not reported in BHP Billiton Iron Ore (2016j).
3. The Naturemap search (DEC, 2016) returned a record for the southwest subspecies of barking owl (*Ninox connivens connivens*), which is a Priority 2 species. This record is considered erroneous and is not discussed further in this assessment.
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Location of conservation significant vertebrate fauna in the Proposed Mining Area C Development Envelope and surrounds

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Minning Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area
BHP Billiton Rail
Great Northern Highway

Significant Fauna Observations
- Fork-tailed Swift (S5)
- Ghost bat (V)
- Grey falcon (S3)
- Northern brushtail possum (S3)
- Northern quoll (E)
- Peregrine falcon (S7)
- Pilbara barking geckos (P2)
- Pilbara flat-headed blind-snake (P1)
- Pilbara leaf-nosed bat (V)
- Pilbara olive python (V)
- Rainbow Bee-eater (S5)
- Western pebble-mound mouse or Ngadj (P4)
- Pilbara flat-headed blind-snake (P1)

Spatial Data - Business Development
BHP BILLITON IRON ORE

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

Inset A

Inset B

Inset C

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_038_E_MAC_Southern_Flank_PER_Map24a_RevC.mxd
Liability

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BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Location of conservation significant vertebrate fauna in the Proposed Mining Area C Development Envelope and surrounds with Habitats

Significant Fauna Observations
- Fork-tailed Swift (S5)
- Ghost bat (V)
- Grey falcon (S3)
- Northern brushtail possum (S3)
- Northern quoll (S)
- Pardine falcon (S7)
- Pilbara barking gecko (P2)
- Pilbara flat-headed blind-snake (P1)
- Pilbara leaf-nosed bat (V)
- Pilbara olive python (V)
- Rainbow dove (S1)
- Western paddle-mound mouse or Ngadj (P4)

Vertebrate Fauna Habitat
- Cleared
- Not mapped
- Drainage Area/Floodplain
- Gorge/Gully
- Hardpan Plain
- Hilltops
- Major Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Sand Plain
- Stony Plain

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

Spatial Data - Business Development
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Location of conservation significant vertebrate fauna in the Proposed Mining Area C Development Envelope and surrounds with Habitats

Scale @ A4: 1:150,000
Prepared: M. LYTTLE
Project No: A780039 REV C
Date: 8/02/2017
Checked: B. BARNETT
Figure: 24b
Revision: Rev C
Reviewed: S. WILLIAMSON

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_039_E_MAC_Southern_Flank_PER_Map24b_RevC.mxd
## Table 33: Confirmed and potential SRE taxa recorded in the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>Taxon</th>
<th>SRE Status</th>
<th>Proposed Mining Area C Development Envelope</th>
<th>Additional Development Envelope</th>
<th>Indicative Additional Impact Assessment Area</th>
<th>EMP Revision 6 Impact Assessment Area</th>
<th>Outside Proposed Mining Area C Development Envelope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Myriapoda</strong></td>
<td></td>
<td><strong>Myriapoda</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Antichiropus ‘DIP006’</em></td>
<td>Confirmed SRE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Antichiropus ‘sp. indet. (juv.)’ (Likely ‘DIP006’)</em></td>
<td>Potential SRE, Likely A. ‘DIP006’,</td>
<td>2</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Antichiropus ‘DIP007’</em></td>
<td>Confirmed SRE</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Antichiropus ‘sp. indet. (juv. and female)’ (Likely ‘DIP007’)</em></td>
<td>Potential SRE, Likely A. ‘DIP007’,</td>
<td>18</td>
<td>8</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><em>Austrostrophus ‘DIP018’</em></td>
<td>Confirmed SRE</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Selenopidae</strong></td>
<td></td>
<td><strong>Selenopidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Karaops banyjima</em></td>
<td>Confirmed SRE</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Karaops ‘sp. indet. (juv.)’</em></td>
<td>Potential SRE</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>?Karaops ‘sp. indet. (juv.)’</em></td>
<td>Potential SRE</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pseudoscorpiones</strong></td>
<td></td>
<td><strong>Pseudoscorpiones</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Synsphyronus ‘PSE014’</em></td>
<td>Confirmed SRE</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mygalomorphae</strong></td>
<td></td>
<td><strong>Mygalomorphae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aname ‘MYG104’</em></td>
<td>Confirmed SRE</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><em>Barychelidae indet. (juv.)</em></td>
<td>Potential SRE</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chenistonia ‘MYG088’</em></td>
<td>Confirmed SRE</td>
<td>3</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxon</td>
<td>SRE Status</td>
<td>Proposed Mining Area C Development Envelope</td>
<td>Additional Development Envelope</td>
<td>Indicative Additional Impact Assessment Area</td>
<td>EMP Revision 6 Impact Assessment Area</td>
<td>Outside Proposed Mining Area C Development Envelope</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------</td>
<td>--------------------------------------------</td>
<td>---------------------------------</td>
<td>---------------------------------------------</td>
<td>--------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Conothele ‘MYG282-DNA’</td>
<td>Confirmed SRE</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Kwonkan ‘MYG339-DNA’</td>
<td>Confirmed SRE</td>
<td>16</td>
<td>15</td>
<td>13</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Missulena langlandsi</td>
<td>Confirmed SRE</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Teyl ‘MYG027’</td>
<td>Confirmed SRE</td>
<td>2</td>
<td></td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Yilgarnia ‘MYG197’</td>
<td>Confirmed SRE</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Isopoda</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spherillo <code>south-flank</code></td>
<td>Potential SRE</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Liability

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Figure: Project No: 1:150,000
Prepared: M. LYTTLE
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Projection: Transverse Mercator
Datum: GDA 1994

MINING AREA C - SOUTHERN FLANK
Location of SRE Invertebrate Fauna in the Proposed Mining Area C Development Envelope

Short-range Endemic Invertebrate Fauna

- Aname 'MYG104'
- Antichiropus 'DIP006'
- Antichiropus 'DIP007'
- Antichiropus indet.
- Austrostrophus 'DIP018'
- Barychelidae indet. (juv.)
- Chemistonia 'MYG088'
- Conothelie 'MYG282-DNA'
- Karaops banyjima
- Karaops indet. (juv.)
- Kwonkan 'MYG339-DNA'
- Missulena langlandsi
- Sphenloc 'south-flank'
- Synsphyronus 'PSE014'
- Teyl 'MYG027'
- Yilgarnia 'MYG197'

Proposed Mining Area C
Approved Mining Area C (Northern Flank) Development Envelope
Mineral Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area
BHP Billiton Rail
Great Northern Highway

Kilometres

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_040_E_MAC_Southern_Flank_PER_Map25a_RevB.mxd
Northern quolls mostly favour rocky habitats (e.g. escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines and treed creek lines) as denning or shelter habitat, and foraging occurs in the vegetated areas surrounding their dens (DSEWPaC, 2011).

The ecology of northern quolls is complex as they use habitats in a variety of ways for denning and foraging, and an individual can use multiple den sites. Northern quolls will den during the day and leave den sites to forage during the night. They are generally considered to be solitary, with females having mutually exclusive denning areas, but can have overlapping foraging areas. Populations fluctuate annually, which is likely to be related to the abundance, dispersion and renewability of food (Oakwood, 2002). Both sexes usually change dens every night, with females each using up to 55 dens (Oakwood, 2008).

There are records of northern quolls from only two locations in the Proposed Mining Area C Development Envelope, and both occur outside the Indicative Additional Impact Assessment Area and the Mining Area C EMP Revision 6 Impact Assessment Area. Evidence of northern quoll has been confirmed in the Proposed Mining Area C Development Envelope from a scat recorded in gorge/gully habitat in the central-western area (Biologic, 2011) and from four fresh scats that are considered likely to be of northern quoll in gorge/gully habitat in the southeast portion of the Additional Development Envelope (Biota, 2012) (Figure 24). Biologic (2013) considered that the presence of scats in the area reflected transient use by northern quolls and may represent a dispersing individual or possibly a breeding male. Regional likelihood mapping undertaken by Biota (2012) considered the Proposed Mining Area C Development Envelope to occur in an area unlikely to support northern quolls, although core habitat for the species (comprising Gorge/Gully and Major Drainage Line habitats; see Figure 22 and Table 27) does occur. Both core habitat and foraging habitat for the northern quoll occurs within the Proposed Mining Area C Development Envelope (Figure 22).

Approximately 1,564 ha of Gorge/ Gully habitat occur within the Proposed Mining Area C Development Envelope, of which 457 ha occur within the Indicative Additional Impact Assessment Area and 393 ha occurs within the Mining Area C EMP Revision 6 Impact Assessment Area (Figure 22). Approximately 63 ha of Major Drainage Line habitat occur within the Proposed Mining Area C Development Envelope, of which 20 ha occur within the Indicative Additional Impact Assessment Area and <0.01 ha occur within the Mining Area C EMP Revision 6 Impact Assessment Area (Figure 22). Suitable foraging habitat comprises the Gorge/Gully habitat and habitats surrounding these areas, often the Major and Minor Drainage Lines. Individuals would likely disperse/ move along Major Drainage Lines. All of these habitats are contiguous with surrounding areas and are not considered to be uncommon in this part of the Hamersley Range.

Given the lack of species records from the area (despite the extent of survey work undertaken for this species within the Proposed Mining Area C Development Envelope and surrounds (13,355 Elliot trap nights, 4,739 cage trap nights, 1,217 camera trap nights, plus extensive diurnal and nocturnal targeted searches (Table 25) over a period of almost 20 years) and the presence of apparently suitable core habitat, it is considered that the northern quoll currently occurs only transiently or at very low density in the Proposed Mining Area C Development Envelope. The magnitude of impacts to the northern quoll arising from implementation of the Proposal is therefore considered minor, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Pilbara leaf-nosed bat (Rhinonicterus aurantia).** The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and WC Act, primarily due to the potential loss of roost sites associated with mining activities, and in particular the recommencement of mining at historically abandoned shafts that have subsequently become important roost sites (DotE, 2016b).
Colonies of the Pilbara leaf-nosed bat are found in three distinct areas: in the mines of the eastern Pilbara, scattered throughout the Hamersley Range in smaller colonies, and in sandstone formations south of the Hamersley Range in a small number of significant colonies (Armstrong, 2001). There are confirmed roosts at Bamboo Creek mine, Copper Hills mine, Klondyke Queen mine, and Lalla Rookh mine; one cave in Barlee Range; and 16 other likely permanent occurrences (DotE, 2016b).

The Pilbara leaf-nosed bat has a very limited ability to conserve heat and water and requires very hot (28 to 32°C) and humid (96% to 100%) roost sites in caves or abandoned mines (Armstrong, 2001). Such caves are relatively uncommon in the Pilbara (Armstrong and Anstee, 2000; Armstrong, 2001), which limits the availability of diurnal roosts for this species.

There are records of Pilbara leaf-nosed bat from only two locations in the Proposed Mining Area C Development Envelope, despite extensive baseline and targeted surveys for conservation significant bats in the area and the presence of apparently suitable habitat. Records are from a single call recorded from a cave in the central-east of the Proposed Mining Area C Development Envelope and from a cave in the western end of the Additional Development Envelope (Figure 24). Both records were considered to come from a single itinerant or dispersing individual from either the well-documented Koodaideri roost some 35 km north or the Kalgan Creek roost approximately 76 km southeast (B. Bullen, Bat Call WA, pers. comm., 2014). With these being the only records from the extensive bat survey effort previously completed in the Proposed Mining Area C Development Envelope and surrounding locality, the data strongly suggest there are no roost sites or important foraging areas for this species present. The magnitude of impacts arising from implementation of the Proposal is therefore considered minor, and it is very unlikely that implementation of the Proposal will result in a change to the Pilbara leaf-nosed bat’s conservation status.

Ghost bat (*Macroderma gigas*). The ghost bat has recently been listed as Vulnerable under both the EPBC Act and WC Act (2015 and 2016, respectively). The key threats to this species have been identified as habitat loss from mining, either due to destruction or disturbance of roost sites and nearby areas or to collapse or reworking of old mine adits; disturbance of breeding sites, primarily due to human visitation; modification to foraging habitat; and mortality from cane toad ingestion (Threatened Species Scientific Committee, 2016). An assessment of potential impacts to the ghost bat arising from implementation of the Proposal has been completed by Biologic (2016b) in conjunction with Bat Call WA (Appendix 5). The impact assessment has been developed considering the results of ghost bat studies undertaken for BHP Billiton Iron Ore since 2011 and was peer reviewed by Mr Norm McKenzie, a wildlife researcher with over 45 years’ experience (McKenzie, 2016; see Appendix 5). Results from this assessment are summarised below.

The ghost bat occurs across northern Australia from the Pilbara region of Western Australia to central Queensland. In the Pilbara bioregion, it occurs in all four IBRA subregions, with a majority of the population occurring in the Chichester subregion. Here, most populations occur in disused mines where up to 500 bats are known to occur. In the Hamersley subregion, populations are more widespread and much smaller in size with most occurring in natural roosts. A recent estimate of its population size within the Pilbara has been given as 1300-2000 individuals (Threatened Species Scientific Committee, 2016); Biologic & BatCall WA (2014) estimated the Hamersley subregion to contain 300-400 individuals. Preferred habitat is typically deep, complex caves beneath bluffs or low rounded hills composed of Marra Mamba Iron Formation or Brockman Iron Formation or in granite tors (Armstrong and Anstee, 2000). It has a varied diet comprising primarily mammals and birds, although reptiles and invertebrates are also consumed (Biologic & BatCall WA, 2014).

Previous studies by Worthington Wilmer *et al.* (1994) have indicated that across Australia the ghost bat is restricted to a few, highly disjunct maternity sites and that females have strong and long-term female
philopatry\(^8\). Further studies undertaken by Worthington Wilmer et al. (1999) included sampling from the Chichester Range in the Pilbara region, and indicated that gene flow is male-mediated in the ghost bat. Ghost bats move between a number of caves seasonally, or as dictated by weather conditions, and require a range of cave sites (Hutson et al., 2001). Outside the breeding season, male bats are known to disperse widely, most likely during the wet season when conditions would allow bats to use caves that would otherwise not be suitable. Within the Hamersley subregion, Armstrong and Anstee (2000) concluded that there are small groups of ghost bats may move about within a local area and that multiple groups may use a cave. Recent studies in the Hamersley subregion (Appendix 5) suggest that there are no or few centralised maternity roosts, and roosts used by pregnant females are more numerous and may vary across years.

Armstrong and Anstee (2000) refer to the presence of two natural maternity roosts in the Hamersley Range, with one further roost in the Chichester Range. Recent work undertaken by Biologic (in prep.) in conjunction with the University of Queensland has documented the presence of pregnant females at seven caves in BHP Billiton Iron Ore’s tenure in the eastern Hamersley Range during 2014 and 2015. Three occur in the Proposed Mining Area C Development Envelope.

For the purposes of impact assessment and management, all caves in the Proposed Mining Area C Development Envelope, and a subset of caves in adjacent BHP Billiton Iron Ore tenure, have been classified as having High or Low value to ghost bats according to the following criteria:

- Low – considered currently to be used only as a feeding roost or have shown no sign of ghost bat use over multiple years of survey.
- High – All other caves, i.e. has suitable physical attributes for a day or maternity roost, ghost bats may have been recorded in the roost, and scat counts have indicated continual use over a period of years.

A majority of caves outside of the Proposed Mining Area C Development Envelope are unclassified as insufficient data are available to determine importance of the roost.

Sixty-three caves have been recorded to date in the Proposed Mining Area C Development Envelope (Figure 26 and Table 34). Twelve High value and 21 Low value caves (totalling 33 caves) have been recorded in the Indicative Additional Impact Assessment Area and 18 (ten High and eight Low) occur within the Mining Area C EMP Revision 6 Impact Assessment Area (Table 35). In total, 51 caves fall within approved or proposed areas of impact (Mining Area C EMP Revision 6 Impact Assessment Area and Indicative Additional Impact Assessment Area) (Table 34).

The 12 caves located outside the proposed areas of impact are widely spaced (up to 10 km apart); and given that ghost bats appear to move from cave to cave regularly (probably to access emerging high value foraging areas as they exhaust previous foraging areas), without mitigation it is considered unlikely that the ghost bat would persist within the Proposed Mining Area C Development Envelope during active mining operations in similar numbers or at all. Whilst there are numerous caves to the west and north east that may accommodate displaced individuals (21 known caves are within 10 km of the Proposed Mining Area C Development Envelope), this would likely put pressure on the surrounding area that is assumed to be operating at carrying capacity\(^9\). Displaced individuals would likely perish or outcompete other groups.

\(^8\) The tendency of an organism to remain in or habitually return to an area.

\(^9\) The maximum, equilibrium number of organisms of a particular species that can be supported indefinitely in a given environment, given the food, habitat and other necessities available in the environment.
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Location of Ghost Bat Caves in the Proposed Mining Area C Development Envelope and surrounds

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Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area

Bat Caves
- High
- Low
- Unclassified
- Artificial Ghost Bat Roost
- BHP Billiton Rail
- Great Northern Highway

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 Coordinate System: Central Project Grid (CPG94)
 Projection: Transverse Mercator
 Datum: GDA 1994

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_042_E_MAC_Southern_Flank_PER_Map26_RevB.mxd
Table 34: Location of caves in the Proposed Mining Area C Development Envelope and adjacent BHP Billiton Iron Ore tenure

<table>
<thead>
<tr>
<th>Location</th>
<th>No. Caves in area (by classification)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Proposed Mining Area C Development Envelope</td>
<td>25</td>
</tr>
<tr>
<td>Additional Development Envelope</td>
<td>23</td>
</tr>
<tr>
<td>Indicative Additional Impact Assessment Area</td>
<td>12</td>
</tr>
<tr>
<td>Mining Area C EMP Revision 6 Impact Assessment Area</td>
<td>10</td>
</tr>
<tr>
<td>Estimate for Pilbara</td>
<td>Not available</td>
</tr>
</tbody>
</table>

Clearing will reduce the area available for foraging and therefore the removal of habitat could have either a high or low impact on the bats, depending on whether it corresponds with their foraging grounds. For the purposes of impact assessment, areas within 2 km of a ghost bat roost are considered to be foraging habitat (although this may not necessarily correspond with actual areas of foraging; see Appendix 5 for more detail on the determination of foraging areas). It is estimated that 20,920 ha of foraging habitat occurs within the Proposed Mining Area C Development Envelope, of which 8,579 ha (41%) occurs within the Indicative Additional Impact Assessment Area and 6,418 ha (29%) occurs within the Mining Area C EMP Revision 6 Impact Assessment Area. Some of this area will likely be reutilised by ghost bats following rehabilitation (either progressive or at closure), as studies (Biologic, 2015b) indicate that the species has a varied diet that comprises mostly common species (including the house mouse, *Mus musculus*).

It is estimated that the Proposed Mining Area C Development Envelope supports a population of approximately 50 individuals, of which approximately half occurs within the Additional Development Envelope and Indicative Additional Impact Assessment Area and the other half occurs within the Mining Area C EMP Revision 6 Impact Assessment Area. The estimate for the Hamersley IBRA subregion is 300 to 400 individuals, which comprises one genetic population (Spencer and Tedeschi, 2016). Without mitigation, the removal of up to 33 caves in the Indicative Additional Impact Assessment Area may result in a reduction of the Hamersley subregion population by between 6% and 8%. Removal of all caves within the Proposed Mining Area C Development Envelope (51 within all impact assessment areas), may result in a reduction of the Hamersley subregion population by between 12% and 17% and the Pilbara region by less than 1%. It is noted that preliminary genetic studies (Spencer and Tedeschi, 2016) estimated the ghost bat population of the Hamersley subregion to be between 700 and 800 individuals. At a species level, the loss of individuals within the Proposed Mining Area C Development Envelope is considered negligible even without application of mitigation.

Other possible impacts to the ghost bat include:

- **Noise**: Impacts from increased noise are considered to be minor. Noise modelling was undertaken by SVT (2016) (Appendix 9) to determine potential noise levels at the entrances to known caves in the Additional Development Envelope and the Indicative Additional Impact Assessment Area. All levels were predicted to be below 70 dB, with the highest levels ranging between 65 dB and 69.1 dB at three caves: SF15 (High), SF22 (Low) and SF31 (Low). SF15 falls in the Indicative Additional Impact Assessment Area, so it may potentially be removed by mining activities. A study undertaken by Bullen and Creese (2014) suggested that sound levels
up to 70 dB are unlikely to result in ghost bats leaving their roost; therefore, the impacts of mining-related sound emissions are unlikely to be significant.

- **Vibrations:** It is suggested that ghost bats will be able to tolerate vibrations of up to 15 mm/s (R. Bullen, pers. comm.), although there has been no specific research undertaken to support this. Furthermore, it would be very difficult to undertake an assessment of vibration tolerance at Southern Flank given the low likelihood of locating a continual population of bats within a cave for study. A vibration assessment undertaken by SVT (2016) predicted likely vibration levels at various distances for single hole and simultaneous blasting of 10 holes in soft and hard ground types. For 10 blast holes in soft ground, the received vibration levels are predicted to be 3.4 mm/s at 1 km and 0.4 mm/s at 2 km, whilst for hard ground, the received vibration levels are predicted to be 19.6 mm/s at 1 km and 6.9 mm/s at 2 km. It is predicted that at 1.1 km a vibration of 15 mm/s will be experienced. One cave (AC13) is located approximately 1.1 km from mining operations at Hope Downs 1. This cave continues to be used by ghost bats, and hormone analysis shows that pregnant females were using this cave in 2014 (Biologic, in prep). It is considered highly likely that the soft ground type would be applicable to caves at Southern Flank, based on current geological knowledge. The impacts of vibrations on retained caves are considered to be low.

- **Dust:** Vegetation clearing, mining, hauling and vehicle movements will result in an increase in airborne particulate matter. A result of this could be a decline in vegetation quality, although no prior studies have been able to detect a significant adverse impact of airborne dust on plant function in the Pilbara (Grierson, 2015). If vegetation was to be affected this could impact faunal assemblages by reducing both food and habitat resources. Even though ghost bats detect prey via sound, they also have excellent vision and it is possible that high dust levels could irritate their eyes or reduce vision and affect their ability to capture prey. The dust modelling for the Proposal (Pacific Environment, 2016) indicates that high dust events are likely at certain locations and times; however a low risk rating is predicted for the majority of the year. Continued implementation of existing dust suppression strategies will result in a low likelihood of the ghost bat being affected by dust.

- **Infrastructure:** Ghost bats are known to become entangled in barbed wire due to their low elevation flying pattern (Armstrong and Anstee, 2000). Recently, a mummified adult male was retrieved from a barbed wire fence in the Juna Downs pastoral lease (Biologic, in prep). The use of barbed wire fencing within mining areas is limited to areas required to comply with safety guidelines such as for use in explosive storage. The impacts from infrastructure are considered negligible.

- **Invasive species:** There is recent evidence that ghost bats predate on cane toads and are susceptible to their toxicity (Purtill 2014; White *et al*., 2016). If cane toads expand into the Pilbara (as predicted by some models e.g. Urban *et al*., 2007; Kearney *et al*., 2008; Molloy *et al*., 2015) populations in the Chichester sub-region (where populations are at their highest) will be particularly susceptible. Mining activity may assist in the rate of spread of cane toads, through vehicle movements and available surface water in the form of turkey nests and waste water treatment facilities. No dewatering discharge is planned for the Proposal. Other invasive species such as buffel grass (*Cenchrus ciliaris*), or any plant species that excludes native species, may degrade habitat in the area, however this is considered unlikely to impact on the ghost bat. Standard weed control measures will assist in reducing the impact of introduced plant species. Disturbance and mining activities (such as refuse disposal) may increase populations of the introduced house mouse (*Mus musculus*), which appears to form a significant component of the ghost bat diet in the Hamersley subregion. The impacts of invasive species
facilitated by mining activities are considered to be low. The impacts of cane toads can be reduced by onsite management.

The magnitude of impacts from implementation of the Proposal is considered unlikely to be significant to the ghost bat at a species or a population\textsuperscript{10} level (McKenzie, 2016), and implementation of the Proposal is unlikely to result in a change to its conservation status. Implementation of the Proposal will likely have a significant impact on the ghost bat at an assemblage\textsuperscript{11} level during the period of mining operations. With mitigation, the long-term impact to the ghost bat assemblage within the Proposed Mining Area C Development Envelope is considered to be moderate.

**Pilbara olive python** (*Liasis olivaceus barroni*). The Pilbara olive python is listed as Vulnerable under both the EPBC Act and WC Act. Threats to the Pilbara olive python include predation of juveniles and prey species by cats and foxes (noting that impacts from foxes predominantly occur in the coastal regions), loss of habitat to gas and mining developments, deliberate killing by humans (either as road kills or mistaken identification as a brown snake), and degradation of water holes due to tourism (Threatened Species Scientific Committee, 2008; DotE, 2016c).

The Pilbara olive python is primarily nocturnal and tends to shelter in small caves or under vegetation during the day, although it is occasionally active after sunrise, particularly in the warmer summer months (DotE, 2016c). In the winter months, adult pythons can sometimes be found basking in the morning sun (DotE, 2016c). The breeding season of the Pilbara olive python extends from June to August, when males will travel up to 3 km in search of a mate (DotE, 2016c). There are limited studies on this species’ home range, but those that have been undertaken estimate it to be between 88 and 449 ha (DotE, 2016c).

The Pilbara olive python is known from a number of sites throughout the Pilbara and is associated with drainage systems, including areas with localised drainage and semi-permanent watercourses (DotE, 2016c). In the Hamersley IBRA subregion, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DotE, 2016c).

There have been four records of the Pilbara olive python within the Proposed Mining Area C Development Envelope. Within the Indicative Additional Impact Assessment Area there has been a single confirmed record (a dead individual), as well as probable scats from two locations. There is suitable habitat present in the form of Gorge/Gully habitat throughout much of the Proposed Mining Area C Development Envelope, including the Additional Development Envelope (Table 27), although only one near-permanent water hole has been recorded during baseline and targeted surveys (Figure 22). While there is ample potential habitat for this species in the Proposed Mining Area C Development Envelope and surrounding areas, there are relatively few records from this region of the Hamersley Range (Table 32). This may, however, reflect the difficulties in recording this species rather than the scarcity of pythons, as the species is not easy to survey and is largely nocturnal.

The key impact to the Pilbara olive python arising from implementation of the Proposal is loss of habitat; approximately 1,564 ha of Gorge/Gully habitat occur within the Proposed Mining Area C Development Envelope, of which 457 ha occur within the Indicative Additional Impact Assessment Area and 393 ha occur within the Mining Area C EMP Revision 6 Impact Assessment Area (Table 30).

\textsuperscript{10} Population is defined as all the individuals of one species in a given area. For the purposes of this impact assessment, the population is defined as the population within the Hamersley subregion, as genetic studies indicate gene flow occurs across the subregion.

\textsuperscript{11} The definition of assemblage adopted for this impact assessment is: the smallest functional community of plants or animals. This is considered to be the group of ghost bats residing within the Proposed Mining Area C Development Envelope.
Fragmentation of Pilbara olive python habitat will occur at a local level due to construction of pits and OSAs, but rehabilitation of these areas will reduce this impact upon closure. As Pilbara olive pythons will readily cross roads and infrastructure areas, fragmentation impacts from construction and operation of roads and conveyors are unlikely to be significantly different from operations approved under MS 491.

Other key impacts to the Pilbara olive python, including predation of juveniles and prey species and deliberate killing by humans, are unlikely to be increased by implementation of the Proposal, provided current management programs are maintained.

The magnitude of impacts to the Pilbara olive python arising from implementation of the proposal is considered minor, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Grey falcon (Falco hypoleucus).** The grey falcon is listed as Vulnerable under the WC Act, primarily due to the species’ very low estimated population size (less than 1,000 individuals) and low number of estimated breeding pairs (200 to 350) (Garnett et al., 2011). Evidence of recent declines in the species is, however, lacking (Reid and Fleming, 1992).

Threatening processes are not well understood for this species and are largely speculative. They include grazing by introduced herbivores, which has resulted in habitat degradation; clearing for agriculture; and introduction of watering points that may have favoured the more mesic-adapted peregrine falcon (Garnett et al., 2011).

The grey falcon tends to have a distribution centred on ephemeral or permanent drainage lines (Garnett et al., 2011) with numerous records from the Fortescue Marsh region. Grey falcons prefer sparsely treed, open plains and drainage lines for hunting and typically nest in the abandoned nest of a raptor or corvid (Slater et al., 2009) in trees or man-made structures, most notably repeater towers. It is a highly mobile and dispersive or migratory species, wintering in northern Australia and dispersing towards the coast during droughts (Marchant and Higgins, 1993).

This species has been recorded from five locations in the Proposed Mining Area C Development Envelope. Three of these records are from the Additional Development Envelope and the Indicative Additional Impact Assessment Area (Table 32) and were all recorded during January/February 2008 (ENV Australia, 2008). The remaining two records were made along Packsaddle Range in 2004 (ecologia, 2004b). The records within the Proposed Mining Area C Development Envelope likely reflect the nomadic nature of the species; and this, along with the relatively small amount of suitable habitat (ephemeral or permanent drainage lines, i.e. Major Drainage Line habitat), suggests that there is unlikely to be a permanent or regular presence in the Proposed Mining Area C Development Envelope.

The magnitude of impacts to the grey falcon arising from implementation of the Proposal is therefore considered negligible, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

**Rainbow bee-eater (Merops ornatus).** The rainbow bee-eater is listed as Migratory under the EPBC Act and under Schedule 5 of the WC Act. It is not considered threatened: the IUCN listing for this species is Least Concern, and it is not discussed in the Action Plan for Australian Birds 2010 (Garnett et al., 2011). It is extremely common and widespread in Western Australia and the Pilbara region (Biota, 2015a).

The rainbow bee-eater has been recorded from five locations in the Proposed Mining Area C Development Envelope. One record is from the Additional Development Envelope, but outside of the Indicative Additional Impact Assessment Area. Three records occur within the Mining Area C EMP Revision 6 Impact Assessment Area. There are over 135,000 records nationally for this species.
There are no breeding records of this species from the Proposed Mining Area C Development Envelope, and breeding habitat (sandy banks) is limited in it. The magnitude of impacts to the rainbow bee-eater arising from implementation of the Proposal is therefore considered negligible, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

Pilbara flat-headed blindsnake (*Anilios ganei*). The Pilbara flat-headed blindsnake is endemic to the Pilbara region and is currently listed as a Priority 1 species by the DPaW. It is a fossorial species, and little is known about its ecology, but it appears to occur in a range of habitats: Wilson and Swan (2010) state that it is associated with moist gorges and gullies, and Biologic (2014) has identified it as potentially occurring in the Calcrete Areas, Mulga, Crest/Slope and Gorge/Gully habitats mapped in BHP Billiton Iron Ore tenure. It was originally listed because it was known from just a few scattered records, but this species has now been more recently recorded from 84 records in the region, including in the Millstream-Chichester National Park. Given the distribution of known records and habitats known to support this species, it almost certainly occurs in Karijini National Park; the absence of records is likely due to limited sampling.

The Pilbara flat-headed blindsnake has been recorded from five locations in the Proposed Mining Area C Development Envelope, of which one record occurs in the Additional Development Envelope and three occur within the Mining Area C EMP Revision 6 Impact Assessment Area (Figure 24). Habitat types suitable for this species (especially Mulga (1,203 ha within the Proposed Mining Area C Development Envelope; 849 ha within the Indicative Additional Impact Assessment Area), Crest/Slope (18,696 ha within the Proposed Mining Area C Development Envelope; 5,916 ha within the Indicative Additional Impact Assessment Area), and Gorge/Gully (1,564 ha within the Proposed Mining Area C Development Envelope; 457 ha within the Indicative Additional Impact Assessment Area; 4,391 ha within the Mining Area C EMP Revision 6 Impact Assessment Area) and Gorge/Gully (1,564 ha within the Proposed Mining Area C Development Envelope; 457 ha within the Indicative Additional Impact Assessment Area; 393 ha within the Mining Area C EMP Revision 6 Impact Assessment Area) are relatively common in the Proposed Mining Area C Development Envelope outside of the impact assessment areas (Table 30). These habitats are also widespread and common outside the Proposed Mining Area C Development Envelope (Table 30). Based on the low number of records in the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area and the availability of suitable habitat for this species outside of it, including in the conservation estate, the magnitude of impacts to the Pilbara flat-headed blindsnake arising from implementation of the Proposal is considered to be minor, and it is very unlikely that implementation of the Proposal will result in a change to its conservation status.

Pilbara barking gecko (*Underwoodisaurus seorsus*). The Pilbara barking gecko is a relatively recently described species (having been distinguished from the more widespread and common *Underwoodisaurus milli*) that is endemic to the Pilbara and is currently listed as a Priority 2 species by the DPaW. It is believed to be rare and has a relatively small distribution for a vertebrate (Doughty and Oliver, 2011), with current records spanning a distance of approximately 240 km. It is unknown whether its distribution is continuous between these areas or if it occurs as a series of isolated populations. It is a saxicoline (rock-loving) species; and given the amount of available habitat, it is considered very likely that there are additional occurrences in this known range (including in Karijini National Park). It is, however, considered unlikely that its distribution is much larger than the current range estimate and probably does not extend beyond the Hamersley IBRA subregion. Further, it appears to be a relictual species, and the possible effects of increases in global temperature in the coming decades are of particular concern (Doughty and Oliver, 2011).

The Pilbara barking gecko has been recorded from six locations in the Proposed Mining Area C Development Envelope; three of these locations occur in the Additional Development Envelope (three
in the Indicative Additional Impact Assessment Area) and three occur within the Mining Area C EMP Revision 6 Impact Assessment Area.

All the records in the Proposed Mining Area C Development Envelope occur in or adjacent to Minor Drainage Line habitat (2,886 ha within the Proposed Mining Area C Development Envelope; 1,272 ha within the Indicative Additional Impact Assessment Area and 471 ha within the Mining Area C EMP Revision 6 Impact Assessment Area) or Gorge/Gully (1,564 ha within the Proposed Mining Area C Development Envelope; 457 ha within the Indicative Additional Impact Assessment Area and 393 ha within the Mining Area C EMP Revision 6 Impact Assessment Area) habitats. These habitats are relatively common within its range and also occur in Karijini National Park. There is also evidence that this species will inhabit caves (M. O’Connell, Biologic, pers. comm., [2015]).

The approximate distribution for the Pilbara barking gecko is 643,500 ha, with over half of this area occurring in Karijini National Park. Habitat mapping is not available for this area, but it is estimated that approximately 90,000 ha within its range comprises core habitat for the species. The removal of an additional 1,460 ha (less than 2% of estimated core habitat) is therefore considered unlikely to have a significant impact on the species.

BHP Billiton Iron Ore recognises that the Pilbara barking gecko is a range-restricted species that will require management to ensure that the EPA’s environmental objectives are met. However, the impacts to habitat for the Pilbara barking gecko arising from implementation of the Proposal are considered to be minor, and it is considered unlikely that implementation of the Proposal will result in a change to its conservation status.

**Western pebble-mound mouse (Pseudomys chapmani)**. The western pebble-mound mouse is listed as a Priority 4 species by the DPaW, as this species has experienced a significant decline in its range from the Gascoyne and Murchison regions and is now largely restricted to the Pilbara region (van Dyck and Strahan, 2008). The species is listed as Least Concern in the *Action Plan for Australian Mammals*, and threats from mining activities are not considered a significant threatening process for the species (Woinarski et al., 2014).

The characteristic mounds constructed by colonies of these mice are commonly recorded in the region, and the species has been recorded during all surveys conducted in the Proposed Mining Area C Development Envelope (excluding those for which the scope was to target specific species, e.g. ghost bat and northern quoll). Its preferred habitat includes the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (van Dyck and Strahan, 2008).

The western pebble-mound mouse has been recorded from 113 locations in the Proposed Mining Area C Development Envelope; 48 of these locations occur in the Additional Development Envelope and 36 occur within the Mining Area C EMP Revision 6 Impact Assessment Area. A large component of the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area contains habitat preferred by this species, i.e. Crest/Slope habitat (18,696 ha within the Proposed Mining Area C Development Envelope; 5,916 ha within the Indicative Additional Impact Assessment Area and 4,391 ha within the Mining Area C EMP Revision 6 Impact Assessment Area), but this habitat is also widespread and common outside the Proposed Mining Area C Development Envelope (191,987 ha mapped within BHP Billiton database) (Table 30), including in Karijini National Park. The western pebble-mound mouse is generally considered common within suitable habitat in the Pilbara; and although there will be a loss of a number of mounds following implementation of the Proposal, it is considered very unlikely that this will have a significant impact on the species, and its conservation status is also considered very unlikely to change.
**Antichiropus `DIP007`.** There are five confirmed records of the SRE species *Antichiropus `DIP007`* (representing adult male specimens), and a further 18 records of juvenile or female *Antichiropus* millipedes considered likely to belong to the same species, based on their occurrence in the same, or similar continuous habitats. Thirteen of these records have been recorded outside the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area, and one has been recorded outside of the Proposed Mining Area C Development Envelope (Table 33).

The primary habitat for *Antichiropus `DIP007`* is considered to be the hill Slope/Crest habitats where the mallee eucalypt, *Corymbia hamersleyana*, occurs (Appendix 5). Patches of dense, sheltered leaf litter debris and deep loam soils occurring at the base of these mallee trees on Hill Slope/Crest habitats appears to provide a microhabitat refuge for the millipede species to aestivate within. Limited dispersal downslope from Hill Slope/Crest habitats where *Corymbia hamersleyana* (mallee form) occurs may be evident from pitfall trapped specimens in nearby gullies, minor drainage lines, and Mulga groves, but there are few records from sampling in these habitats (Biologic 2016c). Habitat for this species is limited to the south, west and north and targeted survey work in suitable habitat (Biologic 2016c) has not recorded the species beyond the inferred habitat extent. Habitat considered potentially suitable for *Antichiropus `DIP007`* occurs within adjacent Hope Downs tenure (Figure 27); however there has been no survey work undertaken there to confirm its presence and there are currently no known records from this area.

Within the Proposed Mining Area C Development Envelope habitat considered suitable for *Antichiropus `DIP007`* covers approximately 7,038 ha (Table 31 and Figure 27). Approximately 3,518 ha occur in the Indicative Additional Impact Assessment Area, and 355 ha occur in the Mining Area C EMP Revision 6 Impact Assessment Area.

Indirect impacts to the species arising from alteration to surface water and groundwater flows; hydrocarbon spills or contamination; introduced species; and increased vibrations, noise and dust are unlikely and considered to be minor (Biologic, 2016a); however, a reduction of the species habitat, and increased fragmentation of that which remains, may make it more susceptible to threatening processes such as fire.

Without mitigation, it is considered that the direct removal of the estimated extent of suitable habitat for *Antichiropus `DIP007`* and associated habitat fragmentation will have a moderate to high impact on this species; however, it is considered likely that the species will persist within the 2,876 ha retained within the Mining Area C Development Envelope. This area of habitat may be increased if suitable microhabitats for the species (i.e. leaf litter and soils at the base of the mallee eucalypt, *Corymbia hamersleyana*), is successfully reinstated in rehabilitated areas and fragmentation is reduced.

**Antichiropus `DIP006`.** There is one confirmed record of the SRE species *Antichiropus `DIP006`* (an adult male specimen), and a further two records of juvenile *Antichiropus* millipedes considered likely to belong to the same species, based on their occurrence in the same or similar continuous habitats. These records all occur along the Packsaddle Range within Major Gorge/Gully habitats (two in the Mining Area C EMP Revision 6 Impact Assessment Area, and one in areas approved under Revision 4 of the EMP), whereas *Antichiropus `DIP007`* records occur along Southern Flank in Hill Slope/Crest habitats, and sampling data suggest it is unlikely that the two species of *Antichiropus* millipedes co-occur.
Liability

BHP BILLITON does not warrant that this map is free from errors or omissions. BHP Billiton shall not in any way be liable for loss, damage or injury to the user of this map or any other person or organization consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.

MINING AREA C - SOUTHERN FLANK
Inferred Extent of Habitat for Antichiropus 'DIP007'

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area
Inferred Antichiropus 'DIP007' Habitat
Inferred Antichiropus 'DIP007' Habitat (Unverified)

BHP Billiton Rail
Great Northern Highway
Knowledge of the primary habitat for *Antichiropus ‘DIP006’* is limited; all three records were collected from the top of south facing Major gorge/gully habitats (within gullies and beneath south-facing ridges) along the Packsaddle Range. Based on what is known of the genus, patches of dense leaf litter and deep soils are expected to comprise the most likely refugial microhabitats, but it remains unknown whether suitable microhabitats for *Antichiropus ‘DIP006’* may also occur under the mallee form of the eucalypt, *Corymbia hamersleyana* on the nearby Hill Slope/Crest habitats along Packsaddle Range, such as is the case for *Antichiropus ‘DIP007’*. Biologic (2015a) regarded the level of impact for direct removal of habitat for *Antichiropus ‘DIP006’* within the Mining Area C EMP Revision 6 Impact Assessment Area to be high.

**Chenistonia ‘MYG088’**

There are three confirmed records of the SRE species *Chenistonia ‘MYG088’* recorded from south-facing ridges, gullies, and gorges within the Mining Area C EMP Revision 6 Impact Assessment Area. Regional context and habitat information regarding this species is limited, as the one male and two female specimens recorded from the Proposed Mining Area C Development Envelope are the only members of the genus known from the Pilbara region. The sites where the species was recorded appeared to be dominated by rocky substrates on slopes, therefore it is inferred that *Chenistonia ‘MYG088’* builds burrows within small patches of soil among rocks in gullies and beneath ridges.

Two of the confirmed records of this species (one male and one female) were located within areas approved for mining under Revision 4 of the Mining Area C EMP, while the third record occurs within the Mining Area C EMP Revision 6 Impact Assessment Area. Biologic (2015a) regarded the level of impact for direct removal of south-facing Major Gorge/Gully systems (the assumed habitat for the species) along Packsaddle Range within the Mining Area C EMP Revision 6 Impact Assessment Area to be high. Habitat extents are presented in Table 28 and Section 11.2.3.2.

**Kwonkan ‘MYG339-DNA’**

There are 17 records for *Kwonkan ‘MYG339-DNA’*. Thirteen records occur within the Indicative Additional Impact Assessment Area and there is one record from within the Mining Area C EMP Revision 6 Impact Assessment Area. There is currently one known record outside the Proposed Mining Area C Development Envelope, which occurs west of the highway on Coondewanna Flats. All records of this species were recorded within drainage habitats, and due to the extent and connectivity of suitable habitat to areas outside of the Proposed Mining Area C Development Envelope, this taxon is considered very likely to also occur outside of it (Biologic 2016c). Impacts to this species are therefore considered to be low.

**Other SRE taxa**

*Austrostrophus ‘DIP018’, Yilgarnia ‘MYG197’* and Barychelidae indet. (juv.) have all been recorded outside of the Additional Development Envelope, the former two also having been recorded outside of the Proposed Mining Area C Development Envelope. Suitable habitat for these taxa is regarded as likely to occur beyond the Proposed Mining Area C Development Envelope (Biologic 2016c), and impacts to these species are therefore considered to be low.

*Karaops banyjima* has only been recorded from one adult female specimen collected from a south-facing ridge habitat within the Mining Area C EMP Revision 6 Impact Assessment Area, although other unidentified juvenile *Karaops* specimens are known to occur throughout the Proposed Mining Area C Development Envelope (Biologic 2016c). Suitable habitat for *Karaops* spiders is expected to occur throughout and beyond the Proposed Mining Area C Development Envelope within the cracks and crevices of rocky outcrops found in major and minor gorges/gullies, ridges and breakaways, and
boulder piles. Although the only confirmed record of *Karaops banyjima* occurs within the Mining Area C EMP Revision 6 Impact Assessment Area, the wider local extent of suitable habitats within and beyond the Proposed Mining Area C Development Envelope suggests that the direct impacts on this species are likely to be no more than moderate.

**Potentially occurring vertebrate fauna species**

Three vertebrate fauna species have been identified as potentially occurring within the Proposed Mining Area C Development Envelope, but have not been recorded during any surveys undertaken to date.

The common greenshank (*Tringa nebularia*) is a migratory species (listed under Schedule 5 of the WC Act) which occurs predominantly in coastal regions with only a few low frequency records associated with significant inland wetlands (Johnstone and Storr, 1998). This species presence was only determined from a database search, and is considered to possibly be associated with the Fortescue Marsh. It is considered unlikely to occur within the Proposed Mining Area C Development Envelope due to the lack of available habitat, and therefore impacts to this species are considered to be negligible.

The northern brushtail possum (*Trichosurus vulpecula arnhemensis*) has recently (November 2015) been listed as a conservation significant species in Western Australia (under Schedule 3 of the WC Act). It has a very restricted distribution in the Pilbara region, with a majority of records occurring within the Chichester Range or northern Pilbara. The nearest record to the Proposed Mining Area C Development Envelope is from a scat recorded approximately 15 km to the east (Astron-Biologic, 2010). No records for this species were returned in database searches. It is largely known from gorges and major drainage lines with eucalypt woodland (Biologic 2011). A targeted survey for the northern brushtail possum was undertaken within the Additional Development Envelope in late 2015 (Biologic, 2016d). There was no evidence of this species presence within the area, and it is considered unlikely that there is a significant or continual population within the Proposed Mining Area C Development Envelope. Core habitat is provided by the Gorge/Gully and Major Drainage Line Habitats, with foraging habitat comprising these areas and surrounding habitats. Dispersal corridors are likely to be via the Major Drainage Line habitat. Impacts to the northern brushtail possum from the Proposal are considered to be low.

In the Pilbara, the Priority 4 short-tailed mouse (*Leggadina lakedownensis*) is strongly associated with native grasslands on cracking clay substrate (Gibson and McKenzie, 2009). This habitat is not present within the Proposed Mining Area C Development Envelope. Given the lack of habitat and species records, despite considerable survey effort using suitable techniques (Table 25), the probability of this species being impacted by the Proposal is considered to be very low.

**11.2.4.2 Indirect impacts**

**Habitat fragmentation.** Habitat fragmentation can cause division and isolation of local populations of animals through disruption of movement patterns. Species most likely to experience such isolation would be those inhabiting continuous stretches of habitat and those with less mobility, such as SRE invertebrates, fossorial herpetofauna and small terrestrial mammals (e.g. western pebble-mound mouse, Pilbara barking gecko, and Pilbara flat-headed blindsnake). However, even highly mobile species, such as bats, may experience disruptions if they are unwilling to fly across large cleared areas while foraging.

Reduced gene flow between separated local groups of these animals could result in founder effects, genetic drift and increased inbreeding. A reduction in population size due to habitat fragmentation may result in loss of allelic richness and gene diversity and may exacerbate local reductions in species numbers (Lande, 1999). For a number of species, this can be remedied by successful rehabilitation;
however, there are currently no available data to show success of recolonisation by conservation significant species.

Areas where fragmentation is most likely to occur are in the eastern section of the Proposed Mining Area C Development Envelope where the Indicative Additional Impact Assessment Area and previous disturbance will create a barrier for fauna dispersal between the northern and eastern part of the Jirrpalpur Range.

The risk of indirect impacts to SRE and vertebrate fauna habitats from habitat fragmentation is regarded as low to moderate and is increased from that approved under MS 491.

**Fire.** Fire is a natural process in the Pilbara that commonly arises through lightning strike, but human activities have the potential to increase the frequency or intensity of fires. An increase in vehicle traffic, mining area machinery use and site-based personnel activity increases the risk of fire. This could impact terrestrial fauna directly through injury or death or indirectly through loss or alteration (due to increased frequency) of fauna habitats. The increased fire risk is considered to be minor for vertebrate fauna and a majority of SRE species and will be managed in accordance with existing management strategies such as retention of fire breaks and retention of emergency firefighting equipment and trained emergency response staff.

Regarding *Antichiropus ‘DIP007’*, it is unclear the extent to which this species is affected by fire; however, as fires occur frequently on hill crests in the Pilbara individuals of this species are likely to survive in deep soil in which they aestivate or within patches of unburnt habitat. A reduction in population range and/ or size will possibly increase the impact of fire; however, maintenance of current fire management strategies will likely alleviate this particularly if patches of unburnt habitat (refuges) exist in the short to medium term to allow the recolonisation of burnt areas after fire. If current fire management strategies can maintain a mosaic of burnt and unburnt patches throughout the remaining habitat, the risk is considered low.

**Light, dust, noise and vibration.** Artificial light could disrupt navigation, cause barriers to movement, impact foraging activity, cause abandoning of roosts and nests and expose nocturnal animals to nocturnal predators (Rich and Longcore, 2006). Additional impacts associated with artificial light are considered to be minor and will be managed according to existing management strategies.

Vegetation clearing, mining, hauling and vehicle movements will result in an increase in airborne particulate matter. Dust can indirectly affect fauna by altering the structure and composition of native vegetation. Continued implementation of existing dust suppression strategies will result in additional impacts to vertebrate fauna from dust being minor.

Responses to noise and vibration vary among species and individuals according to the characteristics of the noise and its duration, life history characteristics of the species, habitat type, season, activity at the time of exposure, sex and age of the individual, level of previous exposure and whether other stresses are present at the time of exposure (Busnel and Fletcher, 1978). Additional impacts to most vertebrate fauna species arising from noise and vibration are considered low. Impacts to the ghost bat are addressed in Section 11.2.4.1.2.

To date there have been no recorded impacts to terrestrial fauna as a result of light, dust, noise or vibration emissions from existing operations.

**Alteration to hydrology.** A detailed assessment of the impacts of surface water alteration was undertaken by MWH (2016) (see Section 11.4). Key components of this assessment in relation to impacts to terrestrial fauna are summarised below.
Alteration of surface water hydrology may impact upon terrestrial fauna by reducing the quality of fauna habitats by creating or removing surface water pools, which some species may be reliant upon as part of their life cycle; or by altering the quality of surface water runoff through increased sedimentation. None of the conservation significant species present in the Additional Development Envelope rely wholly on surface water, and therefore none are likely to be impacted by changes.

At a regional scale, the Additional Development Envelope comprises approximately 5% of the total Coondewanna subcatchment area, 3.5% of the total Weeli Wolli Creek subcatchment area and less than 1% of the total Fortescue Marsh catchment area. Impacts to these receptors are not considered significant at a regional scale (MWH, 2016) and therefore are unlikely to significantly impact terrestrial fauna that use these areas.

Impacts from groundwater drawdown are not considered to be significant. Impacts to the Weeli Wolli Spring PEC are discussed in Section 11.2.4.3.3.

**Introduced species.** The introduction and spread of feral animals and weeds through increased human activity and disturbance could result in changes to species composition, fire frequency and abundance of native communities.

While the impacts of weeds on fauna has generally been neglected (Adair, 1995), they can significantly alter the vegetation of a fauna habitat where infestations occur, resulting in significant declines in species richness or diversity of local fauna (Adair and Groves, 1998). Introduced flora (weed) species may be spread as a result of mobile mining equipment, ground disturbance, construction and ongoing activities of the Proposal.

Introduced fauna species may impact native fauna through a range of factors, including predation, competition for food and shelter, habitat destruction and the spread of diseases. Putrescible waste and artificial water points around camps, offices and crib rooms could attract both native and introduced animals. Apart from the physical threats (entangling in packing material, bottles and cans), animals could also be more vulnerable to introduced predators and road accidents.

Continued implementation of existing feral animal and weed control measures, that have demonstrated that introduction species have not significantly impacted local terrestrial fauna, will result in the additional impacts from introduced species on vertebrate fauna being minor.

**Vehicle movements.** Increased vehicle movements in the Proposed Mining Area C Development Envelope arising from the Proposal may result in an increase in vehicle collisions with wildlife. Roadkill on access tracks has the potential to decrease the abundance of vertebrate fauna species at a local level, including conservation significant fauna species, such as the Pilbara olive python. Road mortality is of particular concern for nocturnal species foraging or travelling near roads at night and species that tend to be active on roads (e.g. basking, foraging) during daytime. Roadkill also attracts scavengers, including birds of prey, which may themselves become victims of vehicle accidents.

As most of the vertebrate fauna potentially affected by vehicle movements are well represented throughout the surrounding area and the Pilbara region, the loss of individuals due to increased vehicle activity is expected to have a minimal impact on the abundance and conservation status of local fauna populations.
11.2.4.3 Regional cumulative impacts

11.2.4.3.1 Habitats

The cumulative loss of fauna habitats is difficult to quantify at a regional scale due to the lack of Pilbara wide fauna habitat mapping, a non-standardised approach to mapping between consultants and proponents, and the lack of availability of this information. Because of this, BHP Billiton Iron Ore used landform mapping to predict impacts at a regional scale from implementation of its strategic environmental assessment (BHP Billiton Iron Ore, 2016b). This assessment indicated the predicted impacts to all landforms under the full development scenario (including the Proposal) was less than 1.5%, with the majority being under 1% (BHP Billiton Iron Ore, 2016c). Additional land clearing associated with implementation of the Proposal is negligible at the landform scale.

11.2.4.3.2 Conservation significant species

For a majority of conservation significant species assessed in Section 11.2.4.1.2 the impacts are considered to be minor and therefore cumulative impacts are unlikely to be significant and are not discussed further in this document. Impacts to the Pilbara olive python, ghost bat, western pebble-mound mouse, Pilbara barking gecko and Pilbara flat-headed blindsnake were identified in BHP Billiton Iron Ore’s Strategic Proposal to require considered management to meet the EPA’s objective for terrestrial fauna (BHP Billiton Iron Ore, 2016c). With the exception of the ghost bat (which is discussed below), implementation of the Proposal is unlikely to alter the assessment for these species and they are not discussed further in this document. The potential impacts were determined to be low for the majority of short range endemic species located in the Proposed Mining Area C Development Envelope. Due to the inherent immobility of short range endemic species all those species that have potential impacts greater than low do not occur outside of the Proposed Mining Area C Development Envelope so assessment of regional cumulative impacts is not warranted.

An assessment of cumulative impacts to the ghost bat within the Hamersley Range has been undertaken by Biologic (2015b; see Appendix 5). Key findings from this assessment are summarised below.

It is estimated that the Proposed Mining Area C Development Envelope supports a population of approximately 50 individuals. The estimate for the Hamersley IBRA subregion is 300 to 400 individuals (Biologic, 2016b), which comprises one genetic population; although it is noted that the population could be almost 800 individuals (Spencer and Tedeschi, 2016). Without mitigation, the removal of up to 51 caves in the Proposed Mining Area C Development Envelope may result in a reduction of the Hamersley subregion population by between 12% and 17%. At a Pilbara regional scale, this would be a reduction of approximately 1%. At a species level, this reduction would be negligible.

It is noted that there are limitations for undertaking a cumulative impact assessment on ghost bats at a regional level as:

- the species has only recently been listed as a threatened species, and hence may not have been targeted during surveys for conservation significant species (e.g. ghost bats weren’t considered in targeted fauna surveys for the Baby Hope Downs project located adjacent to the Proposed Mining Area C Development Envelope (Biota, 2015b));
- most surveys for bats in the Pilbara rely on detection using acoustic recorders or to a lesser extent harp trapping or mist netting. Both techniques rely on detection of individuals during the survey period, and based on current data these techniques are considered unlikely to record ghost bats utilising an area. Acoustic detectors are particularly unreliable for ghost bats;
there are few, if any, surveys undertaken within the region that have similar survey intensity and methods to those undertaken on BHP Billiton Iron Ore tenure. Data that are available in the public domain, generally lack detailed information on roost locations; and

surveys that have recorded ghost bats have generally been undertaken for mining companies, and therefore most records will correlate with mining tenure.

The above limitations are relevant for data obtained with respect to Ghost Bats from other sources, not BHP Billiton Iron Ore datasets. Therefore assessment of potential impacts, including cumulatively for the Proposed Mining Area C DevelopmentEnvelope as discussed in Section 11.2.4.1.2 are considered robust.

There are two active mining operations (both operated by Rio Tinto or its joint ventures) within the vicinity of the Proposed Mining Area C Development Envelope; Hope Downs (located approximately 50 m east) and West Angelas (located approximately 15 km south-east). The ghost bat was first recorded at West Angelas in 1979 (Biologic, 2014b), and monitoring has been occurring since August 2000. It is still detected around West Angelas from the presence of fresh scat material in the monitoring caves and calls on SM2 detectors (Biologic, 2014b); however, how they are using the area is unknown.

The ghost bat has also been recorded at Hope Downs (Bullen, pers. com., 2016) and within the boundary of a new deposit (Biota, 2012), Baby Hope, which has been recently approved and shares a south-eastern boundary with the Proposed Mining Area C Development Envelope. Although the ghost bat was not a species targeted during the fauna survey for this project (Biota, 2015b), it was not picked up on SM2s deployed for Pilbara leaf-nosed bats (although see note above about the efficacy of this technique to record ghost bats).

More broadly in the Hamersley Range, it is difficult to specifically assess the occurrence or continued presence of the ghost bat around mining operations due to the limitations described above. Figure 28 displays known roosts in the Pilbara (Biologic and Bat Call, 2014) and footprints (BHP Billiton Iron Ore and third-party) identified under the full development scenario during BHP Billiton Iron Ore’s Strategic Proposal (BHP Billiton Iron Ore, 2016c). Almost all known caves occur in BHP Billiton Iron Ore tenure or in Karijini National Park and have been identified during surveys conducted for BHP Billiton Iron Ore (Figure 28). It is considered highly likely that caves occur outside these areas, and these will be identified during surveys for other mining companies’ operations in the area.

Irrespective of this, it appears that a large proportion of known caves occur in or adjacent to areas planned for mining; and without mitigation, cumulative impacts to the species are likely. BHP Billiton Iron Ore will therefore continue to undertake research on the ghost bat to understand the ecology of the Hamersley population, current and future impacts from the Company’s mining operations, and actions that can be implemented to reduce impacts to the species.

11.2.4.3.3 Weeli Wolli Spring PEC

The Weeli Wolli Spring PEC is recognised as a focal point for Pilbara birds (DEC, 2009), whilst Weeli Wolli Creek (including the area containing the springs) and Marillana Creek support an isolated population of the chocolate wattled bat (*Chalinolobus morio*), which occurs largely in southern Australia. This species is not listed as a conservation significant species and is listed as Least Concern on the International Union for the Conservation of Nature (IUCN) Red List.

A detailed assessment of impacts to the Weeli Wolli Spring PEC is provided in Section 11.4, and key aspects relating to terrestrial fauna are summarised here.
MINING AREA C - SOUTHERN FLANK
Cumulative Assessment of Impacts to
Ghost Bat Roosts Located in the
Eastern Hamersley IBRA Subregion

Proposed Mining Area C Development Envelope
- BHPBIO Full Conceptual Development Scenario
  - Known Plibara Ghost Bat Roosts
  - BHP Billiton Rail
  - FMG Rail
  - Rio Tinto Rail
- Great Northern Highway
- Karijini National Park

IBRA V6.1 - Subregions
- Ashburton
- Augustus
- Chichester
- Fortescue
- Hamersley

Major Active Iron Ore Mines
- BHP Billiton
- Fortescue Metals Group
- Rio Tinto
- Roy Hill Holdings
The previously forecast residual drawdown at Weeli Wolli Spring presented in the EMP Revision 6 model was around 1.6 m at GWB0018 in 2054 (see Section 11.4). This drawdown occurs following closure of Hope Downs 1 and is attributed to the combined impacts of Hope Downs 1 and Mining Area C dewatering. Maximum drawdown at GWB0018 was modelled to be between 6 and 7 m in 2026 and coincides with the conclusion of Hope Downs dewatering.

Dewatering at Southern Flank is predicted to contribute between 0.2 and 0.5 m of drawdown at GWB0018 in 2054. This drawdown is modelled to occur following the end of aquifer replenishment and mitigation actions at Hope Downs 1. Cumulative groundwater drawdown from the Mining Area C Combined Operations and Rio Tinto Iron Ore's Hope Downs 1 dewatering activities shows a far greater change, whereby water levels are significantly reduced in the lower catchment of the spring area. This drawdown, which shows a range of 3 to 14 m, is associated predominantly with abstraction from Hope Downs 1. The timing and success of Hope Downs 1 closure plans to recover groundwater levels will also influence the water level and potential for a continued impact at Weeli Wolli Spring.

Following closure of Hope Downs 1 the combined cumulative impacts show a range of 1 – 2.5 m drawdown at 2054 with a median drawdown of 1.75 m which is close to the previously assessed change of 1.6 m. Residual drawdown in the upper end of this range (>2 m) has potential to reduce water availability to *Melaleuca argentea* and may result in the population contracting east toward the spring. This contraction of vegetation cover is considered unlikely to impact on the terrestrial faunal values of the PEC or the persistence of the chocolate wattled bat within the area.

### 11.2.5 Mitigation and residual impacts

BHP Billiton Iron Ore have carried out a review of the Western Australian Government’s ‘Mitigation Process’, which is detailed in Section 3 of the *WA Environmental Offsets Guideline* (Government of Western Australia, 2014). The four steps are:

- avoid;
- minimise;
- rehabilitate; and
- offset.

Following consideration of all data gathered during baseline surveys, additional targeted surveys and the outcomes of environmental impact assessments, BHP Billiton Iron Ore have revised its indicative Proposal designs to ensure that these designs address the first two steps of the Mitigation Process, i.e. the designs have ‘avoided’ or ‘minimised’ the impact on terrestrial fauna as far as reasonably practicable.

The original referral to the OEPA in May 2016 estimated clearing of 19,671.2 ha, of which 5,942 ha is located in the current Mining Area C EMP Revision 6 Impact Assessment Area but was in excess of the total disturbance area approved under MS 491. Following implementation of the steps outlined in the mitigation process (Government of Western Australia, 2014), native vegetation clearing may be reduced to 15,693 ha. Implementing this mitigation process at the environmental impact assessment stage have enabled BHP Billiton Iron Ore to present a potential 20% reduction in proposed clearing at the time of submission of this PER document.

Impacts to the ghost bat have been reduced following modification of the Indicative Additional Impact Assessment Area. Fifteen caves considered suitable for use by the ghost bat (seven classified as High value) have been removed from the Modified Indicative Additional Impact Assessment Area (Figure 29), with the number of caves classified as High reduced from 12 to five caves. The total number of caves impacts has been reduced from 51 to 36 caves.
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Impacts to Ghost Bat Caves and Antichirus "DIP007" Habitat Following Mitigation

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area
Indicative Additional Impact Assessment Area
Modified Indicative Additional Impact Assessment Area
Inferred Antichirus "DIP007" Habitat
Priority Ecological Community

Bat caves in proposed impact areas
- High
- Low

Bat caves outside proposed impact areas
- High
- Low
- BHP Billiton Rail
- Great Northern Highway

Scale @ A4: 1:110,000
Date: 30/03/2017
Revision: Rev C
Prepared: M. LYTTLE
Checked: B. BARNETT
Reviewed: S. WILLIAMSON
Project No: A780045 REV C
Figure: 29

Kilometers
Coordinate System: Central Project Grid (CPS84)
Projection: Transverse Mercator
Datum: DGA 1994
Three High value caves (all classified as day roosts, and one has shown evidence of use as a maternity roost) will be retained in the western end of the Additional Development Envelope within 1 km of the Coondewanna Flats PEC, which is considered likely to be used when foraging by the ghost bats. Impacts to foraging habitat are reduced by approximately 173 ha. The retained High value caves are located between 90 and 480 m from proposed impacts.

Depending on the mine sequencing, ghost bats may persist in the western and/or eastern end of the Additional Development Envelope during mining operations. It is considered unlikely that bats will persist in caves that are in close proximity to active mining areas and infrastructure due to localised levels of noise, dust and light; however as the life of the Proposal is 30 years, the disturbance to caves will unlikely occur concurrently and ghost bats should be able to move to areas within the Proposed Mining Area C Development Envelope away from active mining areas. The modifications will therefore likely reduce the number of individuals impacted during mining and increase the number of individuals that may return post mining when compared to predicted impacts prior to mitigation.

If the ghost bat is unable to persist within the Proposed Mining Area C Development Envelope during mining, the retention of caves in the west and east is likely to provide sufficient habitat for re-establishment of individuals and breeding upon closure, particularly once rehabilitated areas can support prey species. Nevertheless, a reduction in numbers would be expected as approximately half of the high value caves are planned to be removed and the gap between the east and west caves could reduce the ability of ghost bats to respond to natural or man-made events such as fire, drought and noise. An estimate of the actual reduction in numbers is difficult but given that half of the high value caves in the immediate area and surrounds are planned for removal, a reduction of individuals by approximately half could be reasonably expected.

Modification of the Indicative Additional Impact Assessment Area has reduced the amount of habitat for *Antichiropus ‘DIP007’* that will be cleared within the Proposed Mining Area C Development Envelope; however it is considered unlikely that this will reduce impacts to the species as retained habitat occurs in a number of isolated areas.

Application of the mitigation hierarchy has predicted that the residual impact to terrestrial fauna is not significant at a species and population level and that biological diversity and ecological integrity can be maintained.

Actions taken to mitigate impacts on terrestrial fauna are summarised in Table 35.

### 11.2.6 Proposed management approach

#### 11.2.6.1 Internal management approach

The proposed management plan provisions (both management and outcome based) for terrestrial fauna are outlined in Table 36 and Table 37. These include management actions, monitoring and reporting details and trigger criteria and response actions where relevant. It is proposed that these management provisions will be formalised through regulation of an Environmental Management Plan via the Ministerial Statement and BHP Billiton Iron Ore’s standard Pilbara-wide Health, Safety and Environment system. A draft of the management plan which includes the management provisions outlined in Table 36 and Table 37 and is located in Appendix 3.
## Table 35: Actions taken to reduce impacts to terrestrial fauna

<table>
<thead>
<tr>
<th>Action Taken</th>
<th>Step in the ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modification of Indicative Additional Impact Assessment Area</td>
<td>Avoid</td>
<td>A restriction of impacts to within the Modified Indicative Additional Impact Assessment Area will reduce impacts to the ghost bat as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• the number of caves retained in the Proposed Mining Area Development Envelope will be increased from 12 to 27 (11 high value), and the removal of foraging habitat has been reduced by 173 ha.</td>
</tr>
<tr>
<td>Modification of Indicative Additional Impact Assessment Area</td>
<td>Minimise</td>
<td>A restriction of impacts to within the Modified Indicative Additional Impact Assessment Area will reduce clearing of Medium and High value vertebrate fauna habitats as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gorge/Gully – clearing reduced from 457 ha to 376 ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Crest/Slope – clearing reduced from 5,916 ha to 5,860 ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Major Drainage Line – clearing reduced from 20 ha to 0 ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mulga – clearing reduced from 849 ha to 432 ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sand Plain – clearing reduced from 394 ha to 115 ha.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Drainage Area/Floodplain – clearing reduced from 668 ha to 625 ha.</td>
</tr>
<tr>
<td>Buffers around ghost bat roosts outside impact assessment areas</td>
<td>Avoid/ minimise</td>
<td>BHP Billiton Iron Ore will commit to retaining a 150 m buffer around all ghost bats roosts that occur outside the Mining Area C Revision 6 EMP Impact Assessment Area and the Modified Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Research into ghost bat ecology in the Pilbara</td>
<td>Minimise/offset</td>
<td>Continued study of the ecology of the ghost bat in the Pilbara will provide more information to assist in identifying key habitats (roosting and foraging) for the species that can be considered in mine plans.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This work will be published so that it is available to third-party operators in the Pilbara and for future mining developments undertaken by BHP Billiton Iron Ore.</td>
</tr>
<tr>
<td>Inclusion of preferred habitat species of <em>Antichiropus 'DIP007'</em> into rehabilitation</td>
<td>Rehabilitation</td>
<td>Rehabilitation of disturbed areas using <em>Corymbia hamersleyana</em>.</td>
</tr>
</tbody>
</table>

### 11.2.6.2 Regulatory management

Impacts to terrestrial fauna will be managed as conditioned by the MS.
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To meet the requirements of Condition(s) X of Ministerial Statement X</strong></td>
</tr>
<tr>
<td><strong>EPA Factor and objective:</strong> Terrestrial fauna – to protect terrestrial fauna so that biological diversity and ecological integrity are maintained</td>
</tr>
<tr>
<td><strong>Key environmental values:</strong> Ghost Bats – listed as Vulnerable under both the EPBC Act and WC Act (2015 and 2016, respectively).</td>
</tr>
<tr>
<td><strong>Objective:</strong> Minimise impacts to ghost bats as far as practicable, as a result of BHP Billiton Iron Ore activities.</td>
</tr>
<tr>
<td><strong>Outcome:</strong> Maintain long term viability of ghost bat population in the Development Envelope.</td>
</tr>
<tr>
<td><strong>Key impacts and risks:</strong> Risk to biological diversity and/or ecological integrity of ghost bats, due to direct loss of habitat (roosts) or indirect impacts due to loss of foraging habitat.</td>
</tr>
</tbody>
</table>

### Management-based provisions

<table>
<thead>
<tr>
<th><strong>Management Actions</strong></th>
<th><strong>Management Targets</strong></th>
<th><strong>Monitoring</strong></th>
<th><strong>Reporting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
</tr>
<tr>
<td><strong>Avoid</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Avoid direct impacts to ghost bat buffer areas, by implementing the PEAHR process prior to land disturbance.</td>
<td>No unauthorised disturbance beyond the Development Envelope or within the Ghost Bat cave buffer zones.</td>
<td>Quarterly land disturbance reconciliation (hectares and spatial footprint).</td>
<td>Notification of management target or objective potential non-compliance will be provided to the OEPA within 7 days of that potential non-compliance being known. A report including any corrective actions identified will be provided to the OEPA via email, once an investigation into the potential non-compliance has been completed. An annual compliance assessment report will be submitted as part of the Annual Environment Report, which will be submitted to OEPA by 1 October each year. This will include key outcomes from the ghost bat research.</td>
</tr>
<tr>
<td><strong>Minimise</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Minimise impacts to all known ghost bat cave locations and foraging habitat, by avoiding direct impacts where practicable and implementing the PEAHR process prior to land disturbance.</td>
<td></td>
<td>Rehabilitation monitoring undertaken in accordance with the Mine Closure Plan and WAIO Rehabilitation monitoring standard.</td>
<td></td>
</tr>
<tr>
<td><strong>Rehabilitation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Progressive rehabilitation within foraging range will be undertaken using Eucalyptus leucophloia or other large tree species (&lt;2 km from ghost bat caves).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Outcomes-based provisions

<table>
<thead>
<tr>
<th><strong>Environment criteria:</strong></th>
<th><strong>Response actions:</strong></th>
<th><strong>Monitoring</strong></th>
<th><strong>Reporting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
</tr>
<tr>
<td><strong>Trigger criteria</strong></td>
<td><strong>Threshold criteria</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• no sign of ghost bat use in High importance caves or artificial roosts (if applicable) within the Proposed Mining Area C Development Envelope, within 5 years of cessation of operations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• no sign of ghost bat use in High importance caves or artificial roosts (if applicable) within the Proposed Mining Area C Development Envelope, within 10 years of cessation of operations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response actions to trigger/threshold criteria exceedance may include, but are not limited to:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Construction/relocation (as appropriate) of, or alteration to, artificial ghost bat habitat;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Reintroduction of ghost bats from captive breeding facilities or other natural colonies within the Pilbara, as appropriate; and/or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Remediate foraging habitat to ensure that it contains feeding trees and suitable habitat for prey species within 2 km of cave locations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five yearly monitoring of High value ghost bat roosts in Proposed Mining Area C Development Envelope following cessation of operations. Methods will be informed by the results from the ongoing research programme and may include scat counts and genetic/hormone analysis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notification of threshold criteria or outcome potential non-compliance will be provided to the OEPA within 7 days of that potential non-compliance being known. A report including any corrective actions identified will be provided to the OEPA via email, once an investigation into the potential non-compliance has been completed. An annual compliance assessment report will be submitted as part of the Annual Environment Report, which will be submitted to OEPA by 1 October each year.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To meet the requirements of Condition(s) X of Ministerial Statement X

<table>
<thead>
<tr>
<th>EPA Factor and objective:</th>
<th>Terrestrial fauna – to protect terrestrial fauna so that biological diversity and ecological integrity are maintained</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key environmental values:</strong></td>
<td>Habitat for Short Range Endemic species Antichirus ‘DIP007’, Antichirus ‘DIP006’ and Chenistonia ‘MYG088’</td>
</tr>
<tr>
<td><strong>Objective:</strong></td>
<td>Minimise impacts to Antichirus ‘DIP007’, Antichirus ‘DIP006’ and Chenistonia ‘MYG088’ habitats as far as practicable.</td>
</tr>
<tr>
<td><strong>Key impacts and risks:</strong></td>
<td>Risk to biological diversity and/or ecological integrity of Antichirus ‘DIP007’, Antichirus ‘DIP006’ and Chenistonia ‘MYG088’ due to direct loss of habitat.</td>
</tr>
</tbody>
</table>

Management-based provisions

<table>
<thead>
<tr>
<th>Management Actions</th>
<th>Management Targets</th>
<th>Monitoring</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Condition clause number and text</strong></td>
<td><strong>Condition clause number and text</strong></td>
<td><strong>Condition clause number and text</strong></td>
<td><strong>Condition clause number and text</strong></td>
</tr>
<tr>
<td>Minimise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Minimise impacts to Antichirus ‘DIP007’ habitat (<em>Corymbia hamersleyana</em>), by avoiding direct impacts where practicable and implementing the PEAHR process prior to land disturbance.</td>
<td>No unauthorised disturbance beyond the Development Envelope</td>
<td>Quarterly land disturbance reconciliation (hectares and spatial footprint). Rehabilitation monitoring undertaken in accordance with the Mine Closure Plan and WAIO Rehabilitation monitoring standard.</td>
<td></td>
</tr>
<tr>
<td>• Minimise impacts to Antichirus ‘DIP006’ and Chenistonia ‘MYG088’ inferred habitat, by avoiding direct impacts where practicable and implementing the PEAHR process prior to land disturbance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rehabilitation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Progressive rehabilitation as described in the Mine Closure Plan will be implemented using local top soil, and include the use of <em>Corymbia hamersleyana</em> material in habitat suitable to support Antichirus ‘DIP007’.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notification of management target or objective non-compliance will be provided to the OEPA and DPAW within 7 days of that potential non-compliance being known. A report including any corrective actions identified will be provided to the OEPA and DPAW via email, once an investigation into the non-compliance has been completed.

An annual compliance assessment report will be submitted as part of the Annual Environment Report, which will be submitted to OEPA by 1 October each year.
11.2.7 Summary and predicted outcome

Table 38 below summarises impacts to terrestrial fauna previously assessed under MS 491, additional changes that may occur following implementation of the Proposal, and the cumulative extent in the Proposed Mining Area C Development Envelope.

In consideration of the outcomes of the environmental impact assessment and proposed management measures, BHP Billiton Iron Ore consider that terrestrial fauna representation, diversity, viability and ecological function at the species, population and community level can be maintained. Nevertheless, residual impacts to terrestrial fauna are considered possible, but are not significant. As a precaution, offsets are applicable for this factor (see Section 11.8).

Table 38: Summary of key terrestrial fauna factors for the Proposal

<table>
<thead>
<tr>
<th>Indicative Additional Impact Assessment Area</th>
<th>EMP Revision 6 Impact Assessment Area</th>
<th>Cumulative extent in Proposed Mining Area C Development Envelope (without Mitigation)</th>
<th>Cumulative extent in Proposed Mining Area C Development Envelope (with Mitigation)</th>
</tr>
</thead>
</table>
| Nine conservation significant species recorded in the Additional Development Envelope:  
  • Northern quoll;  
  • Pilbara leaf-nosed bat;  
  • Pilbara olive python;  
  • Ghost bat;  
  • Grey falcon;  
  • Rainbow bee-eater;  
  • Pilbara flat-headed blindsnake;  
  • Pilbara barking gecko;  
  • Western pebble-mound mouse.  
The northern quoll and rainbow bee-eater have not been recorded in the Indicative Additional Impact Assessment Area. | Eleven conservation significant vertebrate fauna species recorded within Current Approved Development Envelope (two species identified in the Revision 6 EMP have subsequently been delisted). These species are:  
  • Northern quoll;  
  • Pilbara leaf-nosed bat;  
  • Pilbara olive python;  
  • Ghost bat;  
  • Grey falcon;  
  • Rainbow bee-eater;  
  • Peregrine falcon;  
  • Fork-tailed swift;  
  • Pilbara flat-headed blindsnake;  
  • Pilbara barking gecko;  
  • Western pebble-mound mouse. | Eleven conservation significant vertebrate fauna species recorded in Proposed Mining Area C Development Envelope:  
  • Northern quoll;  
  • Pilbara leaf-nosed bat;  
  • Pilbara olive python;  
  • Ghost bat;  
  • Grey falcon;  
  • Rainbow bee-eater;  
  • Peregrine falcon;  
  • Fork-tailed swift;  
  • Pilbara flat-headed blindsnake;  
  • Pilbara barking gecko;  
  • Western pebble-mound mouse. | Eleven conservation significant vertebrate fauna species recorded in Proposed Mining Area C Development Envelope:  
  • Northern quoll;  
  • Pilbara leaf-nosed bat;  
  • Pilbara olive python;  
  • Ghost bat;  
  • Grey falcon;  
  • Rainbow bee-eater;  
  • Peregrine falcon;  
  • Fork-tailed swift;  
  • Pilbara flat-headed blindsnake;  
  • Pilbara barking gecko;  
  • Western pebble-mound mouse. |

Thirty-three caves in Indicative Additional Impact Assessment Area:  
  • 12 High value  
  • 21 Low value  
Removal of 8,579 ha of foraging habitat for ghost bats. | Removal of up to 12 ghost bat roosts, plus a further six caves approved under previous EMP revisions. Removal of 6,418 ha of foraging habitat for ghost bats. | Fifty-one caves in cumulative impact areas:  
  • 20 High value (7 containing pregnant females)  
  • 31 Low value  
Removal of 14,997 ha of foraging habitat for ghost bats. | Up to 36 caves in modified cumulative impact areas:  
  • 14 High value  
  • 22 Low value  
Removal of 14,824 ha of foraging habitat for ghost bats. |
### Indicative Additional Impact Assessment Area

<table>
<thead>
<tr>
<th>EMP Revision 6 Impact Assessment Area</th>
<th>Cumulative extent in Proposed Mining Area C Development Envelope (without Mitigation)</th>
<th>Cumulative extent in Proposed Mining Area C Development Envelope (with Mitigation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No SRE taxa restricted to the Indicative Additional Impact Assessment Area. One taxon, <em>Antichiropus 'DIP007'</em> has a distribution that is likely restricted to the Proposed Mining Area C Development Envelope. Approximately 55% of its habitat occurs within the Indicative Additional Impact Assessment Area.</td>
<td>Four confirmed SRE species currently only known from the Proposed Mining Area C Development Envelope. Habitat for all species potentially occurs outside of it, but fragmentation of habitats may occur.</td>
<td>Four confirmed SRE species currently only known from the Proposed Mining Area C Development Envelope. Habitat for all species potentially occurs outside of it, but fragmentation of habitats may occur.</td>
</tr>
</tbody>
</table>

| Three SRE invertebrates only recorded within the Mining Area C EMP Revision 6 Impact Assessment Area:  
- *Antichiropus 'DIP006'*  
- *Chenistonia 'MYG088'*  
- *Karaops banyjima*  
Habitat for all three species potentially occurs outside this area. | |

### 11.3 Subterranean fauna

#### 11.3.1 EPA objective

The EPA applies the following objective, according to the *Statement of Environmental Principles, Factors and Objectives* (EPA, 2016), in its assessment of proposals that may affect subterranean fauna:

*To protect subterranean fauna so that biological diversity and ecological integrity are maintained.*

#### 11.3.2 Relevant legislation, guidelines and policies

The discussion of the existing environment, impacts and management of subterranean fauna in the Proposed Mining Area C Development Envelope and Groundwater Assessment Area has been compiled in consideration of relevant state legislation and EPA policies and guidance. Table 7 details the relevant EPA documents as identified in the *Mining Area C – Environmental Scoping Document* (OEPA, 2016) and their relevance to this Proposal.

#### 11.3.3 Existing environment

##### 11.3.3.1 Survey effort

Baseline and targeted troglofauna and stygofauna surveys were undertaken in the Proposed Mining Area C Development Envelope and Coondewanna and Weeli Wolli Creek subcatchments between 2007 and 2016. To date, almost 2,750 samples\(^\text{12}\) targeting troglofauna have been collected in the Proposed Mining Area C Development Envelope (Table 39), and almost 1,200 samples targeting stygofauna have been collected within the catchments (Table 40). Locations of drill holes sampled are shown in Figure 30 and Figure 31. Details of sampling dates for all troglofauna surveys undertaken in the Proposed Mining Area C Development Envelope are provided in Table 41. Details of sampling dates for all stygofauna surveys undertaken in the Groundwater Assessment Area and surrounds are provided in Table 42 and Table 43.

---

\(^{12}\) A sample is considered to comprise a trap and a scrape. The use of only one of these techniques is considered a half sample.
All surveys have been undertaken in accordance with the EPA’s Guidance Statement 54: Guidance for the assessment of environmental factors: consideration of subterranean fauna in groundwater and caves during environmental impact assessment in Western Australia (EPA, 2003), Guidance Statement 54a: Sampling methods and survey considerations for subterranean fauna in Western Australia (Technical Appendix to Guidance Statement No. 54) (EPA, 2007) and post-2013, have also been undertaken in accordance with the EPA’s EAG 12: Consideration of subterranean fauna in environmental impact assessment in WA (EPA, 2013d).

All areas within the Proposed Mining Area C Development Envelope that have been surveyed for environmental approvals have had a minimum of two seasons of survey and where possible have used a stratified approach to ensure that all likely fauna habitats present have been sampled and there is adequate geographic coverage. It is noted that collection of samples for troglofauna and stygofauna samples are largely limited to BHP Billiton Iron Ore tenure in areas where drill holes are available, and for stygofauna, where these intersect the water table.

Overall, the extent of subterranean fauna sampling and habitat assessments within proposed impact areas is considered sufficient for the purposes of impact assessment, and to meet the requirements of current EPA guidance.

Table 39: Summary of troglofauna samples collected in the Proposed Mining Area C Development Envelope and surrounds (Bennelongia, 2016a).

<table>
<thead>
<tr>
<th>Area</th>
<th>Scrape</th>
<th>Trap</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved Mining Area C (Northern Flank)</td>
<td>1,799</td>
<td>1,661</td>
<td>3,460</td>
</tr>
<tr>
<td>Development Envelope'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Development Envelope</td>
<td>1,221</td>
<td>812</td>
<td>2,033</td>
</tr>
<tr>
<td>Total</td>
<td>3,020</td>
<td>2,473</td>
<td>5,493</td>
</tr>
</tbody>
</table>

* The number of samples collected was calculated as samples = (no. scrape + no S or D trap)/2

Table 40: Summary of stygofauna samples collected in the Groundwater Assessment Area and surrounding catchments (Bennelongia, 2016b)

<table>
<thead>
<tr>
<th>Area</th>
<th>No. Samples*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater Assessment Area</td>
<td>224</td>
</tr>
<tr>
<td>Mining Area C EMP Revision 6 Groundwater Assessment Area</td>
<td>742</td>
</tr>
<tr>
<td>Weeli Wolli and Coondewanna sub-catchments outside the Groundwater Assessment Area and Mining Area C EMP Revision 6 Groundwater Assessment Area (Reference Area)</td>
<td>222</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,170</strong></td>
</tr>
</tbody>
</table>

* One sample = 6 net hauls for stygofauna
Table 41: Summary of timing of all troglofauna surveys undertaken within the Proposed Mining Area C Development Envelope

<table>
<thead>
<tr>
<th>STUDY AREA</th>
<th>ROUND 1</th>
<th>ROUND 2</th>
<th>ROUND 3</th>
<th>ROUND 4</th>
<th>ROUND 5</th>
<th>ROUND 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Surveys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Deposit</td>
<td>17 January - 12 March 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Deposit</td>
<td>9 January - 14 March 2008</td>
<td>13 March - 14 May 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F Deposit</td>
<td>4 December 2007 - 5 February 2008</td>
<td>5 February - 9 April 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Deposit</td>
<td>1 April - 3 June 2008</td>
<td>5 August - 2 October 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P5 Deposit</td>
<td>9 April - 19 June 2008</td>
<td>13 October - 27 November 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Flank</td>
<td>18 March 2010 - 10 August 2010</td>
<td>17 April - 9 August 2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Targeted Surveys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Deposit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 March 2015 – 6 May 2015</td>
<td></td>
</tr>
<tr>
<td>F Deposit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 March 2015 – 5 May 2015</td>
<td></td>
</tr>
<tr>
<td>STUDY AREA</td>
<td>ROUND 1</td>
<td>ROUND 2</td>
<td>ROUND 3</td>
<td>ROUND 4</td>
<td>ROUND 5</td>
<td>ROUND 6</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------</td>
<td>------------</td>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>P6 Packsaddle</td>
<td>20 April - 24 April 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Flank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15-24 Feb 2016 – 27 April- 03 May 2016</td>
</tr>
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</table>

Table 42: Summary of timing of all stygofauna surveys undertaken within the Mining Area C EMP Revision 6 Groundwater Assessment Area and Groundwater Assessment Area.

<table>
<thead>
<tr>
<th>STUDY AREA</th>
<th>ROUND 1</th>
<th>ROUND 2</th>
<th>ROUND 3</th>
<th>ROUND 4</th>
<th>ROUND 5</th>
<th>ROUND 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Deposit</td>
<td>7 - 9 December 2008</td>
<td>5 September 2011</td>
<td>6 March 2015</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>B Deposit</td>
<td>5-7 May 2008</td>
<td>5 March 2010</td>
<td>24 March 2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Deposit</td>
<td>5-7 May 2008</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>F Deposit</td>
<td>6 December 2007</td>
<td>5-7 May 2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Deposit</td>
<td>10 April 2008</td>
<td>25 May 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1 Deposit</td>
<td>29 May 2008</td>
<td></td>
<td></td>
<td></td>
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<td>P3 Deposit</td>
<td>13 April 2008</td>
<td>25-26 June 2010</td>
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<tr>
<td>P6 Deposit</td>
<td>21 April 2008</td>
<td></td>
<td></td>
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Table 43: Summary of timing of all stygofauna surveys undertaken within Reference Areas.

<table>
<thead>
<tr>
<th>STUDY AREA</th>
<th>JINIDI</th>
<th>MINING AREA C</th>
<th>MUDLARK</th>
<th>TANDANYA</th>
</tr>
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<tbody>
<tr>
<td>Round 1</td>
<td></td>
<td>6 July 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Orebody 16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 2</td>
<td></td>
<td>12 July 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Orebody 41)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Orebody 16 &amp; 41)</td>
<td>(Alligator Jaws, South East Corner)</td>
<td></td>
</tr>
<tr>
<td>Round 4</td>
<td></td>
<td>18 February 2009</td>
<td>13 - 14 February 2009</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Orebody 15)</td>
<td>(Alligator Jaws)</td>
<td></td>
</tr>
<tr>
<td>Round 5</td>
<td></td>
<td>11 - 13 March 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Camp Hill, Mt Wildflower, Wanna Manna)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 6</td>
<td></td>
<td>10 - 12 July 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Camp Hill, Mt Wildflower, Wanna Manna)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 7</td>
<td></td>
<td>23 June - 2 July 2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Orebody 15, 16 &amp; 41)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 8</td>
<td></td>
<td>5 May 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Camp Hill)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 9</td>
<td></td>
<td>13 July 2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Upper Weeli Wolli)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 10</td>
<td></td>
<td>15 - 18 August 2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Rhodes Ridge, Upper Weeli Wolli)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 11</td>
<td></td>
<td>2 - 3 November 2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Rhodes Ridge, Upper Weeli Wolli)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 12</td>
<td></td>
<td>25 September 2014</td>
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<tr>
<td></td>
<td></td>
<td>(Packsaddle West)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 13</td>
<td></td>
<td>26 February 2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Packsaddle West)</td>
<td></td>
<td></td>
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<tr>
<td>Round 14</td>
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<td>20 March 2015</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(Packsaddle West)</td>
<td></td>
<td></td>
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<tr>
<td>Round 15</td>
<td></td>
<td>27 June 2016</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(Packsaddle East)</td>
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<td></td>
</tr>
<tr>
<td>Round 16</td>
<td></td>
<td>22 - 25 August 2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Alligator Jaws, Caymen, Parallel Ridge, South East Corner)</td>
<td>28 - 30 June 2016</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(Floodplain, Mick Bore, Noose, Sweetview, Fork North)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Liability

BHPBIO does not warrant that this map is free from errors or omissions. BHPBIO shall not be in any way liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.
MINING AREA C - SOUTHERN FLANK
Location of Stygoauna Samples
Collected in the Coondewanna and Weeli Wollu sub-catchments

Spatial Data - Business Development
BHP BILLITON IRON ORE

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
Groundwater Assessment
Mining Area C EMP Rev 6 Groundwater Assessment Area
Positive for Stygoauna
Negative for Stygoauna
Area of Mounding ≥ 2 metres
Weeli Wollu Priority Ecological Community - Boundary
Weeli Wollu Priority Ecological Community - Buffer

Coordinates System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

Alluvium - unconsolidated silt, sand and gravel
Colluvium - unconsolidated quartz and rock fragments in soil
Calcrite - sheet carbonate usually formed in major drainage lines
Great Northern Highway
BHP Billiton Rail
Rio Tinto Rail

Liability
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Prepared: M. LYTTLE
Checked: B. BARNETT
Prepared: A780/047 REV C

Revision: Rev C
Reviewed: S. WILLIAMSON

Date: 30/03/2017
Scale @ A4: 1:300,000

Figure: 31

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_047_E_MAC_Southern_Flank_PER_Map31_RevC.mxd
11.3.3.2 Troglofauna habitats

The geology of the Proposed Mining Area C Development Envelope comprises four habitat types relevant to troglofauna. These are ‘hardcap zone’, detritals, mineralised rock and BIF host rock. The hardcap zone, formed from continued weathering of the surface of the deposits and surrounding landscape, constitutes a semi-continuous carapace across the ranges. The formation of hardcap is not limited to a particular rock type and has been observed on unconsolidated sediments, BIF and ore (Crowe, 2012). This zone can be extremely variable in texture and is known to contain frequent voids and cavities. Cavities on a scale of metres are occasionally observed during drilling and mining. Hardcap formation is usually strongest near the surface and often grades into semi-hardcap and then unaltered rock with depth. This stratum is considered to provide important habitat for troglofauna.

The detritals can be divided into Recent Quaternary detritals and three classes of Tertiary detritals. Quaternary detritals usually comprise a mix of ore and shale in a silty matrix and are regarded by BHP Billiton Iron Ore (2016h) as suitable for troglofauna, although there is little sampling evidence that this is the case. The deepest Tertiary detrital class consists of haematite conglomerate or silt and clay, with limited capacity to support troglofauna. The middle Tertiary detrital class consists of vuggy breccia, sand and calcrite that are suitable for troglofauna, together with lenses of clay that are not. The upper Tertiary detrital class consists of gravelly siltstone and siltstone that are likely to provide troglofauna habitat.

The mineralised rock that is BIF contains voids and cavities as a result of weathering; it usually provides important troglofauna habitat. This mineralised BIF is a target for mining when iron ore levels within it are high, although it may also provide suitable habitat for troglofauna when ore concentrations are below commercial grade.

The BIF host rock, precursor to iron ore, consists of finely bedded chert, iron oxides and silicates. The texture of this rock type is fine-grained and dense, with few to no voids and essentially no intergranular pore spaces. Interbedded within the iron formation are shales and cherts that can form bands up to 40 m thick. The shales and cherts are similarly non-porous. Thus, it is unusual for BIF host rock to contain significant troglofauna habitat.

11.3.3.3 Stygofauna habitats

The Proposed Mining Area C Development Envelope occurs in the subcatchment of Weeli Wolli Creek, which is a tributary of the Fortescue River (for more detail refer to Sections 5.6 and 11.4). The Weeli Wolli Creek subcatchment is divided into three subcatchments: 1) Upper Weeli Wolli Creek subcatchment (1,877 km²); 2) Marillana Creek subcatchment (2,050 km²); and 3) Lower Weeli Wolli Creek subcatchment (210 km²) into which the first two flow. The Weeli Wolli Creek subcatchment is flanked by the Coondewanna subcatchment (862 km²), which is part of the Ashburton River catchment. Groundwater sometimes flows across the catchment divide between the Upper Weeli Wolli Creek subcatchment and the Coondewanna subcatchment (URS, 2014). Suitable habitat for stygofauna occurs within both the Upper Weeli Wolli and Coondewanna subcatchments; highest potential habitat occurs where depth to groundwater is less than 40 m within geological units that contain vugs or cavities (e.g. calcrite).

Upper Weeli Wolli subcatchment. The local hydrogeology in the Upper Weeli Wolli Creek subcatchment has been described in RPS (2014), and the information is summarised here. Weeli Wolli Creek and its tributaries flow along valleys confined by outcrops of the Marra Mamba Iron and Brockman Iron formations. Preferential weathering of the Wittenoom Formation between these outcrops has resulted in a low-lying area that has since been filled with Tertiary detrital deposits largely composed of alluvium sourced from the surrounding outcrops and chemically precipitated calcrite. Tertiary
sediments are up to 75 m thick upstream of Weeli Wolli Spring and approximately 20 m thick at the spring.

In the bedrock under Weeli Wolli Spring and the calcrite aquifer immediately upstream of it there are the Wittenoom Formation; Mount Sylvia Formation (low permeability); Mount McRae Shale (low permeability); and Brockman Iron Formation (unmineralised and of low permeability).

The Brockman Iron Formation and Mount McRae Shale are particularly resistant to erosion and form a prominent ridge (the Wildflower Range) along the northern extent of the Upper Weeli Wolli subcatchment. Weeli Wolli Creek flows through this ridge (across the regional geological strike) in a narrow fault-controlled valley. Under the creek, the erosion-resistant Brockman Iron and Mount McRae formations rise to shallow subcrops (i.e. they form a rock bar).

The Tertiary sediments contain an extensive calcrite deposit that has a saturated thickness of around 5 m and is vuggy and permeable. Based on the morphology of Australian groundwater calcrites and because the base of the calcrite sits just below the water table, Weeli Wolli Spring is likely to be an area of active calcrite formation. The calcrite is incised by the creek channel, which is in-filled with Quaternary alluvium. The calcrite is underlain by poorly sorted alluvium of clay, sands and gravels that overlies the bedrock.

**Coondewanna subcatchment.** The local hydrogeology in the Coondewanna subcatchment has been described in URS (2014) and is summarised here. The Coondewanna subcatchment operates as an internally draining system. However, it is hydraulically connected to the regional aquifer systems and overflows to the east during extreme flood events. According to site-specific data and modelling, except during flood events the local aquifers in and around the Coondewanna subcatchment mostly act as discrete or semi-discrete compartments controlled by structure and stratigraphy.

The key hydrogeological units present in the Coondewanna subcatchment comprise: Tertiary detrital valley-fill; calcrite/silcrete; and dolomite.

Overall, the structure of aquifers in the Coondewanna subcatchment is highly variable and not well documented. Weathered, vuggy and karstic formations associated with hydrated zones, dolomite in the Wittenoom Formation, and alluvial successions may act as locally significant aquifers. Calcrites/silcretes horizons show only small cavities and vugs, which may mean the upper detrital zone contains perched aquifers with which calcrite is associated.

The northeast to southwest striking dolerite dykes in the southeast of the catchment form hydraulic barriers and impede groundwater flow, causing local mounding and shallow water tables upstream of the dykes. The water table is around 18 to 23 mbgl in most of the subcatchment. There is a drop of around 30 m in groundwater levels (to 50+ mbgl) in the southeast.

**11.3.3.4 Troglofauna community**

A total of 3,585 specimens of troglofauna have been collected in the Proposed Mining Area C Development Envelope (Appendix 6). These specimens represent at least 126 species from 19 orders (Table 44). Eighty-eight of these species have only been recorded from within the Proposed Mining Area C Development Envelope to date, although a number of these have a wide distribution within it (Table 44). Insects were numerically dominant, and schizomids were also relatively common. Most species, however, occurred at very low abundance, and 49 species were represented by only one specimen (singleton).
Table 44: Troglafauna species recorded in the Proposed Mining Area C Development Envelope

Shading indicates species only known from pit areas within the Indicative Additional Impact Assessment Area (IAIA; orange), Mining Area C EMP Revision 6 Impact Assessment Area (R6; green), or both (blue). Note: MACR = areas outside indicative impact assessment areas within the Proposed Mining Area C Development Envelope (PMACDE).

<table>
<thead>
<tr>
<th>Species</th>
<th>No. Individuals</th>
<th>IAIA</th>
<th>R6</th>
<th>MACR</th>
<th>Recorded Outside PMACDE</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chelicerata</strong></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Arachnida</td>
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<td></td>
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<tr>
<td><strong>Pseudoscorpiones</strong></td>
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<tr>
<td><em>Lagynochthonius</em> <code>PSE039</code></td>
<td>21</td>
<td>7</td>
<td>9</td>
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<tr>
<td><em>Lagynochthonius</em> <code>PSE045</code></td>
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<td>PMACDE (Deposits P2, P3)</td>
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<td><em>Tyrannochthonius</em> <code>PSE050</code></td>
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<td><em>Tyrannochthonius</em> <code>PSE055</code></td>
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<td><em>Tyrannochthonius</em> sp. B14</td>
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<td><em>Tyrannochthonius</em> sp. S05*</td>
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<td><em>Indohya</em> <code>PSE005</code></td>
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<td><strong>Palpigradi</strong></td>
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<td><em>Eukoenenia</em> sp. S01</td>
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<td>PMACDE (Deposits P4, P5, P6) Mudlark</td>
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<td><strong>Schizomida</strong></td>
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<td><em>Draculoides</em> <code>SCH012</code></td>
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<td><em>Draculoides</em> <code>SCH023</code></td>
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<td><em>Draculoides</em> sp. B16</td>
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<td><em>Draculoides</em> sp. B20</td>
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<td><em>Draculoides</em> sp. B47</td>
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<td>PMACDE (Deposits A, B)</td>
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<tr>
<td>Species</td>
<td>No. Individuals</td>
<td>MACR</td>
<td>Recorded Outside PMACDE</td>
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**Araneae**

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**Opiliones**

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**Crustacea**

**Malacostraca**

**Isopoda**

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<td>Troglamadillo sp. B11</td>
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<td><em>Troglamadillo</em> sp. B13</td>
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**Myriapoda**

**Chilopoda**

**Geophilida**

*Australoschendyla* sp. B06 | 2 |      | No       | PMACDE (Southern Flank) |

**Chilopodidae** sp. B07 | 1 |      | No       | PMACDE (Southern Flank) |

**Scolopendrida**

*Cryptops* sp. B07 (=*Scolopendrida* sp. S02) | 2 | 1 | 2 | Yes | PMACDE (Deposits P2, P5), Jinidi |

*Cryptops* sp. B10 (=*Scolopendrida* sp. S05) | 1 |      | Yes | PMACDE (Deposit P1), Eastern Ridge |

*Cryptops* sp. B15 | 2 |      | Yes | PMACDE (Deposits R, P2), Juna Downs |

*Cryptops* sp. B16 | 2 | 1 | No | PMACDE (Southern Flank) |

*Cryptops* sp. B39 | 1 |      | No | PMACDE (Deposit P2) |

*Cormocephalus* 'CHI003' | 1 | 1 | Yes | PMACDE (Deposits P2, P4), Elsewhere in the Pilbara |

*Scolopendrida* sp. B01* | 1 |      | No | PMACDE (Deposit A) |

**Diplopoda**

**Polydesmida**

*Polydesmida* sp. B11 | 1 |      | No | PMACDE (Southern Flank) |

**Polyxenida**

*Lophoturus* madecassus | 33 | 91 | 29 | Yes | PMACDE (Deposits A, B, F, R, P1, P2, P3, P4, P5, Southern Flank), Eastern Ridge, Jimblebar, Jinidi, Juna Downs, Mindy, Mudlark, Orebody 19, Orebody 31, Orebody 39, Orebody 39, Packsaddle East, Whaleback, Yandi, Elsewhere in the Pilbara |

**Spirobolida**

*Trigoniulidae* sp. | 1 |      | Yes | PMACDE (Deposit R), Orebody 19, Packsaddle East, Elsewhere in the Pilbara |

**Pauropoda**

**Tetramerocerata**

*Allopauroptes* sp. B11 | 1 |      | Yes | PMACDE (Southern Flank), Mudlark |
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<td>Nocticola ‘quartermainei’ ms</td>
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<td>Meenoplidae sp. B03 (winged, remnant eyes)</td>
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<td>Yes PMACDE (Deposit P1), Jimblebar, Jinidi, Mindy, Mudlark, Orebody 19, Orebody 21/22, Elsewhere in the Pilbara</td>
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<td>Meenoplidae sp. B04 (small eyes, faint pigment)</td>
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* Species restricted to areas approved for impact under Revision 5 of the Mining Area C EMP so not considered in Revision 6 EMP assessment.
Within the Approved Mining Area C (Northern Flank) Development Envelope, 1,650 specimens of troglofauna have been collected, representing at least 81 species from 17 orders (Table 44). In the Additional Development Envelope, 405 specimens of troglofauna have been collected, representing at least 51 species from 16 orders (Table 44).

Within the Mining Area C EMP Revision 6 Impact Assessment Area (pits only), 1,627 specimens of troglofauna have been collected, representing at least 78 species from 16 orders (Table 44). In the Indicative Additional Impact Assessment Area, 600 specimens of troglofauna have been collected, representing at least 51 species from 16 orders (Table 44).

Forty-one of the 126 species recorded in the Proposed Mining Area C Development Envelope to date have only been recorded in proposed impact assessment areas. These species are discussed further in Section 11.3.3.7.1.

11.3.3.5 Stygofauna community

A total of 6,289 specimens of stygofauna have been collected within the Weeli Wolli and Coondewanna subcatchments (i.e. the Groundwater Assessment Area, Mining Area C EMP Revision 6 Groundwater Assessment Area and Reference Area) (Table 45, Appendix 6), comprising at least 60 species from ten higher level groups (flatworms, nematodes, rotifers, segmented worms, mites, ostracods, copepods, syncarids, amphipods and isopods) (Appendix 6).

In the Groundwater Assessment Area, 27 stygofauna species have been recorded (Table 45), ten of which have not been recorded outside the area of cumulative groundwater drawdown. Two species (Ainudrilus sp. WA26 (PSS) and Bathynella sp. 1) have only been recorded from the Groundwater Assessment Area; four (Dussartcyclops sp. B10, nr Epactophanes sp. B01, Bathynella sp. 2 and nr Notobathynella sp. S01) have only been recorded from the Mining Area C EMP Revision 6 Groundwater Assessment Area; and four (Halacaridae sp. B01, Schizopera sp. B02, Notobathynella sp. and Paramelitidae sp. S04 (BR South)) have records that only occur within both these areas. These species are discussed further in Section 11.3.3.7.3.

Weeli Wolli Spring itself is the richer of the two parts of the Weeli Wolli Spring PEC, with 26 stygofauna species recorded in this part of the Weeli Wolli Spring PEC and its buffer. Of these, 24 were collected in the Groundwater Assessment Area or Mining Area C EMP Revision 6 Groundwater Assessment Area. Only three species have been collected in the Ben’s Oasis buffer.

11.3.3.6 Potential impacts

This section summarises potential direct and indirect impacts from mining within the Proposed Mining Area C Development Envelope. For troglofauna these are impacts from those activities undertaken within the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area (mine pits only), and for stygofauna these are within the Groundwater Assessment Area and Mining Area C EMP Revision 6 Groundwater Assessment Area (Table 46). Potential cumulative impacts within the catchment for stygofauna and troglofauna are considered where information is available.

Information has been summarised from stygofauna and troglofauna impact assessments undertaken in 2015 for update of the EMP Revision 6 (Bennelongia 2015a, b) and in 2016 for the Additional Impact Assessment Area (Bennelongia 2016a, b). Information from the 2015 impact assessments has been updated, where appropriate, in consideration of changes to species taxonomy, conservation listings or increased knowledge of species ecology or distribution. All supporting documents are provided in Appendix 6.
Table 45: Stygofauna species recorded in the Groundwater Assessment Area or Mining Area C EMP Revision 6 EMP Groundwater Assessment Area

Shading indicates species only known from the Groundwater Assessment Area (GAA; orange), Mining Area C EMP Revision 6 Groundwater Assessment Area (R6GAA; green), or both (blue). Note: RA = areas outside groundwater assessment areas

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<td><strong>Maarrka weeliwollii</strong></td>
<td>3 11 Yes</td>
<td>WWLower Weeli Wolli and Marillana catchments⁵</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Paramelitidae Genus 2 sp. B02</strong></td>
<td>44 211 9 Yes</td>
<td>WW, BOEastern Weeli Wolli catchment⁵</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Paramelitidae Genus 2 sp. B03</strong></td>
<td>5 6 Yes</td>
<td>Lower Weeli Wolli and Marillana catchments⁵</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Paramelitidae sp. B03</strong></td>
<td>175 6 Yes</td>
<td>Weeli Wolli catchments⁴</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Paramelitidae sp. B04</strong></td>
<td>1 Yes</td>
<td>Known only from a single drill hole³</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Paramelitidae sp. B16</strong></td>
<td>4 Yes</td>
<td>Lower Weeli Wolli and Marillana catchments⁴</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Paramelitidae sp. S04 (BR South)</strong></td>
<td>55 33 No</td>
<td>Known only from these records⁵, previously assessed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Isopoda</strong></td>
<td><strong>Tainisopidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Pygolabis weeliwolli</strong></td>
<td>16 7 20 Yes</td>
<td>WWLower Weeli Wolli and Marillana catchments⁵</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 46: Impact Assessment Area for Subterranean Fauna

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal extent (Cumulative Impacts)</th>
<th>Regional extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subterranean Fauna (stygofoana)</td>
<td>Groundwater Assessment Area</td>
<td>Groundwater Assessment Area and Mining Area C EMP Revision 6 Groundwater Assessment Area</td>
<td>As for Mining Area C Revised Proposal Extent. This area is predicted from modelling that is inclusive of third party operations such as Hope Downs 1 and therefore Proposed Extent is representative of potential regional impacts.</td>
</tr>
<tr>
<td>Subterranean Fauna (troglofoana)</td>
<td>Indicative Additional Impact Assessment Area and Additional Development Envelope (pit areas with buffer only). Mining Area C EMP Revision 6 Impact Assessment Area (pit areas with buffer only).</td>
<td>Mining Area C EMP Revision 6 Impact Assessment Area and Indicative Additional Impact Assessment Area</td>
<td>As per the Proposed Mining Area C Revised Proposal Extent, as there is little description on troglofauna species and/or no information available for regional records.</td>
</tr>
</tbody>
</table>

The sampling of subterranean fauna has inherent limitations given the available sampling methods and the current state of knowledge on the ecology and taxonomy of troglofauna and stygofauna. Study of subterranean fauna is in its infancy and knowledge of species, populations and communities is rapidly advancing, with BHP Billiton Iron Ore providing extensive data and support for ongoing work on subterranean fauna in the Pilbara (e.g. Trotter et al., 2017). Sampling currently shows a bias to within mining tenure and therefore regional representation is not well understood. Notwithstanding these limitations, BHP Billiton Iron Ore has applied rigour in sampling, data and impact assessment and is confident in our ability to adaptively manage impacts to subterranean fauna.

Potential limitations include:

- **Constrained sampling:** Subterranean fauna sampling is likely to underestimate the true ranges of most species because it is spatially constrained. Drill holes are usually only available for sampling within the tenements of the proponent company and only in areas considered prospective for mining.

- **Low abundance species:** Reliable definition of the ranges of low abundance species requires extensive sampling (Miller et al., 1989, Guisan et al., 2006). Despite a general trend for low abundance species to have smaller ranges than abundant species (Brown, 1984), many low abundance species have widespread, patchy occurrence (Maurer, 1990). Thus, few direct inferences can be drawn about the likely ranges of species collected in the impact assessment areas from few samples, especially species collected as singletons. The likely ranges of these species are most accurately defined using the known ranges of related species and the potential continuity of the surrounding habitat (see EPA, 2013d).

- **Incomplete and inconsistent taxonomy:** The majority of species recorded within the Proposed Mining Area C Development Envelope are undescribed and are only known from within it. A taxonomic database for undescribed troglofauna species in Western Australia, such as would be provided by WAMinals (http://museum.wa.gov.au/research/databases/waminals) is largely incomplete and if the same species is collected by different consultancies it is usually given different informal names. This adds to the difficulty of determining accurate species ranges,
and a number of species may have larger ranges than described in this report. For example, Rio Tinto Iron Ore’s Baby Hope Downs project lies immediately adjacent to Southern Flank within the same ridge. It is likely that the Southern Flank troglofauna community extends into this area but none of the species recorded in the Baby Hope Downs area have the same nomenclature as species at the Proposed Mining Area C Development Envelope (Biota, 2015c). This may be due to the inconsistent application of taxonomy and the lack of species descriptions for most troglofauna within the Pilbara. In fact, from photographs the dipluran Japygidae sp. at Baby Hope Downs appears to possibly be Japygidae ‘DPL002’ collected widely in the central Pilbara and the schizomid Draculoides sp. BHD4 belongs to lineage within Draculoides that is represented by six species at Mining Area C. It is possible that Draculoides sp. BHD4 is recorded under a different name within the Proposed Mining Area C Development Envelope.

11.3.3.7 Direct impacts

11.3.3.7.1 Troglofauna species

Mining may potentially impact species that have all or most of their range restricted to proposed pit areas within the Indicative Additional Impact Assessment Area or Mining Area C EMP Revision 6 Impact Assessment Area or cumulatively if all known records occur within these two areas.

Impact assessments for troglofauna were undertaken by Bennelongia (2015a, 2016a) and are provided in Appendix 6. The assessments included a determination of the likelihood of habitats from which restricted troglofauna were recorded extending outside the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area. When inferring the ranges of individual species using habitat profiling and mapping, it is often necessary to make some assumptions about which of the potentially prospective geological units are actually used by that species. These assumptions depend on factors such as the number of drill holes yielding the species, capture methods, and whether more than one geological unit was present within a hole. Other assumptions about the innate biological constraints on the maximum range of a species may also be made, depending on the variation in life history characteristics of related species and current scientific understanding and knowledge of some species. To ensure these assumptions are accounted for, BHP Billiton Iron Ore has applied the categories described below to indicate the likelihood of species being restricted to the Indicative Additional Impact Assessment Area and/or the Mining Area C EMP Revision 6 Impact Assessment Area to ensure that impact assessments are undertaken on best on available data. Three likelihood categories were used:

- **Possibly.** The available information suggests there is ≥40% probability that the species is restricted.
- **Unlikely.** The available information suggests there is ≤40% probability that the species is restricted.
- **Uncertain.** There is insufficient information to assign a probability of the species being restricted. Given that the species is known only from the indicative impact assessment areas, it is treated as likely to be restricted.

Twenty of the 126 species recorded in the Proposed Mining Area C Development Envelope have only been recorded from the Indicative Additional Impact Assessment Area, and 20 have been recorded only from the Mining Area C EMP Revision 6 Impact Assessment Area. One species is only known from records within the two areas. Twenty-two of the 41 species only recorded from impact assessment areas are singletons (i.e. only known from single records) and a further two have multiple records from a single bore.

Four species (three of which are singletons, and one has multiple records from a single bore) are considered to possibly be restricted to the Indicative Additional Impact Assessment Area and for one
(which is a singleton) the status is uncertain. The remaining 15 species are considered unlikely to be restricted to the Indicative Additional Impact Assessment Area. Note that further investigations were undertaken in relation to the above five species as discussed in detail below.

The status of three of the 20 species (Hanseniella sp. B08, Symphyella sp. B03, and Parajapygidae sp. S03) only known from the Mining Area C EMP Revision 6 Impact Assessment Area is considered uncertain because there is currently little information on which to infer the likely ranges for each of these species. The latter two species are only known from single records.

Indohya ‘PSE005’, which is the only species with records restricted to both impact areas, is considered unlikely to be restricted to areas of proposed or approved impact.

Key findings from the assessment are provided in Table 47 and Figure 32.

Impact assessments undertaken for the Proposal suggest that of the 126 species recorded in the Proposed Mining Area C Development Envelope, the Proposal may impact eight species i.e. 6% or less. Of these eight species, half are possibly impacted and half have uncertain potential impacts. Six are only known from single records (i.e. singletons) and a further one species is only known from multiple records from a single bore. Based on the fact that 6% or less of species may be impacted, BHP Billiton Iron Ore considers that the impacts to troglofauna resulting from the Proposal are not significant. The impact assessment also concluded that the the potential impact to troglofauna populations and assemblages are likely to meet the EPA objective.

11.3.3.7.2 Troglofauna habitats

Detailed habitat assessments have been undertaken for each potentially restricted species within the Proposed Mining Area C Development Envelope (BHP Billiton Iron Ore, 2015d, 2016h), and the results of these were considered for the impact assessment in the previous section. There are inherent scientific difficulties with the undertaking of an impact assessment for troglofauna habitats as:

- Different species use different habitats (geological units, e.g. West Angela, Mount Newman, Detritals) within the strata, and these generally do not correlate with surficial geological mapping;
- The suitability of each of these geological units depends on the species type, the depth from the surface, and the microhabitats within them (i.e. porosity, vuggyness, cracks and voids); and
- Areas that are saturated (i.e. intersect the water table) are not suitable for troglofauna, but these areas may change with natural fluctuations or variations in groundwater levels.

Nevertheless, it is possible to determine relative impacts to troglofauna habitats based on the extent of these subsurface habitats outside the proposed areas of impact (pit voids) and if there are any barriers to movement on a macro scale, which can be determined from the presence of dykes or faults (although the latter may also encourage movement of troglofauna between geological units).

Based on the troglofauna habitat assessments completed for Southern Flank (BHP Billiton Iron Ore, 2016h) suitable troglofauna habitat is hosted within the Mount Newman units of the Marra Mamba Iron Formation, West Angela units of the Wittenoom Formation and the Tertiary Detritals. Above the water table, Mount Newman extends beyond areas of impact to the north and east at the western end of the orebody, and also forms a large area between areas of impact and also to the southeast. West Angela is present outside areas of impact in an east-west direction extending for kilometres along the south of the central and eastern parts of the orebody. Detritals are extensive to the south of Southern Flank, filling a broad valley north of Mount Robinson.
Hardcap alteration across Southern Flank is generally observed in the upper 15-30 m of bedrock, although it has been interpreted to depths of around 100 m in areas of deep detritals, such as in the south of the deposit outside areas of impact. In general, the hardcap alteration ranges from extremely hardcapped, which is angular, porous and exceptionally vuggy to semi-hardcap alteration that is angular, porous, pitted material with little to no vuggs. The main structural features present are two thrust faults, which dip shallowly to the south and are observed to be continuous across the entire Southern Flank area. Distribution of widespread troglofauna species throughout Southern Flank suggests that these faults do not limit connectivity through the Southern Flank deposit (Figure 33), although this may not be the case for all species. A dolerite dyke has been interpreted in the western end of the deposit; however this exists beneath the water table and is therefore not thought to influence troglofauna mobility across the Proposal area.

Within Mining Area C, troglofauna habitat occurs in both the Packsaddle and Jirrpulpur Ranges. Within the Packsaddle Range it is hosted within the Tertiary Detritals, Joffre and Dales Gorge Members of the Brockman Iron Formation. Within the Jirrpulpur Range it occurs in the Tertiary Detritals, West Angelas Member of the Wittenoom Formation, and the Mount Newman and MacLeod Members of the Marra Mamba Iron Formation. Above water table Joffre extends north outside of the Proposed Mining Area C Development Envelope. Tertiary Detritals fill a deep valley between the Packsaddle and Jirrpulpur Ranges and are extensive outside the Mining Area C EMP Revision 6 Impact Assessment Area. The MacLeod Member continues outside of the Mining Area C EMP Revision 6 Impact Assessment Area to the south of the Jirrpulpur Range.

Hardcap alteration at Mining Area C is common, especially through the Packsaddle Range. It is often strongest near the surface and grades into semi-hardcap and then unaltered rock with depth. Core photos from along the Packsaddle Range showed the hardcap alteration to be exceptionally vuggy with larger cavities also present in some locations.

A troglofauna habitat assessment for the Approved Mining Area C (Northern Flank) Development Envelope (BHP Billiton Iron Ore, 2015d) showed that the area has been subjected to a number of major deformation events that have caused wide scale folding and faulting. East-west trending normal faults (south block down) occur throughout Packsaddle Range. At a regional scale this is mapped as one major fault. Major and minor thrust faults (south block up) have been identified throughout the Jirrpulpur Range, mostly cross cutting the Mount Newman and West Angela Members of the Marra Mamba Iron Formation. There was no evidence found during the habitat assessment that suggested that these faults restrict movement of troglofauna, on the contrary it was considered that fault fracturing may aid dispersal in some instances (BHP Billiton Iron Ore, 2015d).
Table 47: Key findings from the troglofauna impact assessments

Species in bold may be possibly restricted to the Indicative Additional Impact Assessment Area or their status is uncertain

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Total Records</th>
<th>Summary of Findings</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Anapistula</em> sp. B02</td>
<td>1</td>
<td>Another species of the genus (<em>Anapistula</em> sp. B01) has a known linear range of 17 km in the central Pilbara (Bennelongia unpublished data). This suggests that moderately wide ranges can be expected for species of <em>Anapistula</em>. <em>Anapistula</em> sp. B02 is known from a single record occurring 650 m within R Deposit. The record of this species occurs within consolidated alluvium, logged by BHP Billiton Iron Ore as tertiary detritals (TD3, TD2 and TD1) (BHP Billiton Iron Ore, 2015d). Based on geological mapping the alluvium is continuous to the north, extending well outside of the R Deposit pit. Hence, it is expected that <em>Anapistula</em> sp. B02 will not be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td><em>nr Andricophiloscia</em> sp. B16</td>
<td>1</td>
<td>Recorded from one sample (trap) in Southern Flank. There are limited data on species distribution on other members of <em>nr Andricophiloscia</em> as most are only known from a single specimen. Trap depth suggests that this species occurs in the West Angela Member which at this location does not extend outside the Indicative Additional Impact Assessment Area in this location.</td>
<td>Limited information available from single record. Currently considered to possibly to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Atelurinae</em> sp. B04</td>
<td>1</td>
<td><em>Atelurinae</em> sp. B04 is a singleton record approximately 150 m within the boundary of B Deposit. It occurs in unmineralised shales and BIF of the MacLeod Member with hardcap occurring from 0-13 m and semi-hardcap from 13-33 m depth. Similar suitable habitat in the MacLeod Member extends to the west and south of the B Deposit pit.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Australoschendyla</em> sp. B06</td>
<td>2</td>
<td>Recorded from two holes with a linear range of 6.6 km and likely from detritals that occur in the top 30 to 40 m from which these holes intersect. The detritals in these locations extend outside the Indicative Additional Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Chilenophilidae</em> sp. B07</td>
<td>1</td>
<td>Recorded from one hole in detritals. At this location, the detritals extend outside the Indicative Additional Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Cryptops</em> sp. B39</td>
<td>1</td>
<td>Species of <em>Cryptops</em> have been found to be very wide-ranging in the Pilbara and, for this reason, it is considered likely that most species collected as troglofauna are troglophiles with a surface dispersal phase in their life history. <em>Cryptops</em> sp. B39 is known from a single record from within P2 Deposit. The record is located within the mapped colluvium, which has been</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cryptorrhynchinae sp. S03</td>
<td>1</td>
<td>Cryptorrhynchinae sp. S03 is known from a single record within P4 Deposit in a drill hole containing unenriched Joffre BIF with some hardcap and semi-hardcap. Hardcap is known to extend beyond both the northern and southern boundaries of P4 Deposit pit. Joffre BIF extends to the north of the maximum pit extent (BHP Billiton Iron Ore, 2015d). Given the prospective habitat outside the proposed mine pit at P4 Deposit and the reasonably widespread nature of other species of the family Curculionidae, Cryptorrhynchinae sp. S03 is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Draculoides sp. B20</td>
<td>4</td>
<td>Recorded from four locations in the Indicative Additional Impact Assessment Area with a linear range of at least 10 km. Records are from drill holes intersecting the Mount Newman or MacLeod Members in both mineralised and unmineralised stratigraphy. The species appears to occur in and possibly move between these two BIF units.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Draculoides sp. B47</td>
<td>9</td>
<td>Draculoides sp. B47 has been recorded from a number of drill holes at both A Deposit and B Deposit and has a known linear range of 4.4 km. It has primarily been recorded in the following geologies: hardcap Marra Mamba and alluviuys/colluvials at A Deposit; and alluviuxs/colluvials and both mineralised and un-mineralised Marra Mamba at B Deposit (BHP Billiton Iron Ore unpublished data). Given the demonstrated distribution of this species, it is likely Draculoides sp. B47 occurs outside of the Mining Area C EMP Revision 6 Impact Assessment Area, in the area immediately south of A Deposit, where similar geology is present (BHP Billiton Iron Ore, 2015d; BHP Billiton Iron Ore unpublished data).</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Draculoides sp. B59-DNA</td>
<td>2</td>
<td>Recorded from two individuals within one drill hole located approximately 5 m from the boundary of Indicative Additional Impact Assessment Area. The linear range of other Draculoides within Southern Flank range between 0.2 km and more than 10 km. This species has been recently differentiated from Draculoides sp. B16 and hence a detailed habitat assessment has not been undertaken; however, it is assumed that it will utilise weathered BIF. Given the proximity of this location to the edge of the Indicative Additional Impact Assessment Area it is considered likely that this species occurs in habitats outside.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Gnaphosidae sp. B01</td>
<td>1</td>
<td>A single Gnaphosidae sp. B01 specimen has been collected within the P2 Deposit approximately 95 m from the northern boundary of the pit. The record is within the mapped</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td><strong>Hanseniella sp. B07</strong></td>
<td>7</td>
<td>Recorded from four drill holes in Southern Flank and one location at Deposit R (in the Mining Area C EMP Revision 6 Impact Assessment Area), with a linear range of 24 km. Analysis of record locations suggests that its preferred habitat is detritals, and there is continuity of this unit outside of the Indicative Additional Impact Assessment Area in the locations from which these species have been recorded.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><strong>Hanseniella sp. B08</strong></td>
<td>4</td>
<td><em>Hanseniella</em> sp. B08 was recorded from four drill holes on the margin between P3 Deposit and P2 Deposit. All four of the drill holes contain unmineralised BIF (Brockman Iron Formation) with hardcap that becomes semi-hardcap with depth. Mapping suggests that surface expression of Brockman Formation (Joffre) extends continuously to the north and east of the P2 Deposit proposed pit. Furthermore, P2 Deposit is cross cut by a number of faults and splays (BHP Billiton Iron Ore, 2015d), which most likely provides conduits for movement of troglofauna.</td>
<td>It is uncertain whether this species is restricted to Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td><strong>Hanseniella sp. B34</strong></td>
<td>1</td>
<td>Recorded from one location with colluvium and alluvium geologies. At this location, this unit extends north outside of the Indicative Additional Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><strong>Indohya ‘PSE005’</strong></td>
<td>9</td>
<td><em>Indohya ‘PSE005’</em> has been collected widely within the Proposed Mining Area C Development Envelope. The species has a range of at least 21 km, although all known locations are currently within the Mining Area C EMP Revision 6 Impact Assessment Area and Indicative Additional Impact Assessment Areas. An assessment of habitats from which it has been recorded suggests that it is a relatively mobile species that is capable of inhabiting various lithologies. Based on the wide documented range of the species across multiple geologies, it is considered unlikely that <em>Indohya ‘PSE005’</em> is restricted to the Indicative Additional Impact Assessment and Current Mining Area C EMP Revision 6 Impact Assessment Area. It probably also occurs outside the Proposed Mining Area C Development Envelope.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
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</tr>
<tr>
<td><em>Indohya</em> sp. S02</td>
<td>2</td>
<td>The two records of <em>Indohya</em> sp. S02 have been collected very close to the proposed pit boundary at P6 Deposit (75 m and 35 m from the boundary). Based on regional geological mapping, these drill holes occur in ferricrete (laterite, unmineralised shales). Based on the mapped geology and the topography of the area, there are no barriers to this species moving within the same or similar geological units outside of the Project Area (BHP Billiton Iron Ore, 2015d). It is likely that <em>Indohya</em> sp. S02 occurs more widely in the adjacent habitat.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Japygidae</em> <code>DPL005</code></td>
<td>2</td>
<td>Recorded from two locations over a linear range of 15 km. Species from this family are known to have ranges over 20 km, and it is believed that a significant number have an above ground dispersal phase that enables them to be moderately widespread. The geological units suggest that it occurs in the Mount Newman or West Angela members, but it may also occur in the upper detritals. The ecology of <em>Japygidae</em> species suggests that this species is likely to be widespread in the Southern Flank area.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Japygidae</em> <code>DPL007</code></td>
<td>3</td>
<td>Recorded from two locations, one at Southern Flank and one at Deposit R (in the Mining Area C EMP Revision 6 Impact Assessment Area), with a linear range of 6 km. At both locations, it was recorded in colluvium and alluvium. These extend beyond the Indicative Additional Impact Assessment Area at these locations.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Parajapygidae</em> <code>DPL023</code></td>
<td>2</td>
<td>Recorded from two locations at Southern Flank with a linear range of 3 km. One record is from colluvium and alluvium geology, which extends outside of the Indicative Additional Impact Assessment Area at this location.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Parajapygidae</em> <code>DPL024</code></td>
<td>1</td>
<td>Recorded from a single location. The drill hole intersected 6 m of scree over extensive West Angela and Mount Newman Members, which appear to be restricted to the Indicative Additional Impact Assessment Area at this location. <em>Parajapygidae</em> is known to contain a number of species that are moderately widespread and have an above ground dispersal phase; however, some may be restricted to the subsurface and have a limited range. It is either a troglophile occupying surface scree therefore has an above ground dispersal phase ensuring it likely to have a wide distribution or a troglobite in Marra Mamba Formation that is likely to be restricted to the Indicative Additional Impact Assessment Area.</td>
<td>It is <em>uncertain</em> whether this species is restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td><em>Parajapygidae</em> sp. B25</td>
<td>1</td>
<td>Recorded from a single location, in a hole mapped as consolidated alluvium. At this location, the geology extends outside of the Additional Impact Assessment Area.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
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<td>-------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Parajapygidae sp. B27</td>
<td>1</td>
<td>Parajapygidae sp. B27 is known from a single record within P2 Deposit. It occurs in an area mapped as unmineralised Joffre BIF, with hardcap occurring from 0-12 m and semi-hardcap occurring from 12-36 m. Unmineralised Joffre BIF extends continuously outside of the P2 Deposit pit with a surface expression of approximately 4.7 km². Furthermore, a number of faults and splays occur at P2 Deposit (BHP Billiton Iron Ore, 2015d). This fracturing may provide conduits for troglofauna movement. The extension of Joffre BIF and faults and splays outside P2 Deposit reduces the likelihood that Parajapygidae sp. B27 is restricted to the mine pit within this deposit.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td><strong>Parajapygidae sp. S03</strong></td>
<td>1</td>
<td>Parajapygidae sp. S03 is known from a single record within P6 Deposit. The geology of the drill hole consists of mineralised detritals (TD3) and Dales Gorge Member with hardcap occurring from 0 to 27 m (BHP Billiton Iron Ore, 2015d). Hardcap is known to extend outside of the Mining Area C EMP Revision 6 Impact Assessment Area, but the remainder of the geology in the surrounding area is not well understood (BHP Billiton Iron Ore, 2015d). Parajapygidae sp. S03 probably occurs outside P6 Deposit pit but the limited data for this species (and family) and the poor understanding of the geology nearby mean there is uncertainty about the likely range of this species.</td>
<td>It is uncertain whether this species is restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Pauropodidae sp. B12</td>
<td>1</td>
<td>The taxonomy of pauropods in Australia is not well established (Scheller 2013) but some species in the Pilbara have extensive ranges, such as Pauropodidae sp. B01 (known linear range of 287 km), while other species typically have smaller ranges in the order of 10 km or less (Bennelongia, unpublished data). Pauropodidae sp. B12 is known from a single record, which was collected approximately 120 m inside the northern boundary of the P3 Deposit. Drill-hole logs suggest Pauropodidae sp. B12 occurs within hardcapped Weeli Wolli Formation BIF. Based on the surface geological mapping both the Weeli Wolli Formation and the hardcap alteration extend well to the north of the P3 Deposit pit (BHP Billiton Iron Ore, 2015d).</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Philosciidae sp. B03</td>
<td>17</td>
<td>This species was recorded on three occasions from the same drill hole with 17 individuals recorded. A number of these records were from traps, whose depth corresponded with the Mount Newman Member. One record is from a scrape, and therefore this record may have come from a different type of geology; other Philosciidae species are known to occur in detritals (e.g. Philosciidae sp. B15 below) and can be wide ranging. The Mount Newman Member at this location does not extend outside the Indicative Additional Impact Assessment Area.</td>
<td>Currently considered to possibly to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Philosciidae sp. B15</td>
<td>1</td>
<td>Recorded from one drill hole, which only intersected detritals above the water table. At this location, the detritals extend outside the Indicative Additional Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Prethopalpus julianneae</td>
<td>1</td>
<td>Known from a single record in the Indicative Additional Impact Assessment Area. Record is from a scrape sample, so unknown which geology type it could occur in, but it is considered likely to have been occupying the Mt Newman Member. MacLeod Member, a predominantly shale and chert upper layer of the Marra Mamba Formation, does occur more widely and may possibly also be suitable habitat although there is not strong evidence of Prethopalpus species using this geology. The Mt Newman Member at the location of this record does not extend continuously outside the Indicative Additional Impact Assessment Area and the species probably has a small range.</td>
<td>Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Prethopalpus maini</td>
<td>5</td>
<td>Known from five drill holes across Southern Flank with a linear range of 18 km. Records from most drill holes it was recorded from suggest that it occurs in the Mount Newman Member or in hardcap that extend outside the Indicative Additional Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Prethopalpus pearsoni</td>
<td>3</td>
<td>Prethopalpus pearsoni has a known linear range of 0.9 km at P4 Deposit. The drill holes from which it has been recorded occur within mapped unit Martite goethite (Joffre) and have been logged as Joffre Member with hardcap alteration present at depths of up to 30 m (BHP Billiton Iron Ore, 2015d). The modelled stratigraphy indicates that both the hardcap alteration and the Joffre units in which this species occurs extend to the north well beyond the pit boundary (BHP Billiton Iron Ore, 2015d). It is expected that the range of Prethopalpus pearsoni is larger than currently documented and that the species occurs beyond the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Prethopalpus sp. B06</td>
<td>2</td>
<td>Prethopalpus sp. B06 is known from two records at Mining Area C. One specimen was collected 20 m from the pit boundary of R Deposit and the other was at B Deposit. These records are separated by a linear distance of 7.7 km and an extensive sequence of alluvial deposits (BHP Billiton Iron Ore, 2015c). Although the specimens were collected from drill holes comprising Marra Mamba (including hardcap nearer the surface), it is likely this species makes some use of the alluvials that occur between R Deposit and B Deposit. Furthermore, suitable habitat in the hardcapped Marra Mamba extends to the north of B Deposit pit boundary; and suitable Marra Mamba habitat extends to the north of R Deposit (BHP Billiton Iron Ore, 2015d). It is, therefore, considered unlikely that Prethopalpus sp. B06 is restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Prethopalpus sp. B15</td>
<td>1</td>
<td>Recorded as bycatch in a stygofauna haul in Southern Flank, which intersected the Marra Mamba Iron Formation and detritals. It is considered likely to occur within the West Angela</td>
<td>Limited information available from single record collected as by-catch.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Prethopalpus sp. B24</td>
<td>1</td>
<td>Recorded from one sample in Southern Flank, which intersected detritals and mineralised West Angela and Mount Newman members stratigraphy. All these units are continuous outside the Indicative Additional Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Prethopalpus sp. (Araneae sp. S07)</td>
<td>1</td>
<td>Prethopalpus sp. (Araneae sp. S07) is known from a single record about 360 m within P5 Deposit. The record occurs within the mapped unit Brockman Formation (Mt Whaleback Shale). Hardcap has been logged from 0 to 21 m depth in the area, and it is likely that this hardcap and the shallower Dales Gorge Member are the units providing the suitable habitat for this species (BHP Billiton Iron Ore 2015d). Habitat mapping has shown hardcap extends from the collection site to beyond of the pit boundary.</td>
<td>It is considered unlikely to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Symphyella sp. B03</td>
<td>1</td>
<td>Symphyella sp. B03 is known from a single record within the R Deposit pit. It occurs within the Marra Mamba Formation where hardcap has been identified from 0 to 10 m depth (BHP Billiton Iron Ore, 2015d). Suitable habitat exists in the hardcapped MacLeod Member, which extends to the south of R Deposit. The hardcapped detritals to the north may also provide suitable habitat for this species. Symphyella sp. B03 probably occurs outside R Deposit pit but the limited data for this species (and genus) mean there is uncertainty about the range of the species.</td>
<td>It is uncertain whether this species is restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>?Theridiidae sp. B01</td>
<td>1</td>
<td>Species of Theridiidae have very rarely been collected as troglofauna in the Pilbara (Bennelongia unpublished data), so related species provide little basis for inferring the likely range of ?Theridiidae sp. B01. ?Theridiidae sp. B01 is known from a single record at D Deposit, approximately 120 m from the pit boundary. The collection site is within mapped colluvium and alluvium (detritals of ore, chert and BIF clasts) and Marra Mamba formation (Mount Newman Member and MacLeod Members) (BHP Billiton Iron Ore, 2015d). Suitable habitat within the detritals extends within and to the north of D Deposit and suitable habitat within the Mt Newman and MacLeod Members extends well to the south beyond the proposed mine pit (BHP Billiton Iron Ore, 2015d). While the range characteristics of the Theridiidae family are unknown, its occurrence in widespread colluvium and alluvium suggests the range of ?Theridiidae sp. B01 extends outside the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>It is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
</tr>
<tr>
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<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Troglarmadillo sp. B03</td>
<td>6</td>
<td>Troglarmadillo species in the Pilbara typically have ranges of 2-3 km (Halse and Pearson 2014). By comparison, <em>Troglarmadillo</em> sp. B03 is a wide-ranging species with a linear range of 17 km. The species has been recorded from six drill holes in A Deposit, D Deposit, E Deposit and F Deposit. It occurs within mapped geological units alluvium / colluvium and martite goethite superfine ore (BHP Billiton Iron Ore, 2015d). The moderately extensive range of the species and its occurrence in alluvium / colluvium at A, D, E and F deposits suggests it makes use of Tertiary detritals as habitat. Hence, <em>Troglarmadillo</em> sp. B03 is also likely to occur within the extensive Tertiary detrital deposits stretching along the valley to the north of the Range, where there has been almost no sampling because of the lack of drill holes.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Troglarmadillo sp. B14</td>
<td>12</td>
<td>Recorded on four occasions from two drill holes at depths corresponding with detritals which extend continuously to the south of the Indicative Additional Impact Assessment Area. The range of these records is 11.2 km. It probably occurs patchily in detritals throughout the Southern Flank ridge, including areas south of the Indicative Additional Impact Assessment Area.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Typhlozuphium longipenne</td>
<td>1</td>
<td><em>Typhlozuphium longipenne</em> is known from a single record occurring within an area of Joffre units that are mostly enriched (Fe &gt;50%) and have hardcap and semi-hardcap alteration from the surface to about 70 m depth (BHP Billiton Iron Ore, 2015d). Limited stratigraphic information is available to the north and south of the mine pit boundary at P2 and P3 Deposits but current resource modelling shows that suitable habitat for troglofauna is present in the Joffre Member to the north of the pit boundaries (BHP Billiton Iron Ore, 2015d). Further, the stratigraphy of P2 Deposit is cross cut by a number of faults and splays that may provide conduits for troglofauna movement to the north of the P2 Deposit mine pit.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Typhlozuphium sp. B03</td>
<td>1</td>
<td><em>Typhlozuphium</em> sp. B03 is known from a single record in F Deposit. Stratigraphy of the drill hole in which it was collected was not logged but, based on geological mapping, the outcropping unit is colluvium and alluvium (Tertiary detritals). Alluvial and colluvial material extends continuously outside of the F Deposit pit to the west and north (BHP Billiton Iron Ore, 2015d). It is likely that <em>Typhlozuphium</em> sp. B03 occurs only in the vicinity of Mining Area C but, if the species occurs in the Tertiary detritals within the mine pit, it probably also occurs beyond the pit.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Tyrannochthonius ‘PSE055’</td>
<td>17</td>
<td><em>Tyrannochthonius ‘PSE055’</em> has been recorded from 12 drill holes and has a linear range of 18.25 km across Mining Area C at Deposits A, F, P4 and P6. It is considered highly likely to occur in similar habitat across and potentially beyond its linear range and therefore is considered unlikely to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area (Bennelongia, 2017).</td>
<td>It is considered <em>unlikely</em> to be restricted to the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
</tr>
<tr>
<td>Taxon</td>
<td>Total Records</td>
<td>Summary of Findings</td>
<td>Predicted Outcome</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><em>Tyrannochthonius</em> sp. B14</td>
<td>1</td>
<td>Known from one specimen in the Indicative Additional Impact Assessment Area. The genus is typically known from small numbers of specimens, but those with multiple records usually have small ranges (though there are exceptions). The geology from which this species was recorded is unknown; but it is considered likely that it occurs from within the Mt Newman Member which is continuous to the south of the Indicative Additional Impact Assessment Area. Ten other troglofauna species have been recorded from this area indicating it is likely suitable habitat for this species.</td>
<td>It is considered <em>unlikely</em> to be restricted to the Indicative Additional Impact Assessment Area.</td>
</tr>
</tbody>
</table>


MINING AREA C - SOUTHERN FLANK

Troglofauna species potentially restricted to the Indicative Additional Impact Assessment Area and/or the Mining Area C Rev 6 EMP Impact Assessment Area (or species whose range outside is considered uncertain)

BHP BILLITON IRON ORE

Proposed Mining Area C Development Envelope
Current Approved Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment Area (Pit)
Indicative Additional Impact Assessment Area (Other)
Indicative Additional Impact Assessment Area (Pit)
Great Northern Highway
BHP Billiton Rail
Rio Tinto Rail

Restricted Troglofauna
- Hanseniella sp. B08
- Parajapygidae 'DPL024'
- Parajapygidae sp. S03
- Philosciidae sp. B03
- Prethopalpus julianneae
- Prethopalpus sp. B15
- Symphyella sp. B03
- nr Andricophiloscia sp. B16

Scale @ A4: 1:150,000
Prepared: M. LYTTLE Project No: A780048 REV D
Date: 30/03/2017
Checked: B. BARNETT
Figure: 32

Spatial Data - Business Development

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

Note: This map may not be used for the design, manufacture or installation of mining equipment or works. The map is intended for use by BHPBIO personnel and project stakeholders as a tool to support decision-making. Map users are responsible for determining the suitability of use for any particular purpose.
Troglofauna Species

- Cryptops sp. B15
- Draculoides 'SCH022'
- Lagynochthonius 'PSE039'
- Parajapygidae 'DPL020'
- Pauropodidae sp. B14
- Pelicinus sp. B02
- Troglarmadillo sp. B03
- Typhlozuphium humicolum

Proposed Mining Area C Development Envelope

GEOLOGY

AFj - Jeerinah - Shale
AFjd - Jeerinah - Dolerite
AFjm - Jeerinah - Roy Hill Shale (marker chert)
AFjr - Jeerinah - Roy Hill Shale
AHd - Wittenoom - Unknown Member
AHda - Wittenoom - West Angela Member
AHdb - Wittenoom - Bee Grove Member
AHlg - Wittenoom - Parakotos Member
Ahm - Marra Mamba - Marree Member
Ahmx - Marra Mamba - Marree Member
Ahnx - Marra Mamba - MI Newman Member
AF - Jeerinah - Roy Hill Shale (marker chert)
AFy - Jeerinah - Roy Hill Shale
AH - Mt McRae Shale
AHs - Mt Sylvia Formation
CID - Robe - Oolitic channel iron deposit
Cza - Alluvium (consolidated)
Czb - Silcrete (indurated)
Czc - Colluvium & alluvium
Czcb - Colluvium & alluvium (chert & BIF clasts)
Czcg - Indurated colluvium (Canga)
Czci - Indurated Czc / Czcb
Czcm - Colluvium & alluvium (ore, chert & BIF clasts)
Czco - Colluvium & alluvium (ore clasts)
Cz - Unknown
Czl - Ferricrete (laterite)
Czm - Oakover - Micritic lacustrine limestone
Czp - Playa deposits
Czpi - Consolidated ferruginous pisolites
H1 - Martite (microplatey haematite)
H2 - Martite goethitic supergene ore (ochereous)
H2/AHda - Martite goethitic supergene ore (ochereous)
H2/AHmm - Martite goethitic supergene ore (ochereous)
H2/AHmn - Martite goethitic supergene ore (ochereous)
H2/PHbd - Martite goethitic supergene ore (ochereous)
H2/PHbj - Martite goethitic supergene ore (ochereous)
H2/PHbw - Martite goethitic supergene ore (ochereous)
PHbd - Brockman - Dales Gorge (BIF & Shale)
PHbj - Brockman - Joffre (BIF with chert & shale)
PHbw - Brockman - Mt Whaleback Shale
PHby - Brockman - Yandicoogina Shale
PHj - Weeli Wolli - BIF
PKd - Dolerite sills
Pd - Dolerite dykes
Pdd - Dolerite dykes
Pds - Weeli Wolli - Dolerite sills
Qa - Alluvium (drainage channels) - unconsolidated silt, sand and gravel
Qb - Alluvium (drainage channels) - unconsolidated silt, sand and gravel
Qc - Talus & colluvium
Trnc - Alluvium haematite
Trns - Alluvium haematite (red ochre detritus)

BHP BILLION IRON ORE

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SPECIAL DATA - BUSINESS DEVELOPMENT

Date: 30/03/2017
Scale: 1:160,000
Checked: B. BARNETT
Prepared: M. LYTTLE
Project No: A780/049 REV A
Revision: Rev A
Reviewed: S. WILLIAMSON

Coordinate System: GCS GDA 1994
Datum: GDA 1994

Spatial Data - Business Development

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Numerous dolerite intrusives have been mapped throughout the Mining Area C region (BHP Billiton Iron Ore, 2015d). Dolerite sills intrude the Weeli Wolli Formation and the Yandicoogina Shale Member in the Mining Area C region. They can be seen outcropping in some northern areas of the Packsaddle Range and directly to the north of these areas. Thickness of the sills range from 10 cm to over 100 m with the thicker sills being better exposed due to less weathering and alteration. The troglofauna habitat assessment (BHP Billiton Iron Ore, 2015d) found that the suite of post-tectonic cross-cutting dolerite dykes observed in the Mining Area C region is highly weathered and friable. Major dykes trending in a north-west south-east direction occur between the boundaries of a number of the deposits. The troglofauna habitat assessment determined that at least one of these dykes is unlikely to represent a barrier to movement for troglofauna due its weathered nature, with the species (*Draculoides* sp. SCH012) occurring on both sides of the dyke (BHP Billiton Iron Ore, 2015d).

As modification of the Indicative Additional Impact Assessment Area (see Section 11.3.4) did not avoid impacts to all troglofauna species *possibly* restricted to the proposed areas of impact (pits and buffers) a further assessment (Bennelongia, 2017; Appendix 6) was undertaken using information from an updated habitat assessment for each of the five potentially impacted species that focussed on the proposed pit areas as the primary area of impact (BHP Billiton Iron Ore, 2016h). The updated habitat assessment utilised updated imagery obtained using an optical televiewer (OTV) and development of a 3D habitat model for each species using Leapfrog™ geological modelling software. The revised impact assessment (Bennelongia, 2017) used the data from the habitat assessment as a surrogate approach to impact assessment. This approach is consistent with the EPA’s (2013d) Environmental Assessment Guideline.

The revised impact assessment concluded that habitat for three troglofauna species (*Prethopalpus juliannae*, Philosciidae sp. B03 and *nr Andricophiloscia* sp. B16) occurs outside the current pit shell footprint, and for one of these species (*nr Andricophiloscia* sp. B16) habitat also occurs outside of the pit buffer. It is uncertain if habitat for *P. juliannae* also occurs outside the pit buffer.

As all five potentially impacted species are known from a single drill hole (and all but one from a single animal) it is difficult to determine habitat from which the animal occurs. Therefore there remains some uncertainty about the likelihood of habitat occurring outside the pit shell (and buffer) for the remaining two species (i.e. *Prethopalpus* sp. B15 and Parajapygidae ‘DPL024’) as this is contingent on the type of habitat being used by the species. It is also noted that there is scientific uncertainty as to whether Parajapygidae ‘DPL024 is a troglobite or a troglophile; if it is the latter it is considered very unlikely to be restricted to areas of impact.

A summary of information on the likely ranges of the five potentially restricted species is presented in Table 48.

**Table 48: Summary of information on likely ranges of the five potentially restricted troglofauna species**

<table>
<thead>
<tr>
<th>Species</th>
<th>Habitat Present Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pit Shell</td>
</tr>
<tr>
<td><em>Prethopalpus</em> sp. B15</td>
<td>Yes if species occurs in detritals otherwise uncertain</td>
</tr>
<tr>
<td><em>Prethopalpus juliannae</em></td>
<td>Yes</td>
</tr>
<tr>
<td>Philosciidae sp. B03</td>
<td>Yes</td>
</tr>
<tr>
<td><em>nr Andricophiloscia</em> sp. B16</td>
<td>Yes</td>
</tr>
<tr>
<td>Parajapygidae ‘DPL024’</td>
<td>Yes if species occurs in detritals otherwise uncertain</td>
</tr>
</tbody>
</table>
This further assessment of habitat availability for these five species has resulted in the reduction of potential impacts to troglofauna species. The impact and habitat assessments have resulted in six species of troglofauna with an uncertain impact from a total of 126 species within the Proposed Mining Area C Development Envelope. This potential impact is not considered significant.

11.3.3.7.3 Stygofauna species

Impact assessments for stygofauna were undertaken by Bennelongia (2015b, 2016b) and are provided in Appendix 6. Key findings are provided below.

For the purposes of the impact assessment, the Groundwater Assessment Area was considered to be all areas modelled with a groundwater drawdown of 2 m or greater that have not previously been assessed under MS 491. The groundwater model considered cumulative impacts from existing operations at Mining Area C and Hope Downs in addition to those predicted for the additional impacts from the Proposal. In the Pilbara, a modelled drawdown of 2 m or greater is considered to have the potential to impact on stygofauna because it represents the point where the scale of anthropogenic change exceeds the extent of natural fluctuations in baseline groundwater levels. Pre-drawdown conditions are represented by a single value in the modelling, rather than a consideration of the range of natural groundwater fluctuations. For the purposes of this impact assessment, a conservative approach has been adopted that assumes that any drawdown greater than 2 m will result in complete removal of 100% stygofauna habitat from this area, in reality this may not be the case.

Potential impacts to stygofauna from the Proposal are:

- Direct impacts – due to removal of habitat through pit excavation and groundwater drawdown; and
- Indirect impacts – from reduced habitat quality, including water quality changes, changed habitat structure, reduced energy sources, or ingress of pollutants (see Humphreys [2009]). It is considered that reduced habitat quality is more likely to result in lowered animal densities rather than to threaten species persistence.

The considerable extent and habitat connectivity of the alluvial aquifers (and to a lesser extent the calcrete deposits) of the Tertiary detrital valley-fill successions in the Weeli Wolli and Coondewanna subcatchments probably provide for easy dispersal of stygofauna species between areas of groundwater drawdown and surrounding aquifers. A number of taxa (amphipods and isopods) occur both in the Groundwater Assessment Area and the Mining Area C EMP Revision 6 Groundwater Assessment area and in surrounding catchments. This suggests there are few, if any, physical barriers to restrict the wider ranges of species occurring in the cumulative groundwater drawdown areas.

Of the 53 species recorded in the cumulative Groundwater Assessment Areas, ten species are known only from areas of cumulative groundwater drawdown (i.e. the Groundwater Assessment Area, the Mining Area C EMP Revision 6 Groundwater Assessment Area or both areas). Four species (the worm Aindrlus sp. WA26 (PSS), mite Halacaridae sp. B01, copepod Schizopera sp. B02, and syncarid Bathynella sp. 1) have been recorded within the vicinity of Weeli Wolli Spring (Figure 34). Given that habitat connectivity along Weeli Wolli Creek is likely to be high for all stygofaunal species, the potential conservation threat to all four species is considered to be low.

Four individuals of the syncarid Notobathynella sp. have been recorded; two from a bore within the Mining Area C EMP Revision 6 Groundwater Assessment Area and two from a bore 13.4 km away within the Groundwater Assessment Area (Figure 34). It is unclear whether the specimens in the two locations are the same or separate species; however as both bores are within 1.5 km of the edge of the Groundwater Assessment Area or Mining Area C EMP Revision 6 Groundwater Assessment Area and
there appears to be no hydrological barrier preventing the species’ range(s) from extending eastwards or southwards into areas of no impact, the conservation threat to *Notobathynella* sp. is considered to be low irrespective of whether the specimens belong to one or two species.

Eighty-seven individuals of *Paramelitidae* sp. S04 (BR South) have been recorded in 21 samples from 13 drill holes with a linear range of approximately 11 km. While there is no hydrological barrier, such as a dyke, to prevent a broad western extension of the range of *Paramelitidae* sp. S04 (BR South), the depth to groundwater increases in the west (Figure 34) and the effect of greater depth on the suitability of habitat for *Paramelitidae* sp. S04 (BR South) is unknown. However, locally *Paramelitidae* sp. S04 (BR South) is certain to occur outside the Groundwater Assessment Area on the western side of bore EXR0733. This bore is located only 5 m within the Groundwater Assessment Area. While there are no figures on the size of home ranges of stygofauna species within an aquifer, the ranges of larger, active stygofauna species such as amphipods are likely to extend over distances of at least several metres. On this basis, the animal collected from bore EXR0733 may itself have been partially occupying the habitat outside the Groundwater Assessment Area.

The habitat to the west of bore EXR0733 is hydrogeologically the same as that around the bore. It also provides habitat for *Paramelitidae* sp. S04 (BR South) as illustrated by the collection of another individual of *Paramelitidae* sp. S04 (BR South) approximately 4 km west at bore AN0119R (once again inside the Groundwater Assessment Area by 280 m) (Figure 34). A conservative interpretation is that the 4 km of habitat outside the Groundwater Assessment Area that lies between the two records must form part of the range of *Paramelitidae* sp. S04 (BR South).

Given the strong evidence that the distribution of *Paramelitidae* sp. S04 (BR South) extends outside the Groundwater Assessment Area, the conservation threat to the species from groundwater drawdown associated with the Proposal is considered to be low.

Four species, the copepods *nr Epactophanes* sp. B01 and *Dussartyclops* sp. B10, and the syncarids *nr Notobathynella* sp. S01 and *Bathynella* sp. 2, have only been recorded within the Mining Area C EMP Revision 6 Groundwater Assessment Area. In assessing whether groundwater drawdown is likely to threaten the conservation status of these four species, it was recognised that the ranges of the species are likely to have been underestimated because of the low numbers of records of three of the four species. While habitat connectivity appears to be high throughout the Mining Area C EMP Revision 6 Groundwater Assessment Area, the ranges of *nr Epactophanes* sp. B01, *Bathynella* sp. 2 and *Dussartyclops* sp. B10 are unclear because of their occurrence as a singleton or from a single location respectively, therefore the potential threat to these species is uncertain.

*nr Epactophanes* sp. B01 is known from a single specimen along the northern edge of the Groundwater Assessment Area (Figure 34). The specimen was dissected and slide-mounted for identification, so genetic analysis is not possible. It belongs to the harpacticoid family Canthocamptidae, which is commonly collected as stygofauna in the Pilbara (Karanovic 2006; Halse *et al.* 2014). Some canthocamptid species have been observed to have considerable ranges (tens of kilometres), while others appear to have tightly restricted distributions (<5 km). While there is evidence of broad habitat connectivity for species of amphipod between the collecting site and the Marillana Creek catchment to the north (at least five species of amphipod or isopod occur within both catchments; see Appendix 6), the range of *nr Epactophanes* sp. B01 may be determined by intrinsic characteristics of the species, water chemistry or other factors. The record of this species occurs approximately 1.5 km from the Groundwater Assessment Area, and it is noted that updated modelling has reduced this distance from that modelled for the Mining Area C EMP Revision 6 Groundwater Assessment Area. The potential impacts to *nr Epactophanes* sp. B01 are unclear because of their occurrence as a singleton, therefore the potential threat to these species is uncertain.
Stygofauna species potentially restricted to the cumulative Groundwater Assessment Areas

- Anudrilus sp. WA26 (PSS)
- Bathynella sp. 1
- Bathynella sp. 2
- Dussartcyclops sp. B10
- Halacaridae sp. B07
- Notobathynella sp.
- Paramelitidae sp. S04 (BR South)
- Schizopera sp. B02
- nr Epactophanes sp. B01
- nr Notobathynella sp. S01

Liability
BHP Billiton does not warrant that this map is free from errors or omissions. BHP Billiton shall not in any way be liable for loss, damage or injury to the user of this map or any other person or organization consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of its use for any particular purpose.
Dussartcyclops sp. B10 is known from three specimens from one drill-hole (Figure 34). It belongs to the family Cyclopidae, which is very commonly collected as stygofauna in the Pilbara (Karanovic 2006; Halse et al. 2014). The genus Dussartcyclops has been collected a number of times in the Pilbara, with Dussartcyclops mortoni having a range of 12 km and Dussartcyclops sp. B11 having a range of 16 km, while other species appear to have more tightly restricted distributions. Despite some evidence of habitat connectivity between the collection site and other parts of the Coondewanna catchment, the likely range of Dussartcyclops sp. B10 is currently unclear and whether the proposed development poses a threat to the species is unknown.

At the time of assessment for the Mining Area C EMP Revision 6, a record of nr Notobathynella sp. S01 was recorded only 77 m from the edge of the Mining Area C EMP Revision 6 Groundwater Assessment Area and its range was considered to almost certainly extend into areas unlikely to be impacted. Consequently, the level of threat to nr Notobathynella sp. S01 was assessed as low (Bennelongia, 2016a). A subsequent revision of the groundwater model (2016) shows that one record of nr Notobathynella sp. S01 occurs within 5 m of the edge of the Groundwater Assessment Area, and therefore the level of threat to this species remains low.

Bathynella sp. 2 is known from four animals collected as by-catch in a troglofauna net scrape from one drill-hole at Southern Flank (Figure 34). It belongs to the order Syncarida that are a common element of stygal communities worldwide and are frequently collected during stygofauna surveys in Australia. Some Western Australian species of the family Parabathynellidae have been studied both genetically (Abrams et al. 2012; Guzik et al. 2008) and taxonomically (e.g. Cho and Humphreys, 2010; Cho et al. 2005). Some species of the family Bathynellidae in the Pilbara (to which the genus Bathynella belongs) are currently the subject of a PhD study by Guilia Perina (see Perina et al. 2016). The available data indicate there is high diversity of Bathynella species and that ranges are typically short. Bathynella sp. 2 was collected in the Mining Area C EMP Revision 6 Groundwater Assessment Area at Southern Flank and is treated as separate species from Bathynella sp. 1 recorded at Weeli Wolli in the Groundwater Assessment Area because they are 27 km apart (although they are both genus level identifications). If the range of Bathynella sp. 2 extends >5.4 km southwards it would occur outside the cumulative drawdown area. The animal was collected from a dry drill-hole in 2016 that sits in a flood plain between Southern Flank and Mt Robinson that extends to the west, east and south. With only one record the likely range of Bathynella sp. 2 is unknown and it is uncertain how this species may be impacted by the Proposal.

Note that there are inherent scientific limitations in undertaking an assessment of impacts to stygofauna species generally within the areas of impact as discussed in Section 11.3.3.6. Notwithstanding these, BHP Billiton Iron Ore has considered all available data and ecological knowledge of stygofauna species and is therefore confident that the impact assessments undertaken are robust.

Based on the fact that of the 53 stygofauna species located in the groundwater assessment areas the impact to all but three species (whose impact is uncertain due to lack of scientific knowledge of the species) is low, it is considered that the impact to stygofauna species as a result of the Proposal is not significant and no further mitigation or offsets are required.

11.3.3.7.4 Stygofauna habitats

Maximum drawdown footprints have been used to assess potential impacts to stygofauna within the assessment area. The 2 m contour line was used as a precautionary threshold for impact as it was considered that drawdown of greater than 2 m may pose a potential risk to stygofauna species, although this risk is dependent on species mobility and the extent of suitable deeper habitat in which the species may persist.
Suitable habitat for stygofauna is hosted below water table within the enriched units of the Marra Mamba Iron Formation, West Angela units of the Wittenoom Formation, calcrete aquifers around Weeli Wolli Spring and the Tertiary Detritals. Sections of these habitats inside the 2 m footprint will be dewatered with changes closer to mining operations being greater but changes to water table will reduce with distance. Some sections of habitat close to orebodies with significant below water table resources are likely to be dewatered completely but the extent of dewatering is difficult to estimate for aquifers further away as total aquifer thickness is hard to define. Large areas of habitat remain outside the impact footprint including tertiary detritals in valleys to the south and west of South Flank, calcrete aquifers downstream of Weeli Wolli Spring and aquifers associated with Ben’s Oasis.

Tertiary detritals can range from coarse sand and gravels with abundant pore space through to clay rich layers with microscopic voids and low habitat availability. Similarly calcretes can range from vuggy material with significant pore space to crystalline deposits with very little pore space. Connection between voids in calcretes is variable and can be created during formation or by chemical dissolution post-deposition.

Mapping of widespread surrogate stygofauna within the Upper Weeli Wolli and Coondewanna catchments suggests that there are few barriers to movement for stygofauna (Figure 35).

Note that there are inherent scientific limitations in undertaking an assessment of impacts to stygofauna habitats generally within the areas of impacts as discussed in Section 11.3.3.6. Notwithstanding these, BHP Billiton Iron Ore has made consideration of all available data and knowledge of stygofauna habitats and is therefore confident that the impact assessments undertaken are robust.

As suitable habitat for stygofauna remains outside of the Proposed Mining Area C Development Envelope and Groundwater Assessment Area the impact to stygofauna habitat is not considered significant.

### 11.3.3.8 Indirect impacts

#### 11.3.3.8.1 Troglofauna

Current scientific knowledge of indirect impacts on troglofauna as a results of mining and associated activities is limited. Factors potentially reducing habitat quality and which will therefore have an indirect impact on troglofauna include changed habitat structure, reduced energy sources, ingress of pollutants and reduced humidity. Bennelongia (2016a) considered it likely that these factors would reduce animal densities rather than threaten species persistence, and therefore none of the below impacts are considered significant to troglofauna. Possible consequences of likely factors are (Bennelongia, 2016a):

1. **Percussion from blasting.** Blasting may have indirect effects on troglofauna through reducing or altering underground structure (usually via rock fragmentation and collapse of voids). It is also possible that blast impacts could detrimentally affect some troglofauna directly through concussion. However, both types of effects are likely to dissipate rapidly with distance from the pit and blasting is not considered here as a significant impacting activity beyond the pit boundary.

2. **Overburden stockpiles and waste dumps.** These artificial landforms may reduce inputs of nutrients and dissolved organic matter to subterranean habitats as a result of reduced organic matter on the surface and perhaps reduced rainfall recharge. Rainfall may sometimes run off stockpiles rather than infiltrating through them. While stockpiles and dumps may create a shadow of reduced energy and nutrient sources, this may reduce the quality of habitat. Tree roots, which may provide an important source of energy and nutrients to troglofauna, are removed by all forms of land clearing. These indirect impacts may reduce the quality of habitat but are not considered here as a significant impacting activity for the Proposal.
(3) Contamination of landforms by hydrocarbons. Any contamination is likely to be localised and minimised by engineering and management practices for the containment of hydrocarbon products. It is not considered a likely risk to troglofauna.

(4) Lowering the watertable in the vicinity of the mine pits. Lower water tables are sometimes thought to have the potential to impact on troglofauna by altering humidity. The humidity requirements of troglofauna have rarely been studied. While it has been stated that some cave species may persist at humidity greater than about 80% (Humphreys, 1990), species in the landscape matrix are more likely to require humidity of very close to 100% (Howarth, 1980; Hadley et al., 1981). While pit excavation can cause drying of habitat through the walls of the pit, in most situations dewatering below an undisturbed surface probably has little effect on humidity at depth. Therefore, this aspect is unlikely to result in a significant impact to troglofauna.

11.3.3.8.1 Stygofauna

Current scientific knowledge of indirect impacts of reduced habitat quality, rather than direct habitat removal as a results of mining and associated activities is limited. Factors potentially reducing habitat quality include water quality changes, changed habitat structure, reduced energy sources, or ingress of pollutants (see Humphreys, 2009). Bennelongia (2016d) considered that reduced habitat quality is more likely to result in lowered animal densities than to threaten species persistence and therefore none of the below impacts are considered significant to stygofauna. Possible consequences of likely factors are (Bennelongia, 2016d):

(1) Water quality changes. In most situations, water quality changes occupy relatively small areas (Rösner, 1998; Zhu et al., 2001), although increases in groundwater salinity may be more extensive (Commander et al., 1994; Sharma and Al-Busaidi, 2001) and salinity changes may potentially threaten some species in the Pilbara, where stygofauna occur mostly in fresh water (<1,000 mg/L). The tolerance of stygofauna species in the Groundwater Assessment Area to increased salinity is unknown but based on surface studies it is likely that overall stygofauna species richness will decline sharply if groundwater salinity reaches 2,000 mg/L (Pinder et al., 2010). Changes of this magnitude have been observed in parts of the Pilbara as a result of mining (Commander et al., 1994). It is not predicted that implementation of the Proposal will result in changes to salinity of groundwater and therefore the potential impact to stygofauna habitat as a result of water quality changes is considered very low.

(2) Percussion from blasting. Blasting may have a direct effect on stygofauna through percussion and indirect detrimental effects through altering underground structure (usually rock fragmentation and collapse of voids) and causing transient increases in groundwater turbidity. Subterranean fauna have been collected adjacent to areas where blasting is occurring regularly, suggesting that impacts are experienced only over short distances and are unlikely to be significant.

(3) Overburden stockpiles and waste dumps. These artificial landforms may cause localised reduction in rainfall recharge and associated entry of dissolved organic matter and nutrients. The effects of reduced carbon and nutrient input are likely to be expressed over many years and are unlikely to significantly impact on stygofauna as lateral movement of groundwater should bring in carbon and nutrients. These indirect impacts may reduce the quality of habitat but are not considered here as a significant impacting activity for the Proposal.
Stygofauna Species
- Australocamptus sp.
- Maarrka weelwollii
- Paramelitidae sp. B03
- nr Billibathynella sp. B02
- (=Parabathynellidae sp. 503)

Proposed Mining Area C
Development Envelope
WA Hydrographic
Subcatchment

- Alluvium - unconsolidated silt, sand and gravel
- Colluvium - unconsolidated quartz and rock fragments in soil
- Calcrete - sheet carbonate
- usually formed in major drainage lines

BHP Billiton Rail
Rio Tinto Rail
Great Northern Highway

Widespread surrogate stygofauna in the Upper Weeli Wolli and Coondewanna subcatchments
(4) Aquifer recharge from run-off over disturbed ground. Quality of recharged water within mine sites is often poor because of rock break-up and soil disturbance (e.g. Gajowiec, 1993; McAuley and Kozar, 2006). Impacts will be minimised through management of surface water and installing drainage channels, sumps and pump in the pit to prevent recharge though the pit floor. While poor quality of recharge water may reduce population densities, it is unlikely to affect species persistence and is therefore not considered significant for this Proposal.

(5) Contamination of groundwater by hydrocarbons. Any contamination is likely to be localised and will be minimised by engineering and management practices to ensure the containment of hydrocarbon products. Therefore the potential impacts are not considered significant for this Proposal.

11.3.3.9 Cumulative impacts

None of the species identified within the Proposed Mining Area C Development Envelope have been identified within the Rio Tinto’s adjacent Baby Hope project area, although there is almost certainly a continuation of the communities in Southern Flank into this area. The lack of taxonomic consistency between adjacent tenements is likely due to the fact that a majority of species recorded within the Pilbara are undescribed and a taxonomic database for undescribed troglofauna species in Western Australia, such as would be provided by WAMinals (see limitations at the start of Section 11.3.3.6) is largely incomplete. Therefore if the same species is collected by different consultancies it is usually given different informal names.

Impacts to stygofauna presented in Sections 11.3.3.7.3 and 11.3.3.9.1 have considered cumulative impacts associated with approved mining operations at Mining Area C and Rio Tinto’s Hope Downs operations - the only mining operations currently operating within the subcatchment. It is noted that the Groundwater Assessment Area has been determined from groundwater drawdown modelling using information available to BHP Billiton Iron Ore in the public domain.

Therefore the conclusions with respect to potential cumulative impacts to troglofauna and stygofauna are consistent with those presented in Section 11.3.3.6.

11.3.3.9.1 Weeli Wolli Spring PEC

A hydrological impact assessment has been undertaken that considers likely impacts to Weeli Wolli Spring based on dewatering associated with the Proposal and cumulative operations within the subcatchment. This document is provided in Appendix 7, and key outcomes relevant to stygofauna outlined below.

Groundwater drawdown associated with the Proposal is not expected to exceed 1 m at Weeli Wolli Spring; dewatering at Southern Flank is predicted to contribute between 0.2 and 0.5 m drawdown at Weeli Wolli in 2054, which is modelled to occur following the end of aquifer replenishment and mitigation actions at Hope Downs (BHP Billiton Iron Ore, 2016I).

Cumulative groundwater drawdown from dewatering activities shows a more significant change, whereby water levels in the Weeli Wolli Spring area will be lowered within a range of 3 to 14 m. This is primarily associated with abstraction from Hope Downs. The timing and success of Hope Downs closure plans to recover groundwater levels will also influence the water level and potential for a continued impact at Weeli Wolli Spring.

Following closure of Hope Downs the combined cumulative impacts show a range of 1 – 2. 5 m of maximum drawdown at 2054 with a median drawdown of 1.75 m which are similar to the previously assessed change of 1.6 m (BHP Billiton Iron Ore, 2016I). This drawdown is less than 2 m, which is considered to be the level of change considered likely to impact on stygofauna. As a precaution, the
CPWRMP outlines a number of management measures and mitigation options that can be used as part of BHP Billiton Iron Ore’s adaptive management to ensure that potential impacts to stygofauna resulting from drawdown are minimised. Management measures include, but are not limited to, managed aquifer recharge or infiltration basins.

Habitat connectivity along Weeli Wolli Creek is likely to be high for all stygofaunal species (Bennelongia, 2016b), and there are a number of species that occur in both Weeli Wolli Creek and Marillana Creek (e.g. *Meridiescandona marillanae*). Whilst the revised groundwater model shows a slight increase in the area of calcrete potentially impacted by cumulative operations within the subcatchment, the conservation values of individual stygofauna species occurring in the PEC are unlikely to be threatened because of the existence of abundant stygofauna habitat downstream.

No groundwater drawdown is anticipated at the Ben’s Oasis component of the Weeli Wolli Spring PEC as a result of dewatering from the Proposal or cumulative drawdown within the Upper Weeli Wolli subcatchment.

The potential impacts to subterranean fauna based on the predicted changes to the Weeli Wolli Spring PEC, as discussed above, are not considered significant.

**11.3.4 Mitigation and residual impacts**

BHP Billiton Iron Ore has carried out a review of the Western Australian Government’s ‘Mitigation Process’, which is detailed in Section 3 of the *WA Environmental Offsets Guideline* (Government of Western Australia, 2014). The four steps are:

- **avoid**;
- **minimise**;
- **rehabilitate**; and
- **offset**.

Following consideration of all data gathered during baseline surveys, additional targeted surveys and the outcomes of EIAs, BHP Billiton Iron Ore has revised its indicative Proposal designs to ensure that these designs address the first two steps of the Mitigation Process, i.e. the designs have ‘avoided’ or ‘minimised’ the impact on subterranean fauna as far as reasonably practicable.

The initial impact assessment undertaken for troglofauna (Bennelongia, 2016a) identified a number of species that may be restricted to pit areas associated with the Proposal. A review of this assessment area was undertaken and a Modified Indicative Additional Impact Assessment Area developed for Southern Flank, in accordance with the steps outlined in the Mitigation Process (Government of Western Australia, 2014). As a result, there are seven fewer troglofauna species potentially restricted to the Modified Indicative Additional Impact Assessment Area (Bennelongia, 2016e). The modification does include three new species, but all are considered *unlikely* to be restricted to habitats within the Modified Indicative Additional Impact Assessment Area. Four species remained possibly restricted under both scenarios and for one species there is limited information to assess if this modification will reduce impacts; this species remains as *uncertain*. Further work was undertaken with respect to habitat for these five species (Section 11.3.3.7.2). This work concluded that the impact to three species remained uncertain. The modification does not alter the outcomes for those species that occur in the Mining Area C EMP Revision 6 Impact Assessment Area. A summary of the changes to the impact assessment is provided in Table 49 and actions taken to reduce the impacts of the Proposal on subterranean fauna are summarised in Table 50.
Table 49: Summary of troglofauna species only recorded within Indicative Additional Impact Assessment Areas

Species uncertain are shown in bold.

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<th>Higher Group</th>
<th>Species</th>
<th>Assessed IAIAA</th>
<th>Modified IAIAA</th>
<th>No. of Animals</th>
<th>No. of Holes</th>
<th>Likely Range (km)</th>
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<tr>
<td></td>
<td>Parajapygidae ‘DPL023’</td>
<td>x</td>
<td>x</td>
<td>2</td>
<td>2</td>
<td>3.1</td>
<td>Unlikely</td>
</tr>
<tr>
<td></td>
<td>Parajapygidae ‘DPL024’</td>
<td>x</td>
<td>x</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>Uncertain</td>
</tr>
<tr>
<td></td>
<td>Parajapygidae sp. B25</td>
<td>x</td>
<td></td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>Unlikely</td>
</tr>
<tr>
<td></td>
<td>Coleoptera</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>nr Claviger sp. B01</td>
<td>x</td>
<td></td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>Unlikely</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>17</td>
</tr>
</tbody>
</table>
Table 50: Actions taken to reduce impacts to subterranean fauna

<table>
<thead>
<tr>
<th>Action Taken</th>
<th>Step in the ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
</table>
| Modification of Indicative Additional Impact Assessment Area | Avoid | Modification of the Indicative Additional Impact Assessment Area has:  
- reduced the number of potentially restricted species by seven;  
- one species of uncertain status has been removed from potential disturbance areas;  
- three species added to the Modified Indicative Additional Impact Assessment Area, but all are considered unlikely to be restricted to habitats within it. |
| Retention of potential troglofauna habitat suitable for six uncertain species outside pit shells | Minimise | Minimise impacts to habitats considered to be potentially suitable for potentially restricted troglofauna. |

Following application of the mitigation hierarchy and actions above, BHP Billiton Iron Ore have concluded that the residual impacts are not significant and therefore the application of offsets is not warranted for this factor.

However, BHP Billiton Iron Ore will continue to support continued research into subterranean fauna habitats and taxonomy to increase understanding of subterranean species and their distribution in the Pilbara. These studies may include environmental DNA studies and taxonomic study of Diplurans.

11.3.5 Proposed management approach

11.3.5.1 Internal management approach

The proposed management provisions for subterranean (troglofauna) fauna are outlined in Table 51. The proposed management provisions in relation to interface of stygofauna and hydrological processes are outlined in Table 57 and Table 58. These include management actions, monitoring and reporting details and trigger criteria and response actions where relevant. It is proposed that these management provisions will be formalised through regulation of an Environmental Management Plan via the Ministerial Statement and the BHP Billiton Iron Ore’s standard Pilbara-wide Health, Safety and Environment system. A draft of the management plan, which includes the management provisions outlined in Table 51, is located in Appendix 3.

11.3.5.2 Regulatory management

Impacts to subterranean fauna will be managed via an environmental management plan regulated by the MS.

Table 51: Draft Proposed Environmental Management Plan Provisions – Subterranean Fauna (troglofauna)

<table>
<thead>
<tr>
<th>EPA Factor and objective:</th>
<th>Subterranean Fauna – to protect subterranean fauna so that biological diversity and ecological integrity are maintained.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key environmental values:</td>
<td>Subterranean fauna (troglofauna) species to which impacts from the Proposal are uncertain* - Hanseniella sp. B08, Symphyella sp. B03, Parajapygidae sp. S03, Prethopalpus sp. B15, Philosciidae sp. B03; and Parajapygidae “DPL024”.</td>
</tr>
</tbody>
</table>
**Objective:** Minimise impacts, as far as practicable, to habitat for subterranean fauna (troglofauna) species to which impacts from the Proposal are uncertain.

**Key impacts and risks:** Risk to biological diversity and/or ecological integrity of subterranean fauna (troglofauna), due to direct loss of habitat (mine pits).

<table>
<thead>
<tr>
<th>Management-based provisions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Actions</strong></td>
</tr>
<tr>
<td>Condition clause number and text</td>
</tr>
</tbody>
</table>

**Minimise**
- Minimise impacts to subterranean fauna (troglofauna) species to which impacts from the Proposal are uncertain*, by avoiding clearing for mine pits outside the Modified Indicative Additional Impact Assessment area where practicable and implementing the PEAHR process prior to land disturbance.
  - No unauthorised disturbance beyond the Development Envelope.
  - Quarterly land disturbance reconciliation (hectares and spatial footprint).
  - Notification of management target or objective potential non-compliance will be provided to the OEPA within 7 days of that potential non-compliance being known. A report including any corrective actions identified will be provided to the OEPA via email, once an investigation into the potential non-compliance has been completed.
  - An annual compliance assessment report will be submitted as part of the Annual Environment Report, which will be submitted to OEPA by 1 October each year.

In consideration of the outcomes of the EIA and proposed management measures, BHP Billiton Iron Ore considers that subterranean fauna (troglofauna) is a key environmental factor for the Proposal as the Proposal will result in a net loss of subterranean fauna habitat.

In undertaking impact assessments associated with the Proposal for subterranean fauna BHP Billiton Iron Ore have had due regard for the principles of ecological sustainable development of the EP Act.

**11.3.6 Summary and predicted outcome**
In consideration of the outcomes of the EIA and proposed management measures, BHP Billiton Iron Ore considers that subterranean fauna (troglofauna) is a key environmental factor for the Proposal as the Proposal will result in a net loss of subterranean fauna habitat.

In undertaking impact assessments associated with the Proposal for subterranean fauna BHP Billiton Iron Ore have had due regard for the principles of ecological sustainable development of the EP Act.

Based on these principles, BHP Billiton Iron Ore have undertaken what it considers reasonable approach to the application of the mitigation hierarchy and assessment of significance of residual impacts. BHP Billiton Iron Ore consider that the EPA objective for subterranean fauna will be met. Table 52 summarises impacts to subterranean fauna previously assessed under MS 491, additional changes likely to occur following implementation of the Proposal, and the cumulative extent in the Proposed Mining Area C Development Envelope.
### Table 52: Summary of key subterranean fauna factors for the Proposal

<table>
<thead>
<tr>
<th>Indicative Additional Impact Assessment Area/ Groundwater Assessment Area</th>
<th>MAC EMP Revision 6 Impact Assessment Area/ Groundwater Assessment Area</th>
<th>Cumulative Impacts (without Mitigation)</th>
<th>Cumulative Impacts (with Mitigation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Troglofauna</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twenty species of troglofauna only known from within the Indicative Additional Impact Assessment Area.</td>
<td>Twenty species of troglofauna only known from within the Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>Four species considered to be possibly restricted to the Indicative Additional Impact Assessment Area:</td>
<td>Impacts to six species are uncertain. Three occur in the Indicative Additional Impact Assessment Area:</td>
</tr>
<tr>
<td>One species only known from the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>One species only known from the Indicative Additional Impact Assessment Area and Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>• nr Andricophiloscia sp. B16,</td>
<td>• Prethopalpus julianneae,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prethopalpus sp B15,</td>
<td>• Philosciidae sp. B03,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Philosciidae sp. B03.</td>
<td>• Parajapygidae &quot;DPL024&quot;,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Hanseniella sp. B08,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Parajapygidae sp. S03,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Symphyella sp. B03.</td>
</tr>
<tr>
<td><strong>Stygofauna</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six species are known only from the Groundwater Assessment Area or this area and the Mining Area C EMP Revision 6 Drawdown Area;</td>
<td>Four species are known only from the Mining Area C EMP Revision 6 Groundwater Assessment Area:</td>
<td>Seven of the ten species restricted to the Groundwater Assessment Area and/or the Mining Area C EMP Revision 6 Groundwater Assessment Area are considered likely to occur outside. It is uncertain whether three species occur outside these areas as all are only known from single drill holes and therefore information on the likely range is unknown. These species are:</td>
<td>Due to the uncertainty of the range of nr Epactophanes sp. B01, Bathynella sp. 2 and Dussartyclops sp. B10 it is unknown whether mitigation will reduce impacts to these species.</td>
</tr>
<tr>
<td>• Ainudrilus sp. WA26 (PSS),</td>
<td>• nr Epactophanes sp. B01,</td>
<td>• nr Epactophanes sp. B01,</td>
<td></td>
</tr>
<tr>
<td>• Halacaridae sp. B01,</td>
<td>• Dussartyclops sp. B10</td>
<td>• Dussartyclops sp. B01,</td>
<td></td>
</tr>
<tr>
<td>• Schizopera sp. B02,</td>
<td>• nr Notobathynella sp. S01.</td>
<td>• Bathynella sp. 2</td>
<td></td>
</tr>
<tr>
<td>• Bathynella sp. 1,</td>
<td>• Bathynella sp. 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Notobathynella sp,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Parameliella sp. S04 (BR South)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All are considered likely to occur outside.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11.4 Hydrological processes

11.4.1 Introduction and EPA objective

The EPA applies the following objective, according to the Statement of Environmental Principles, Factors and Objectives (EPA, 2016), in its assessment of proposals that may affect hydrological processes:

To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.

11.4.2 Relevant legislation, guidelines and policies

The discussion of the existing environment, impacts and management of hydrological processes in the Proposed Mining Area C Development Envelope has been compiled in consideration of relevant State legislation, EPA Policies and Guidance. Table 7 details the relevant EPA documents as identified in the Mining Area C – Southern Flank Environmental Scoping Document (OEPA, 2016) and their relevance to this Proposal.

Other relevant guidelines which have informed the assessment against this factor include:

- Pilbara Regional Water Plan 2010-2030 (DoW, 2010);
- Pilbara Regional Water Supply Strategy: a Long-term Outlook of Water Demand and Supply (DoW, 2013a);
- Strategic Policy 2.09: Use of Mine Dewatering Surplus (DoW, 2013d);
- Operational Policy No. 1.02: Policy on Water Conservation/Efficiency Plans, Achieving Water Use Efficiency Gains through Water Licensing (DoW, 2009); and
- Operational Policy No. 5.08: Use of Operating Strategies in the Water Licensing Process (DoW, 2011).

Studies, investigations and surveys undertaken to date, the study area covered, and the relevant guidelines referred to and any limitations of the studies have been previously listed in Table 9.

11.4.3 Existing environment

An overview of the conceptual groundwater model, including ecohydrological aspects, is given below.

Regional groundwater flow occurs predominantly in the aquifers of the Wittenoom Dolomite (particularly the karstic Paraburdo member) and overlaying Tertiary detritals. As such, regional groundwater flow is concentrated in the valleys and intervening alluvial plains of the Proposed Mining Area C Development Envelope and surrounds.

Prior to mining-related activities in the wider catchment, groundwater flows were from west to east (from Coondewanna Flats to Weeli Wolli Spring). Water levels ranged from approximately 660 mAHD to approximately 560 mAHD over this area. The pre-mining depth to water table varied based on topography but was generally closer to the land surface in low-lying areas. At Coondewanna Flats the water table ranged from 18 to 25 mbgl and within the Weeli Wolli Spring PEC water levels ranged from 3 to 8 mbgl.

From a surface water catchment perspective, the Additional Development Envelope straddles the boundary between the Weeli Wolli Creek and Coondewanna catchments. The western portion of the development drains westwards across the Great Northern Highway into Lake Robinson within the
internally draining Coondewanna catchment. The eastern portion drains into tributaries of Weeli Wolli Creek, which discharges into the Fortescue Marsh (refer Figure 9).

Water supply abstraction in the Approved Mining Area C (Northern Flank) Development Envelope commenced in 2001 from C Deposit (the local Marra Mamba aquifer) and the western end of the North Flank Valley (regional aquifer), with additional temporary abstractions used during construction of the railway line and Coondewanna airstrip. Dewatering commenced at Mining Area C in mid-2010.

The Hope Downs Management Services Pty Ltd approved Hope Downs 1 Mining operations are located within the Northern Flank Valley. Dewatering commenced in January 2007 and is proposed to continue until the end of 2025 (i.e. until the end of mining and infilling) (HDMS, 2000). This is predicted to have a significant impact on flows at Weeli Wolli Spring and Rio Tinto Iron Ore are artificially supporting the system until the natural flow returns to within 10% of pre-mining rates. This is potentially up to 20 years after decommissioning (HDMS, 2000).

Key environmental groundwater and surface water receptors within the vicinity of the Proposal are:

1. The Water Resource (surface and groundwater);
2. Coondewanna Flats (including Lake Robinson); and
3. Weeli Wolli Spring (including Ben's Oasis)

The location of these assets are presented on Figure 9 and a description of the environmental receptors and hydrological dependency is summarised below for the water resource and was previously explained in Section 11.1 and 11.3.

The groundwater resource consists of three primary aquifers within the Upper Weeli Wolli catchment including:

a) the orebody aquifer developed through mineralisation of the BIF;
b) the Wittenoom dolomite, which is located within the topographic low areas; and
c) the overlying alluvial tertiary detrital sediments.

The aquifer yields, permeability and storage volumes vary laterally and vertically through each aquifer unit. The hydraulic connection between the aquifer systems (including between groundwater and surface water systems) is considered to be variable and constrained by structural controls, mineralisation and vertical permeabilities.

Figure 36 shows the conceptual model for groundwater movement across the catchment. Groundwater recharge primarily occurs in the Coondewanna Flats area as a result of surface water ponding in Lake Robinson, and subsequent infiltration, after large rain events. A small proportion of groundwater recharge takes place across the remainder of the catchment, which is associated with seasonal surface water flow in Weeli Wolli Creek and diffuse rainfall recharge occurring in areas with exposed bedrock and along minor drainage lines. Groundwater moves broadly from west to east from Coondewanna to Weeli Wolli Spring via the Northern Flank and Southern Flank valleys within the tertiary detritals and Wittenoom dolomites.

Discharge from the groundwater system is mainly by outflow to the surface at Weeli Wolli Spring and groundwater throughflow beneath the springs. Evaporation and tree usage of groundwater, particularly around Weeli Wolli Spring, accounts for the remainder of pre-mining groundwater outflow from the catchment. While water moves broadly from west to east it is estimated that this takes in the order of
hundreds of years due to the range of hydrogeological conditions along the pathway. This is reflected in the relatively slow rate of drawdown propagation and in the modelled aquifer recovery times.

Groundwater through flow exiting the Upper Weeli Wolli catchment at Weeli Wolli Spring is estimated to be 12 ML/d. Of the total volume abstracted as part of the Proposal, between 50% and 70% is predicted to be from aquifer storage and the remainder from through flow.

Water usage and dewatering within the Approved Mining Area C (Northern Flank) Development Envelope is currently managed under Mining Area C EMP Revision 6 (BHP Billiton Iron Ore, 2015a).

The Mining Area C EMP Revision 6 (BHP Billiton Iron Ore, 2015a) contains management objectives, management actions, monitoring requirements, indicators and trigger criteria, contingency actions and reporting requirements to meet the intent of Condition 5 of MS 491. These are discussed further in Section 11.4.10.

11.4.4 Hydrological assessment overview
The hydrological impact assessment (Appendix 7) considered the following hydrological change aspects at key water dependent receptors (Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis) and also the water resource:

- Groundwater level (addressed in this Section 11.4.6);
- Groundwater quality (addressed in Section 11.5.4 - Inland Waters Environmental Quality);
- Surface water flow volume and persistence (addressed in this Section); and
- Surface water quality (addressed in Section 11.5.4 - Inland Waters Environmental Quality).

The assessment was completed in context to the broader adaptive management approach for the Upper Weeli Wolli catchment (also known as the Fortescue Marsh catchment area), which focuses on the key water dependent receptors, including the water resource and importantly considers impact in relation to outcome-based thresholds which have been already adopted for the key assets. The approach allows for the progressive development of scientific knowledge and therefore sets precautionary thresholds and objectives which reflect this level of technical knowledge, including the application of preventative and mitigating controls.

11.4.4.1 Groundwater modelling
Groundwater modelling has been carried out for the Proposal (BHP Billiton Iron Ore, 2016l, 2015a). Definition of assessment areas relevant to each factor and the isolated and cumulative cases are given in Section 11.4.5.

The objectives of the modelling were to provide predictions of the likely magnitude and timing of changes to the groundwater levels due to future dewatering of the Mining Area C and Southern Flank deposits across the modelling domain and specifically at three eco-hydrological receptors; Weeli Wolli Spring, Ben’s Oasis and Coondewanna Flats. The modelling provided an evaluation of the potential drawdown impacts associated with dewatering activities at the 14 deposits at Mining Area C (with inclusion of Hope Downs 1) and the additionality of the potential impacts for Southern Flank dewatering activities. The modelling also provided a prediction of the cumulative changes at these receptors from activities at Southern Flank, current Mining Area C and planned operations (i.e. mining of all 14 deposits) and Hope Downs (operated by Rio Tinto). Predictions covered periods of both active mining and mine closure across the various mining assets. The modelling was undertaken on a catchment scale domain so was not confined to the Proposed Mining Area Development Envelope, and therefore represents the worst case scenario for prediction of potential impacts. The model domain and modelling approach is discussed in more detail in Appendix 7.
The model covered an area with a wide range of data density, with Southern Flank and areas east toward Ben's Oasis having the least long term data. As a result predictions for these areas using a single model would have significant uncertainty as many different model calibrations would be possible.

To enable a robust assessment, multiple models were constructed where key parameters for regional connectivity were allowed to vary to achieve calibration (BHP Billiton Iron Ore, 2016). This provided a range of plausible models in areas with scarce data that could be used for assessment.

The initial model set comprised 2,000 variants, of these 192 calibrated with sufficient confidence to be used in the impact assessment. The resulting outputs are presented as a range of drawdown responses as a result of dewatering from proposed operations at Southern Flank, as well as cumulative response from other operations.

The outputs have been presented as series of percentile bands for both drawdown and abstraction volumes. Percentile cutoffs at 20% and 80% have been used for the purposes of informing EIA. In this case, low percentiles represent a smaller drawdown footprint and dewatering requirement while the high percentiles represent a larger drawdown footprint and dewatering requirement. These percentiles represent the likelihood that the actual impact will be less than the value indicated e.g.: for the P80 2 m contour line, there is 80% probability that drawdown will be less than 2 m. This distribution is a result of assumptions made in the modelling process (including conceptual model and aquifer geometry) as well as the accuracy and completeness of the monitoring data sets. Importantly, previous modelling results and field monitoring generally fall between the 20th and 80th percentile of the model outputs, demonstrating that this approach is both consistent with previous work and represents observations from the catchment.

For the purposes of the assessment the 80th percentile of drawdown was selected as a conservative case for changes to water levels. This case was used to assess potential changes at key water dependent receptors including Weeli Wolli Creek, Ben's Oasis and Coondewanna Flats.

A water balance forecast was generated for the combined Northern and Southern Flank operations based on modelled dewatering volumes and is shown in Figure 37.
Figure 36: Conceptual groundwater flow within project area
Dewatering activities planned within the Indicative Additional Impact Assessment Area means that the Southern Flank ore body is net water negative as a stand-alone operation; but considered as a single operation with the current Approved Mining Area C Development Envelope, the combined water balance moves towards neutral. As a result it is anticipated the majority of production water supplies will be delivered from dewatering activities across the Mining Area C hub. If dewatering rates drop below the water demand, strategic advance dewatering will be carried out or an alternative water supply borefield will be developed. Any potential impacts to the environmental from the Camp Hill borefield has been assessed as part of the development of the Mining Area C EMP Revision 6 for both water supply and managed aquifer recharge (MAR) purposes and subsequently an assessment of a MAR borefield at Juna Downs has been undertaken. Periods of surplus are expected and will continue to be managed with reference to the guidance of the DoW (2013d), Strategic Policy 2.09 Use of Mine Dewatering Surplus and will be preferentially returned to ground through injection into MAR borefields.

![Combined Operations Water Balance Prediction](image)

**Figure 37: Combined operations water balance forecast**

Key dewatering activities and water effecting areas are shown diagrammatically in Figure 38.

### 11.4.4.2 Surface water modelling

Surface water modelling and a cumulative impact assessment have been carried out for the Indicative Additional Impact Assessment Area (MWH, 2016) and for the additional disturbance associated with Mining Area C (RPS, 2015).

Surface water modelling was completed for the Proposal using the 2 dimensional TUFLOW model (WBM, 2016). Direct rainfall was applied on the model grid based on design rainfall depths calculated by interpolating values from the 1987 Bureau of Meteorology Intensity-Frequency-Duration (IFD) data and the probable maximum precipitation as estimated using the Generalised Short Duration Method. Infiltration data were similarly developed. It was not practical to apply direct rainfall on the Pebble Mouse Creek catchment area due to its large size (166 km² upstream of Southern Flank). Instead, this drainage line was inserted as a boundary condition into the TUFLOW model using a flow hydrograph developed from the RORB runoff routing model. A total of 18 models were run for pre-development and post development scenarios at rainfall events ranging from the 2-year to 10,000-year annual recurrence interval (ARI).
11.4.5 Potential impacts

BHP Billiton Iron Ore commissioned RPS Aquaterra (RPS, 2013) to undertake a hydrogeological assessment for Mining Area C EMP Revision 6. Pit designs and development rates for all deposits associated with EMP Revision 6 (derived from the 2014 mine plan) were included in model predictions. For the Proposal a hydrogeological assessment was carried out using an updated groundwater model that incorporated the Southern Flank mine plans and dewatering requirements.

BHP Billiton Iron Ore commissioned MWH (MWH, 2016) to carry out a Surface Water EIA which has informed assessment of the Indicative Additional Impact Assessment Area and Additional Development Envelope.

A range of technical studies were also collectively used to inform and develop the BHP Billiton Iron Ore Mining Area C Hydrological Impact Assessment (Appendix 7), which supports this Proposal application.

Discussion relating to the potential impacts of groundwater dewatering on stygofauna habitat is provided in Section 11.3.3.7.4 and the potential impacts on groundwater and surface water dependent vegetation is provided in Section 11.1.4.

The extents, or boundaries, used to assess the potential impacts of this Proposal, of the Revised Proposal (that is this Proposal plus the existing Mining Area C operations) and cumulative or regional extents vary for each factor. Table 53 details the areas assessed for this Hydrological Processes factor.

Table 53: Impact assessment areas for hydrological processes

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrological Processes</td>
<td>Modelled over Coondewanna and Weeli Wolli subcatchments and is inclusive of potential impacts from the proposed Southern Flank ore body, Mining Area C current operations and Hope Downs 1 project. Impact assessment determined the significance of additional impact from dewatering activities. For surface water catchment impacts, the Impact assessment areas are used for assessment of potential impacts.</td>
<td>Modelled over Coondewanna and Weeli Wolli subcatchments and is inclusive of potential impacts from the proposed Southern Flank ore body, Mining Area C current operations and Hope Downs 1 project. Impact assessment determines the overall impact the Proposal, existing Mining Area C operations and third party operations at Hope Downs.</td>
<td>Assessed over Coondewanna, Weeli Wolli and Fortescue subcatchments inclusive of third party operators Hamersley Hope Downs Management Services Hope Downs 1 Project and Baby Hope Project.</td>
</tr>
</tbody>
</table>
MINING AREA C - SOUTHERN FLANK

Dewatering and water effecting areas

Proposed Mining Area C Development Envelope
Current Approved Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment
Indicative Additional Impact Assessment Area
BHP Billiton Rail
Rio Tinto Rail
Great Northern Highway

Deposit A MAR Bores
Rail Loop Supply Bores
Dewatering
Receptors
Water Effecting Activities
Water Effecting Activities

Spatial Data - Business Development
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Dewatering and water effecting areas

Proposed Mining Area C Development Envelope
Current Approved Development Envelope
Additional Development Envelope
Mining Area C EMP Rev 6 Impact Assessment
Indicative Additional Impact Assessment Area
BHP Billiton Rail
Rio Tinto Rail
Great Northern Highway

Deposit A MAR Bores
Rail Loop Supply Bores
Dewatering
Receptors
Water Effecting Activities
Water Effecting Activities

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

BHP Billiton does not warrant that this map is free from errors or omissions. BHP Billiton shall not be in any way liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.

Scale @ A4: 1:200,000
Prepared: M. LYTTLE
Project No: A780/052 REVA
Date: 30/03/2017
Checked: B. BARNETT
Prepared: M. LYTTLE
Figure: 38
Reviewed: S. WILLIAMSON
Revision: Rev A

Document Path: Y:\Jobs\A501_A1000\A780\3Project\A780_052_E_MAC_Southern_Flank_PER_Map38_RevA.mxd
Ground disturbance activities, such as the creation of pits, OSAs and other infrastructure, will occur within the Weeli Wolli Creek and Coondewanna subcatchments and, collectively, within the regional Fortescue Marsh catchment area (also known as the Upper Fortescue River catchment). Some of the ore bodies in the Indicative Additional Impact Assessment Area and the Mining Area C EMP Revision 6 Impact Assessment Area lie below the water table based on the mine design at the time of referral of this Proposal. Therefore, the Proposal will require in-pit and ex-pit dewatering (i.e. groundwater abstraction) to facilitate dry mining conditions ahead of mining.

For the purposes of this section, the Mining area C EMP Revision 6 Groundwater Assessment Area defines the area bound by a 2 m drawdown contour that is predicted from modelling undertaken for the dewatering of the 14 deposits within the Mining Area C Development Envelope and the Hope Downs 1 operations. The potential impacts to the hydrological processes, inland water environmental quality factors, stygofauna and groundwater dependent vegetation (GDV) elements associated with extra disturbance at Mining Area C used this assessment area. Those for stygofauna were discussed in Section 11.3.3.7 and to GDV in Section 11.1.4.

The potential impacts resulting from the dewatering activities for the Southern Flank ore body development used an area termed the Groundwater Assessment Area. This area is defined as the area where the cumulative (Southern Flank, Mining Area C and Hope Downs 1 dewatering) modelled drawdown is 2 m or more over and above the natural climatic fluctuations which extends beyond the Proposed Mining Area C Development Envelope (see Figure 5).

### 11.4.5.1 Groundwater

The following groundwater-affecting activities have been assessed as part of the hydrological change assessment undertaken for the Proposal.

**Dewatering.** Dewatering is a key mining activity to access BWT ore and will take place across three nominal deposits located in the Additional Development Envelope and in multiple deposits in the Mining Area C EMP Revision 6 Impact Assessment Area. The lowering of groundwater levels during mine dewatering activities may result in the natural groundwater level being drawn down and the potential modification of the natural groundwater and surface water conditions in the orebody and the region, and potentially modification of the regional key water receptors of Coondewanna Flats, Weeli Wolli Spring and Ben’s Oasis.

**Water supply.** A water supply borefield may be required once mine dewatering volumes fall below water demand volumes. The potential impacts from water supply occur from lowering of groundwater levels and are as described above for dewatering.

Water supplies for the Proposal will continue to be delivered from proactive dewatering activities. The Camp Hill borefield located 15 km west of Mining Area C was impact assessed by BHP Billiton Iron Ore as part of the work supporting the development of the Mining Area C EMP Revision 6 (BHP Billiton Iron Ore, 2015a) as one of the potential options for a future source of mine water to meet processing, construction and dust suppression demand.

**Management of surplus water.** Surplus mine water will occur during periods when the mine water demand is less than the dewatering rate. Surplus mine dewatering can be managed through various methods, some of which may alter groundwater levels, impact riparian tree health or change water quality.

Potential surplus management methods include: use by operations, discharge to surface water, evaporation, supply to third parties and return to aquifer via MAR. Of these methods, use by operations and MAR (through infiltration and injection) are the preferred approaches for surplus management. Use
on site is predominately related to dust suppression. By using surplus dewater for this purpose it negates the need to seek another water supply for this activity thereby reducing the overall stress on local aquifers. The use of MAR, rather than surface discharge, results in the surplus water being returned to the same or nearby catchments and therefore there is less net loss of water from the aquifer. The ongoing MAR trial at Mining Area C (currently located at A Deposit) demonstrated a feasible option for mitigating drawdown. As a result a MAR strategy has been developed to address the surplus requirements of the combined operation which involves progressive development of MAR borefields.

Surplus is planned to be sent to MAR borefields at Juna Downs and Camp Hill, both of which were assessed as options in the work supporting the Mining Area C EMP Revision 6. There is potential for groundwater mounding from the MAR borefield at Juna Downs to interact with the root systems of the vegetation at the Coondewanna Flats PEC. Modelling has been carried out for Juna Downs (Appendix 7) and mounding triggers and thresholds have been developed to prevent detrimental change at the PEC (Table 57). Mounding triggers will be developed for Camp Hill, prior to this option being executed, to prevent impacts to vegetation using a similar approach.

MAR can also be achieved using infiltration to groundwater through surface water drainage lines, where the underlying geology is favourable. This approach is currently in use at Mining Area C in an area north west of the mine known as Runaway Valley, where large gravel deposits underly the drainage line. In this case discharge volumes are limited to prevent permanent water flow and mounding is monitored to prevent inundation of root systems in adjacent vegetation.

Other surplus disposal options have been considered and discounted either on the basis of cost (evaporation), availability (third-party supply) or potential environmental impact (discharge to surface water).

**Pit void.** Pit voids that extend below the natural water table may provide an ongoing source of groundwater reduction via evaporation from the surface of the formed lake in the void. The effects of the lowered groundwater levels are as described in for dewatering.

Once dewatering ceases the recovery of the water level to pre-mining levels will be controlled by natural recharge from the catchment and will take considerably longer than the pumping period. An outcome based management strategy will be used to reduce the risk of pit lakes on the surrounding aquifer. The backfilling of pit voids to above pre-mining water is one option available as part of the mine closure strategy and will be considered where ongoing monitoring is indicating that impacts to water quality or quantity as a result of pit lakes are potentially above those predicted as part of this Proposal.

The modelling carried out for the Proposal showed that:

- An expected 20-60 ML/d of dewatering volume of which approximately 42 ML/d will result from the 14 deposits at Mining Area C and the remainder from the Southern Flank ore body development.
- Drawdown at Coondewanna will be between approximately 8 and 22 m (without mitigation), of which approximately 6-9.5 m results from 14 deposits at Mining Area C and the remainder (2-12.5 m) from the Southern Flank ore body development.
- Drawdown at Weeli Wolli Spring will be on average 1.75 m (without further mitigation other than that planned by Rio Tinto Iron Ore), of which approximately 1.25 to 1.55 m results from 14 deposits at Mining Area C and the remainder (0.2 to 0.5m) from the Southern Flank ore body development.
The scenario of leaving open voids at A and E Deposits in the Mining Area C current operations post-closure is predicted to lead to a permanent reduction in the groundwater levels at closure, particularly at Coondewanna Flats. However, this risk is mitigated by commitments to backfill pit voids as detailed in the Mining Area C Closure Plan (BHP Billiton Iron Ore, 2016m).

Table 54 summarises the potential groundwater hydrological impacts of the Proposal.

Average drawdown predicted at two key receptors (Weeli Wolli Spring and Ben’s Oasis) as a result of the Proposal are lower than the regional drawdown from current operations in the catchment. The Proposal may result in an increased drawdown of groundwater under Coondewanna Flats but studies have demonstrated that the vegetation is not groundwater dependent. Therefore the predicted impacts to hydrological processes are not considered significant. However, ongoing monitoring and adaptive management tools (see Section 11.4.10) will be implemented to verify predictions and associated potential impacts.

11.4.6 Potential cumulative impacts – groundwater

From a cumulative impact assessment perspective, the following BHP Billiton Iron Ore and third party operations were included in the assessment:

- proposed additional groundwater drawdown from the Additional Impact Assessment Area;
- groundwater drawdown from the Current Mining Area C EMP Revision 6 Impact Assessment Area; and
- Hope Downs Management Services Hope 1 Iron Ore Mine (third-party – based on publicly available information).

Hope Downs Management Services ‘Baby Hope Mine Project’ is located immediately to the south-east of the Additional Development Envelope, however, is not a below-water table operation and as such, was not considered in this cumulative groundwater modelling assessment.

The regional groundwater drawdown response to Mining Area C dewatering is predicted to propagate out from the Marra Mamba orebodies in an east-west direction following the higher transmissivity Wittenoom dolomite and detrital aquifers. The extent of drawdown associated with dewatering Brockman deposits will be less significant owing to low permeability rocks (shale and BIF) around these deposits limiting the propagation of drawdown.

The Mining Area C EMP Revision 6 predicted a water level change, which was predicted to extend preferentially towards Coondewanna Flats (~6-9.5 m), with a smaller, and much later, change predicted at Weeli Wolli Spring (~1.6 m). The extent of drawdown from Northern Flank to Ben’s Oasis was considered unlikely owing to geological controls, catchment boundary features and the distance from Northern Flank.

Modelling carried out to inform the potential impacts of Southern Flank (BHP Billiton Iron Ore, 2016l) anticipates no material change to that previously predicted and assessed for the preparation Mining Area C Revision 6 for Weeli Wolli Spring and Ben’s Oasis (BHP Billiton Iron Ore, 2015a).

Coondewanna may experience falling groundwater levels as a result of dewatering the western Marra Mamba deposits of Southern Flank and Northern Flank, and to a lesser extent through dewatering of the eastern Marra Mamba deposits in these areas. The forecast drawdown range at Coondewanna predicted in the Mining Area C EMP Revision 6 model was between 6 and 9.5 m by 2036. The cumulative model, incorporating the additional dewatering at Southern Flank shows that, without mitigation, total drawdown would be between 8 and 22 m in the central area of Coondewanna Flats by 2047 at which point water levels begin to recover.
Table 54: Summary of groundwater hydrology impacts for the Proposal

<table>
<thead>
<tr>
<th>Indicative Additional Impact Assessment Area</th>
<th>Mining Area C EMP Revision 6 Impact Assessment Area</th>
<th>Proposed Extent (Revised Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional 20-60 ML/d (7-22 GL/a) of groundwater abstraction (peak) from Southern Flank</td>
<td>The maximum dewatering rate may be up to 42,000 kL/d (15.3 GL/a).</td>
<td>A total of 60-100 ML/d (22-37 GL/a).</td>
</tr>
<tr>
<td>Drawdown beneath Coondewanna is predicted to be between 8 and 22 m at GWB0039 without mitigation. Studies indicate this will not impact PEC as it relies on surface water rather than groundwater. Southern Flank is predicted to contribute approximately 0.2 to 0.5 m to a cumulative drawdown at Weeli Wolli Springs in 2054 (without mitigation).</td>
<td>Drawdown beneath Coondewanna is expected to be between 6 m and 9.5 m. With mitigation (e.g. MAR) this can be reduced and maintained at less than 1m Ben’s Oasis is likely to be less than about 2 m without mitigation; and Weeli Wolli Spring is likely to be less than approximately 1.6 m without additional mitigation (after the period of proposed mitigation by Rio Tinto Iron Ore).</td>
<td>Drawdown beneath Coondewanna is predicted to be between 8 and 22 m at GWB0039. Studies indicate this will not impact PEC as it relies on surface water rather than groundwater. Weeli Wolli Spring is likely to be less than an average of 1.75 m (after the period of proposed mitigation by Rio Tinto Iron Ore).</td>
</tr>
<tr>
<td>The scenario of leaving open pit voids at Highway Deposit is predicted to have additional reduction in the final recovery groundwater levels at Coondewanna Flats and Weeli Wolli Spring, without mitigation. Mitigating options such as backfilling and managed aquifer recharge will be implementation if ongoing monitoring indicates groundwater levels lower than those predicted.</td>
<td>The scenario of leaving open voids at A and E Deposits post-closure is predicted to have a potential reduction in the final recovery groundwater levels, particularly at Coondewanna Flats, without mitigation. BHP Billiton Iron Ore has committed to backfilling these voids to mitigate the potential reduction in final groundwater levels.</td>
<td>The scenario of leaving open voids at A, E and Highway Deposits post-closure is predicted to have a potential reduction in the final recovery groundwater levels, particularly at Coondewanna Flats and Weeli Wolli Spring. Mitigating options such as backfilling and managed aquifer recharge will be implementation if ongoing monitoring indicates groundwater levels lower than those predicted.</td>
</tr>
</tbody>
</table>

Coondewanna Flats is classified as a PEC based on vegetation and habitat aspects. Based on the above predictions and the fact that data shows that the vegetation is not groundwater dependent it is concluded that the Proposal will not have a significant impacts to the Coondewanna Flats PEC. Impacts to water quality are discussed in Section 11.5 which also concludes that impacts to the PEC are not significant.

Modelling of cumulative groundwater drawdown from the combined Mining Area C - Northern and Southern Flank operations and Hope Downs dewatering showed water levels are reduced in the Weeli Wolli Spring area. Drawdown during the peak of dewatering activities shows a range of 3 to 14 m at GWB0018 and is associated predominantly with abstraction from Hope Downs.

The hydraulic connection between the recharge area at Coondewanna Flats and spring flow at Weeli Wolli Spring means that a significant and permanent drawdown at Coondewanna Flats may cause a reduction in water level in the aquifer at Weeli Wolli Spring, potentially impacting stream flow. Groundwater modelling for closure scenarios discussed in Section 11.7.4.4 show that long-term groundwater recovery at Weeli Wolli Spring may be limited if water levels are permanently reduced at Coondewanna Flats. Modelling and field data show that current measures such as MAR, tree watering
and infiltration are plausible mitigation options for managing any long term impacts at Weeli Wolli Spring.

Following closure of Hope Downs (including the aquifer replenishment and mitigation actions outlined in HDMS, 2000) the combined cumulative impacts show a range of 1 to 2.5 m drawdown at Weeli Wolli Spring in 2054 with a median drawdown of 1.75 m. Dewatering at Southern Flank is predicted to contribute between 0.2 and 0.5 m of drawdown at GWB0018 in 2054. The forecast residual drawdown at Weeli Wolli Spring predicted in the Mining Area C EMP Revision 6 model was around 1.6 m at GWB0018 in 2054. As discussed in Section 11.1.4.3.3, a drawdown of less than 2 m at this location is considered unlikely to be detrimental to the Silver paperbark population in the Weeli Wolli Spring PEC.

Allowing for differences in modelling methods between proponents, data limitations (e.g. baseline conditions for Weeli Wolli Spring) and technical uncertainties inherent in long term forecasts, this range of drawdown is not represent a significant impact to the water resource, Coondewanna Flats or Weeli Wolli Spring receptors.

As part of the development of the Mining Area C EMP Revision 6, groundwater levels were predicted to rise and fall in the vicinity of the Camp Hill borefield as the system was assessed to be used for both surplus MAR and subsequently as a water supply borefield. The groundwater mounding was predicted to be up to 40 m. Operational borefield management and design will ensure that water levels remain >10 m from the ground surface during surplus injection.

Additional modelling has since been carried out on the planned injection of surplus water at the Juna Downs MAR scheme. The scheme has the potential to mitigate (reduce) the drawdown at Coondewanna Flats. MAR has advantages over other surplus water disposal options, such as direct discharge to surface drainages, by having a small surface disturbance footprint. However, as managed aquifer recharge effectively replenishes groundwater systems at much higher rates than natural recharge processes, it has the potential to elevate groundwater levels (i.e. create a groundwater ‘mound’) in a zone around the injection bores for a period of time. Modelling predicts the progression and extent of the MAR groundwater mound over the 18-year operating life of the MAR scheme (2016 to 2034) and indicates that mounding is likely to peak around 17 m below ground surface in 2028. At this depth it is unlikely to have a negative impact on the nearby vegetation.

The analysis of the predictions of the various numerical groundwater models (BHP Billiton Iron Ore, 2016) indicates that groundwater within the entire catchment area will be affected to some extent from the cumulative mine related activities from both this Mining Area C hub and Hope Downs, but is not considered significant.

Although groundwater drawdown and changes to the water resource attributed to this Proposal activities could extend >10 km west and east of the mine, the resulting impacts to the groundwater resource and groundwater dependent ecosystem are considered to be manageable with adaptive management (see discussion in Section 11.4.10). It is recognised that dewatering activities have the potential for localised drawdown the groundwater level during operations, the use of an adaptive management approach will ensure that the EPA objective to protect the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, can be met at the key water assets.

In summary the potential cumulative impact to groundwater hydrology of the Proposal, existing Mining Area C operation and third party operations is:

- Predicted drawdown at Coondewanna of 8 to 22 m - it is not considered that this will result in an impact to the vegetation, which is surface-water dependent.
- An average drawdown of 1.75 m at Weeli Wolli Spring following a period of mitigation by Rio Tinto at Hope Downs 1 operations – it is not considered that this will result in impacts to the ecohydrological aspect of the springs.
- A predicted drawdown of 1m at Ben Oasis – it is not considered that this will result in impacts to the ecohydrological aspect oasis.
- Post-closure, the recovery of the groundwater system is likely to take hundreds of years at Coondewanna Flats and Ben’s Oasis, and tens of years at the Weeli Wolli Spring without mitigation (such as MAR).

11.4.7 Potential impacts – surface water

The following surface water-effecting activities have been assessed as part of the hydrological change assessment.

Reduced surface water availability. Proposed pit and OSA developments have the potential to impact surface water resources and have the potential to impact surface water resources by:
- changing local surface water flow patterns, or
- affecting surface water runoff volumes and quality (the latter is discussed in Section 11.5.4).

Surface water ultimately flows towards Weeli Wolli Creek and supports Coondewanna Flats.

Previous surface water assessment has determined that surface water flow would increase slightly (~0.5%) in the Coondewanna subcatchment and decrease ~0.8% in the Weeli Wolli Spring subcatchment.

The outcomes from the assessment of the potential impact of the Proposal on surface water are documented in Table 55.

Water quality and sedimentation impacts assessed are discussed in Section 11.5 – Inland Waters Environmental Quality and indirect impacts to flora and vegetation and terrestrial fauna from surface water modifications are discussed in Section 11.1 and 11.2.

Table 55: Potential surface water impacts of the Proposal

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Mining Area C EMP Revision 6 Impact Assessment Area</th>
<th>Proposed Extent (Revised Proposal)</th>
</tr>
</thead>
</table>
| No creek diversions are proposed in the Proposed Southern Flank Development Envelope. The closest Southern Flank indicative pit design is located 100 m away from the 10,000-year ARI floodplain of the Pebble Mouse Creek, therefore, creek capture is not considered to pose a risk. OSAs located in 100 year floodplain have potential to add sediment to drainage systems. OSA design and sediment management systems will control this risk. The Indicative Additional Impact Assessment Area impacts approximately:
  - 3.5% of the Weeli Wolli Spring sub-catchment area;
  - 4.7% of the Coondewanna sub-catchment area and;
  - less than 1% of the Fortescue Marsh catchment. This predicted change is considered minimal with respect to overall catchment volumes as runoff remains within historic ranges. | From a hydrological perspective, relevant impacts assessed were interruption to existing surface water flow patterns. It was predicted that impacts to surface water flows were not significant as the Mining Area C EMP Revision 6 Impact Assessment Area equates to 0.18% of the Fortescue Marsh sub-catchment area. This predicted change is considered minimal with respect to overall catchment volumes as runoff remains within historic ranges. | Predicted impact of Proposal to surface water catchment are not significant as runoff volumes are expected to remain within historic ranges. |
11.4.8 Potential cumulative impacts– surface water

From a cumulative impact assessment perspective, the following BHP Billiton Iron Ore and third-party operations were included in the assessment:

- ground-disturbance associated with the Indicative Additional Impact Assessment Area;
- current approved ground-disturbance associated with the Mining Area C EMP Revision 6 Impact Assessment Area;
- approved ground disturbance associated with the Hope Downs Management Services ‘Hope 1 Iron Ore Mine’ (third-party – based on publicly available information and aerial photography); and
- approved ground disturbance associated with the Hope Downs Management Services ‘Baby Hope Mine Project’ (third-party operation – based on publicly available information and aerial photography).

For surface water engineering, the DMP generally require consideration of the probable maximum flood (PMF) event for mine closure. The 10,000-year ARI event was considered representative of the PMF event and was used to assess flood conditions in the Southern Flank mine area and inform closure design.

Modelling of flood events has shown no risk of creek capture for Pebble Mouse Creek, the most significant drainage feature within the mine footprint. Minor drainage will runoff into some pits but these are not considered to have a significant impact on the total runoff volumes reaching Fortescue Marsh. The reduction in catchment area consequently reduces peak flows and volumes but is not considered to be significant on a regional scale.

In summary the potential cumulative impacts to surface water are:

- a reduction in surface water flow into Coondewanna catchment of approximately 6.9%;
- a reduction in surface water flow into Upper Weeli Wolli catchment of 6.2% from cumulative BHP Billiton Iron Ore operations and 7.2% including third party operations impacts; and
- a reduction in surface water flow into the Fortescue Marsh catchment of 2% from BHP Billiton Iron Ore and third party operations.

11.4.9 Mitigation and residual impacts

BHP Billiton Iron Ore has carried out a review of the Western Australian Government’s ‘Mitigation Process’, which is detailed in Section 3 of the *WA Environmental Offsets Guideline* (Government of Western Australia, 2014). The four steps are:

- avoid;
- minimise;
- rehabilitate; and
- offset.

Following consideration of all data gathered during baseline surveys, additional targeted surveys and the outcomes of EIAs, BHP Billiton Iron Ore has considered this Proposal and addresses the first three steps of this hierarchy to meet the Hydrological Processes factor.

Actions taken are summarised in Table 56.
**Table 56: Actions taken to reduce impacts to hydrological processes**

<table>
<thead>
<tr>
<th>Action Taken</th>
<th>Step in the 'Mitigation Process'</th>
<th>Reduction in Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewatering volumes will continue to be used as a process supply when dewatering rates are in excess of demand requirements.</td>
<td>Minimise</td>
<td>The predicted water balance indicates that this is likely to occur at various stages between 2021 and 2034. The activity will see dewatering water being preferentially used over a stand-alone water supply borefield, minimising the net draw on the water resources. Water transfer between Northern Flank and Southern Flank will increase water use efficiency. Sourcing water from third party surplus will be considered where practicable.</td>
</tr>
<tr>
<td>Consistent with the DoW Mine Water in Mining Guideline (DoW, 2013b), and where practicable and feasible, surplus groundwater will continue to be preferentially returned to the aquifer through MAR.</td>
<td>Minimise and Mitigate</td>
<td>This practice will be used to reduce the extent and duration of groundwater drawdown and mitigate the impact to water resources, for example to mitigate drawdown at Coondewanna Flats if required. However, it is recognised that there are practicable and aquifer limitations with MAR. It is not part of the Proposal to undertake surface water discharge and currently it is not predicted that this option will be required. In the event that surface water discharge is required, necessary statutory approvals will be sought at this time.</td>
</tr>
<tr>
<td>Surplus water is planned to be introduced into the proposed Camp Hill borefield from about 2018 onwards, as well as Juna Downs, effectively storing water into the dolomite and alluvial aquifers.</td>
<td>Minimise</td>
<td>The MAR borefields may be reversed and the borefield will be pumped as a water supply (approximated to be post 2040). Camp Hill and Juna Downs are proposed as suitable potential storage location. Planned injection of surplus water at the Juna Downs MAR scheme has the potential to reduce the extent of drawdown as Coondewanna Flats.</td>
</tr>
<tr>
<td>Surface water will continue to be diverted around the mining footprint to the extent practicable to minimise the loss of surface water flow in the natural drainage systems.</td>
<td>Minimise</td>
<td>This will minimise reduction in runoff volumes by enabling catchments which are intercepted by infrastructure to be directed downstream.</td>
</tr>
<tr>
<td>Where practical, BHP Billiton Iron Ore will restrict clearing of vegetation to the Modified Additional Impact Assessment Area, this will reduce the impact to the Weeli Wolli surface water catchment area.</td>
<td>Avoid</td>
<td>The reduction in clearing will result in the following changes to the surrounding catchment areas: • 3.2% of the Weeli Wolli Spring sub-catchment; • 7.6% of the Coondewanna sub-catchment and; • less than 1% of the Fortescue Marsh catchment. The modification to the impact assessment area has resulted in a reduction in impacts to catchment area for the Weeli Wolli Spring Catchment, no change to the Fortescue Marsh catchment but a slight increase at the Coondewanna Catchment. The impacts are still within regional and seasonal variations in the catchments.</td>
</tr>
</tbody>
</table>

Backfilling of below the water table mine voids as a mitigation option is further discussed in Section 11.7.5, Rehabilitation and Decommissioning.

The residual impacts following implementation of the above actions is not considered significant and therefore does not warrant application of offsets for this factor.
11.4.10 Proposed management approach

11.4.10.1 Internal management approach

The strategic approach to site water management is the same as is currently outlined in the EMP Revision 6 (BHP Billiton Iron Ore, 2015a). This utilises a regional water management strategy (with underlying catchment plans) to meet our commitments and obligations and also provide a regionally consistent methodology for identifying and managing water related environmental and community risks, considering:

- Hydrological changes (baseline, current and future conditions of groundwater, soil moisture and surface water) resulting from BHP Billiton Iron Ore dewatering operations.
- 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 and actual) attributable to BHP Billiton Iron Ore mining activities.
- Required risk-based adaptive management techniques that are feasible (tested and practicable) to mitigate potential impacts to acceptable levels during operations and closure.

Regional water management uses an adaptive management approach, via the CPWRMP. This process uses the findings of ongoing ecohydrogeological technical studies to inform the management actions required to achieve outcome-based objectives. Adaptive management is risk-based and will be used proactively to counteract, mitigate or manage potential impacts (both predicted and actual) to an acceptable level. This approach has been incorporated into the Mining Area C EMP Revision 6 to manage impacts to water receptors.

The adaptive management approach is cyclic and involves the definition of key water assets for which a hydrological baseline is determined (if possible) and objectives set. These objectives for those water assets relevant to the Proposal are:

- For Weeli Wolli Creek: to prevent any significant impact on Weeli Wolli Spring (including Ben’s Oasis) as a result of BHP Billiton Iron Ore operations
- For Coondewanna Flats: to prevent any significant impact on priority vegetation communities within Coondewanna Flats (including Lake Robinson) as a result of BHP Billiton Iron Ore operations; and to minimise impact on groundwater levels and quality and to minimise potential impacts on the surrounding environment.

Any potential changes to the water assets are predicted through monitoring and modelling and managed by establishing and implementing appropriate management options. Ongoing monitoring and reviewing of data and options is undertaken regularly to ensure impacts are avoided, mitigated or minimised. Management options for the Mining Area C hub may include, but not be limited to, transfer of surplus water between Northern and Southern Flank, storage of water for use in turkey’s nests, infiltration basins, sediment basins or MAR and irrigation of trees. A number of these options (e.g. MAR and infiltration) return groundwater to the same aquifer thereby mitigating the potential for groundwater drawdown. Further discussion on management and mitigation options is described in the CPWRMP (Appendix 7).

As part of this approach BHP Billiton Iron Ore have undertaken a number of ecological studies to better understand connection between our operations and receptors and their reliance on water. As a result of these studies management thresholds have been defined (for Coondewanna Flats) and to date no significant change to the key ecohydrological receptors have been observed.
Some water risks will be mitigated by closure commitments as detailed in the Mine Closure Plan (BHP Billiton Iron Ore, 2016m). An adaptive management approach is used in developing closure plans and has identified mitigating controls for water risks such as backfilling pits. A commitment to backfill to above water table at A and E deposits is considered to mitigate the risk of long term drawdown from these pits.

The approach addresses the overall water catchment management area and the specific BHP Billiton Iron Ore operations within the catchment (Central Pilbara, Mining Area C hub). It applies catchment scale water management principles, allows for future approval processes and will simplify and provide transparency on water management criteria, risks, controls and water licences.

The regional water management approach requires that specific regulatory commitments are linked to outcome-based objectives and adaptive management methods for significant receptors if impacted by BHP Billiton Iron Ore operations.

11.4.10.2 Site-specific management approach

The current accepted Mining Area C EMP Revision 6 (BHP Billiton Iron Ore, 2015a) contains management objectives, management actions, monitoring requirements, indicators and trigger criteria, contingency actions and reporting requirements. These have been reviewed and where still relevant, integrated into the CPWRMP.

As a result of modelling carried out to inform this assessment, BHP Billiton Iron Ore considers the following changes to the current triggers and thresholds are appropriate for Coondewanna Flats:

- Coondewanna ecohydrological communities are unlikely to be dependent upon groundwater and therefore the predicted magnitude and rate of change in hydrological conditions outlined above are unlikely to result in an impact to the PEC. As a result of these findings, this assessment suggests that the current Condition 5 of MS 491 (BHP Billiton Iron Ore, 2015a) outlining two water level investigation triggers for Coondewanna Flats be removed. Should tree condition monitoring or future studies indicate Coondewanna is groundwater dependent, mitigation measures such as water injection or tree watering will be implemented.

- New modelling suggests that there may be potential for mounding as a result of the proposed Juna Downs MAR scheme. As such, BHP Billiton Iron Ore is proposing to establish upper water level targets and thresholds, along with ecological indicators to prevent detrimental changes at the PEC. These are presented in Table 57.

With regard to Weeli Wolli Spring and Ben’s Oasis, BHP Billiton Iron Ore considers that it has met its previously accepted commitments to review the triggers at Weeli Wolli Spring in line with the following from the EMP Revision 6 (BHP Billiton Iron Ore, 2015a):

- at notification of pre-closure of Rio Tinto Iron Ore’s Hope Downs mining operation: this commitment is not yet applicable; however, it is carried over into the CPWRMP and will remain a commitment;

- if other BHP Billiton Iron Ore BWT operations are approved in the catchment: the modelling carried out to inform this PER assessment is considered to have met this commitment; however, the commitment will be carried over into the CPWRMP for future application, should it be required;

- if changes are identified via the annual or triennial aquifer review process: this commitment will be carried over into the CPWRMP; and

- as required by BHP Billiton Iron Ore: this commitment will be carried over into the CPWRMP.
Table 57 and Table 58 presents the proposed management plan provisions for the Proposal. Management is also discussed in the CPWRMP (Appendix 7).

11.4.10.3 Regulatory management approach

Hydrological processes at the current approved Mining Area C area are managed by the following regulatory processes:

- MS;
- 5C licence and associated Groundwater Operating Strategy;
- Part V licence; and

This management approach will continue under this Proposal. Dewatering volumes will continue to be managed through the DoW groundwater licensing process. Table 57 and Table 58 presents the proposed management plan provisions for the Proposal. It is proposed that these management provisions will be formalised through regulation of an Environmental Management Plan via the Ministerial Statement and the BHP Billiton Iron Ore’s standard Pilbara-wide Health, Safety and Environment system. A draft of the management plan (CPWRMP) which includes the management provisions outlined in Table 57 and Table 58 is located in Appendix 7.

11.4.11 Summary and predicted outcome

In consideration of the outcomes of the EIA and proposed management measures, BHP Billiton Iron Ore considers that the hydrological regimes of groundwater and surface water can be maintained so that existing and potential uses, including ecosystem maintenance, are protected. This will be achieved through the application of the CPWRMP, which includes outcome based objectives, management actions and relevant triggers and thresholds that are summarised below.
### Table 57: Draft Proposed Environmental Management Plan Provisions – Hydrological Processes – Coondewanna Flats

To meet the requirements of Condition(s) X of Ministerial Statement X.

<table>
<thead>
<tr>
<th>EPA Factor and objective: Hydrological Processes</th>
<th>To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key environmental values: Coondewanna Flats Priority Ecological Community</td>
<td></td>
</tr>
<tr>
<td>Outcome:</td>
<td>No net-loss of the biological diversity and/or ecological integrity of the Coondewanna Flats Priority Ecological Community, as a result of BHP Billiton Iron Ore activities.</td>
</tr>
<tr>
<td>Key impacts and risks: Coondewanna Flats Priority Ecological Community (PEC) has the potential to be impacted from surplus water discharge, resulting in changes to the biological diversity and/or ecological integrity of the PEC.</td>
<td></td>
</tr>
</tbody>
</table>

#### Outcome-based provisions

<table>
<thead>
<tr>
<th>Environment criteria:</th>
<th>Response actions:</th>
<th>Monitoring</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger criteria</td>
<td>Trigger level actions</td>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
</tr>
<tr>
<td>Threshold criteria</td>
<td>Threshold level actions</td>
<td>Condition clause number and text</td>
<td>Condition clause number and text</td>
</tr>
</tbody>
</table>

**Water Quantity in the Coondewanna Flats Priority Ecological Community Monitoring Zone – Groundwater level**

- **Trigger criteria**: <15 mbgl\(^1\) at any of the following monitoring bores: GWB0039M, HCF0032M, HCF0044M and HCF0045M
- **Threshold criteria**: <7 mbgl\(^2\) at any of the following monitoring bores: GWB0039M, HCF0032M, HCF0044M and HCF0045M

Response actions to trigger criteria exceedance may include, but are not limited to:
- Commence vegetation monitoring;
- Decrease surplus water discharge rate; and
- Alter surplus water discharge regime.

Response actions to threshold criteria exceedance may include, but are not limited to:
- Decrease surplus water discharge rate;
- Alter surplus water discharge regime; and
- Cease surplus water discharge.

Monitoring: Monthly monitoring of groundwater levels (mbgl) of GWB0039M, HCF0032M, HCF0044M and HCF0045M during operations (i.e. active dewatering / surplus water discharge).

Notification in the event that the threshold criteria has been exceeded or potential non-compliance to the outcome, will be provided to the OEPA and DoW within 7 days of that potential non-compliance being known. A report including any corrective actions identified will be provided to the OEPA and DoW via email, once an investigation into the potential non-compliance has been completed.

An annual compliance assessment report will be submitted as part of the Annual Environment Report and Annual Aquifer Report, which will be submitted to OEPA by 1 October each year.

**Tree health of indicator tree species\(^3\) in the Coondewanna Flats Priority Ecological Community Monitoring Zone**.

Monitoring of tree health will be undertaken in response to trigger of groundwater level <15 mbgl.

- **Trigger criteria**: Statistically significant canopy decline (defined as Crown Condition Score (CCS) compared to reference trees over four consecutive monitoring periods within monitoring sites 12, 15 or 20.
- **Threshold criteria**: Statistically significant canopy decline (defined as Crown Condition Score (CCS) compared to reference trees over eight consecutive monitoring periods; or death of any tree (contributable to water stress), within monitoring sites 12, 15 or 20.

Response actions to trigger criteria exceedance may include, but are not limited to:
- Decrease surplus water discharge rate; and
- Alter surplus water discharge regime.

Response actions to threshold criteria exceedance may include, but are not limited to:
- Decrease surplus water discharge rate;
- Alter surplus water discharge regime; and
- Cease surplus water discharge.

Following exceedance of water quantity trigger criteria:
- Biannual Crown Condition Score (CCS) of indicator tree species\(^3\) at monitoring sites 12, 15 and 20 and three reference sites on BHP Billiton Iron Ore tenure.

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\(^1\) Corresponds to the point at which groundwater levels could interact with the roots of *E. victrix*, further details in Appendix C of CPWRMP.

\(^2\) Groundwater Level: Corresponds to the point at which groundwater levels could interact with the roots Acacia species, further details in Appendix C of CPWRMP.

\(^3\) Species: *E. victrix* (AQ2, 2016). Details of species water dependency provided in Appendix C of CPWRMP.
Table 58: Proposed Environmental Management Plan Provisions – Hydrological Processes – Weeli Wolli Spring

<table>
<thead>
<tr>
<th>EPA Factor and objective:</th>
<th>Hydrological Processes - To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key environmental values:</td>
<td>Weeli Wolli Spring Priority Ecological Community</td>
</tr>
<tr>
<td>Outcome:</td>
<td>No net-loss of the biological diversity and/or ecological integrity of the Weeli Wolli Spring Priority Ecological Community, as a result of BHP Billiton Iron Ore activities.</td>
</tr>
<tr>
<td>Key impacts and risks:</td>
<td>Weeli Wolli Spring Priority Ecological Community (PEC) has the potential to be impacted from groundwater, resulting in changes to the biological diversity and/or ecological integrity of the PEC. However, this drawdown is predominantly associated with abstraction from Hope Downs.</td>
</tr>
</tbody>
</table>

### Outcome-based provisions

<table>
<thead>
<tr>
<th>Environment criteria:</th>
<th>Response actions:</th>
<th>Monitoring</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger criteria</td>
<td>Response actions to trigger criteria exceedance may include, but are not limited to:</td>
<td>Monthly monitoring of groundwater levels (mbgl) within the Weeli Wolli Spring Priority Ecological Community Monitoring Zone during operations (i.e. active dewatering / surplus water discharge):</td>
<td>Reporting in the event that the trigger criteria has been exceeded will be as per the Ministerial Statement Compliance Assessment Plan and relevant Groundwater Operating Strategy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At receptor:</td>
<td>Annual reporting will be conducted as per the Ministerial Statement Compliance Assessment Plan and relevant Groundwater Operating Strategy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o GWB0016DM;</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>o GWB0016SM;</td>
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<td>o GWB0017DM;</td>
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<td>o GWB0017SM;</td>
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<td>o GWB0018SM;</td>
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<td>o GWB0018SM;</td>
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<td>o GWB0032DM;</td>
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<td>o GWB0021SM;</td>
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<td></td>
<td>o GWB0022SM;</td>
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<td>o GWB0013M;</td>
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<td>o GWB0014BM;</td>
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<td>o GWB0015M;</td>
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<td></td>
<td></td>
<td>o HEPX0001</td>
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<tr>
<td></td>
<td></td>
<td>• Early warning:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>o GWB0013M;</td>
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<tr>
<td></td>
<td></td>
<td>o GWB0014BM;</td>
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<td></td>
<td></td>
<td>o GWB0015M;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and HEPX0001</td>
<td></td>
</tr>
</tbody>
</table>

### Trigger criteria for change in risk profile of impacts attributable to BHP Billiton Iron Ore activities:

- At notification of pre-closure of Rio Tinto Iron Ore’s Hope Downs mining operation;
- If other BHP Billiton Iron Ore below water table operations are approved in the catchment;
- If changes are identified via the annual or triennial aquifer review process; and
- As required by BHP Billiton Iron Ore.
11.5 Inland waters environmental quality

11.5.1 Introduction and EPA objective

Mining projects have the potential to impact the quality of inland water environments through the construction and operation of the Proposal, as well as through the discharge of surplus water back into the environment. This section provides an overview of these issues and the relevant supporting studies and investigations.

The EPA applies the following objective, according to the Statement of Environmental Principles, Factors and Objectives (EPA, 2016), in its assessment of proposals that may affect inland waters environmental quality:

To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.

11.5.2 Relevant guidelines and approvals

As part of the preparation of this assessment against the inland waters environmental quality factor, all EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

The following guiding documents were also relevant in the consideration of impacts to inland waters environmental quality:

- Operational Policy No. 1.02. Policy on Water Conservation/Efficiency Plans, Achieving Water Use Efficiency Gains through Water Licensing (DoW, 2009);
- Operational Policy No. 5.08. Use of Operating Strategies in the Water Licensing Process (DoW, 2011);
- Water Quality Protection Note No. 30. Groundwater Monitoring Bores (DoW, 2006);
- Water Quality Protection Guidelines No. 4. Mining and Mineral Processing, Installation of Minesite Groundwater Monitoring Bores (Water and Rivers Commission, 2000b);
- Water Quality Protection Guidelines No. 5. Mining and Mineral Processing, Minesite Water Quality Monitoring (Water and Rivers Commission, 2000c);
- Water Quality Protection Guidelines No. 9. Mining and Mineral Processing, Acid Mine Drainage (Water and Rivers Commission, 2000d);
- Water Quality Protection Guidelines No. 11. Mining and Mineral Processing, Mine Dewatering (Water and Rivers Commission, 2000e); and
- Environmental and Water Assessments Relating to Mining and Mining-related Activities in the Fortescue Marsh Management Area (EPA, 2013c).

11.5.3 Existing environment

The existing mining infrastructure at Mining Area C is located in the main Northern Flank valley. This main valley is relatively linear, being contained by the ridgelines lying along its north and south sides. The existing mining developments straddle the catchment divide between the Coondewanna subcatchment to the west and the Weeli Wolli Creek subcatchment to the east. The catchment divide
extends to the Additional Development Envelope where the eastern end of the valley drains west into Coondewanna while the rest of the area drains east into Pebble Mouse creek and on into Weeli Wolli Creek. Surface water catchments boundaries and flow directions are shown in Figure 39.

Mining Area C contains a second valley, located south of the main North Flank valley which drains into the main North Flank valley downstream of the mine development areas to the east. This second valley is wider and has a larger catchment area than the main Northern Flank valley.

Southern Flank valley receives drainage from the higher ground north of the main valley and from the north-eastern slopes of Mount Robinson. Drainage from the Southern Flank ridgeline generally passes through narrow valleys or gorges before reaching the valley floor. The valley floor drains into Pebble Mouse creek which enters Southern Flank valley from the south and continues on to the east.

Following a rainfall event, runoff from the ridgelines is relatively concentrated and rapid. Upon entering the natural valley floor, these discharges tend to spread out over a wider flow zone and slow down, thus reducing the flow peak and sediment-carrying capacity. Where runoff from the steeper valley sides enters the valley floor, sediment deposits have accumulated; and in the more confined main North Flank valley, these deposits can influence the valley floor drainage patterns.

Discharges from the north-western area of the Northern Flank valley enter the main valley through a break in the north side ridgeline. Based on the valley floor contours, discharges from this subcatchment currently flow eastwards into the Weeli Wolli Creek drainage system; however, it is likely that historically these discharges would have oscillated between flowing east and flowing west, depending on the shape of the accumulated sediment delta. During flood events, discharges from this subcatchment would be relatively concentrated when passing through the ridgeline, then would spread out over a wider flow zone and slow down upon entering the valley floor.

Water quality in the catchment is considered to be good, with baseline surface water quality as expected for a relatively undisturbed catchment with total dissolved solids up to 100 mg/L. Groundwater in the catchment typically has a low salinity with a typical total dissolved solids range between 600 and 700 mg/L. This is considered to be a consequence of rainfall recharge and throughflow mechanisms in the aquifer. Groundwater chemistry in the valley aquifers have a predominantly carbonate signature as a result of the dolomite aquifers in these areas and groundwater has a slightly basic pH, typically between 7 and 8.

No significant changes in groundwater or surface water quality have been observed since mining commenced. Minor fluctuations in salt levels have been linked to rainfall with groundwater becoming slightly fresher following large rainfall events.
Figure 39: Surface water catchments and flow directions
11.5.4 Potential impacts

The extents, or boundaries, used to assess the potential impacts of this Proposal, of the Revised Proposal (that is this Proposal plus the existing Mining Area C operations) and cumulative or regional extents vary for each factor. Table 59 details the impact assessment area for the Inland Waters Environmental Quality factor.

Table 59: Impact assessment areas for inland waters environmental quality

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inland Waters Environmental Quality</td>
<td>Assessment of Coondewanna and Weeli Wolli subcatchments. Includes potential impacts from the proposed Southern Flank ore body, Mining Area C current operations and Hope Downs 1 project. Impact assessment determined the significance of additional catchment reduction due to the Proposal.</td>
<td>Assessment of Coondewanna and Weeli Wolli subcatchments. Includes potential impacts from the proposed Southern Flank ore body, Mining Area C current operations and Hope Downs 1 project. Impact assessment determined the cumulative impacts of the Proposal, existing Mining Area C operations and third party operations at Hope Downs.</td>
<td>As per Mining Area C Revised proposal Extent as impacts assessed for whole catchments and inclusive of third party operators.</td>
</tr>
</tbody>
</table>

The following surface water potential impacts have been assessed as part of the hydrological change assessment:

- **Reduced surface water availability.** Surface water flow and runoff will be intercepted and diverted to prevent inflow to and inundation of the open pits and to prevent flooding of infrastructure. Proposed pit and OSA developments have the potential to impact surface water resources by:
  - increasing the risk of erosion and sedimentation, or
  - introducing contamination to the subsurface from chemicals.

  As described previously, the surface water ultimately flows east towards Weeli Wolli Creek with a smaller percentage going west towards Coondewanna Flats.

- **The storage and handling of waste products.** The inappropriate handling and management of soluble waste materials has the potential to contaminate surface water and groundwater.

- **Acidic or saline pit lakes.** The water within pit voids may increase in salinity through concentration, or develop AMD characteristics via interactions with the wall rocks. The altered water quality may remain isolated within the pit or under some hydrological conditions, groundwater may flow through the pit and therefore the pit may alter the downstream groundwater chemistry.
As discussed in Section 11.7.4.1, AMD risk is considered low to very low due to the lack of AMD source material. As a result the risk of acidic pit lakes in the Proposed Mining Area C Development Envelope has been assessed as low to negligible. Potential exists for pit lakes to become saline overtime and as such an adaptive management approach will be taken. BWT pit void backfill is a mitigating option if required to maintain suitable surface and groundwater quality.

Changes to surface water volumes within the catchment are detailed in Table 55 of Section 11.4.7. Section 11.4 includes an assessment of changes to Hydrological Processes which considers changes to surface water catchments. Potential impacts to specific receptors are discussed in more detail in Section 11.1.4.3.3 (Weeli Wolli) and Section 11.1.4.3.4 (Coonde wanna). No significant changes to surface water quality in either the Weeli Wolli catchment or Coonde wanna catchment have been observed from monitoring data as a result of operations to date and no changes are predicted for water quality as a result of the Proposal.

A summary of impacts the proposed change and the proposed extent is provided in Table 60.

Table 60: Summary of inland waters environmental quality potential impacts

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Proposed Extent (Revised Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed OSA 36 encroaches on the Pebble Mouse Creek 100-year floodplain, which is a potential erosional risk. Current management of OSAs such as landform design, waste characterisation and rock armouring will ensure this risk is minimised. This management is further discussed in Section 11.7. It is predicted that even in a 1 in 10,000 flood event there is no significant impact to quality of water in Pebble Mouse Creek as there is no risk of creek capture for Pebble Mouse Creek. The likelihood of the formation of acidic or saline pit lakes (if they are present) is considered low to negligible. Proposed pit and OSA developments for the P2, P5, P6 and R deposits and modifications to the existing indicative deposit and OSA boundaries have the potential to impact surface water resources by changing local surface water flow patterns, by affecting surface water runoff volumes and quality, by increasing the risk of erosion and sedimentation, or by contamination from chemicals or hydrocarbons. It is predicted that there is no significant impact to surface water flow, runoff volumes or quality for additional disturbance. With current management practises with respect to chemical and hydrocarbon containment it is predicted that risk of contamination to surface water is low. The current storage and containment management for chemical and hydrocarbons has resulted in no surface water or groundwater contamination to date. Potential impacts on natural surface water quality are negligible. The risk assessment concluded that the potential for AMD is low due to the oxidised nature of the ore.</td>
<td>Assessment shows that there is not predicted to be significant impacts to water quality as a results of the Proposal. Overall, AMD is not considered to pose a risk to inland waters environmental quality.</td>
</tr>
</tbody>
</table>
As an assessment of surface and groundwater flow and quality in the catchment has shown that AMD risk is low, impacts to water quality from sedimentation is low and potential contamination of waters resulting from chemical or hydrocarbon storage is low.

Therefore it is concluded that is no significant risk to inland water environmental quality predicted due to implementation of the Proposal.

### 11.5.5 Mitigation and residual impacts

For the three key environmental receptors in the catchment there is considered to be negligible risk from the proposed development for the following reasons:

- **Coondewanna Flats** will have a small reduction in catchment area but surface runoff into the catchment is expected to be maintained within historic ranges. Sediment control for water entering Coondewanna Flats will reduce the likelihood of impacts due increased sediment in surface water.
- **Weeli Wolli Creek and spring system** will have a small reduction in catchment area but surface runoff into the catchment is expected to be maintained within historic ranges. Sediment control for water entering the Weeli Wolli catchment will reduce the likelihood of impacts due increased sediment in surface water.
- **The surface water catchment supporting Ben’s Oasis** is outside of the development footprint with project development and operations unlikely to impact water quality in this catchment.

Where possible, surface water flows will be diverted around operational areas with the aim of maintaining water flow volumes as far as practicable.

Although only 8% of the proposed ore in the Indicative Additional Development Envelope is below the water table, if not backfilled, the orebody at the western end of the Indicative Additional Development Envelope has the potential to remain as a pit lake, which ultimately could become saline. An adaptive management approach will be taken to manage pit lake salinity such that BWT pit void backfilling deployed if required to maintain suitable groundwater and surface water quality. With backfilling of pits available as a mitigation measure to manage the potential for pit lakes to become saline and or acidic.
over time is not considered that salinity or acidic pit lakes are possible in relation to this Proposal and is the primary reason why BHP Billiton Iron Ore considers that Inland Waters Environmental Quality is not considered to be a key environmental factor.

Following application of the mitigation hierarchy, the residual impacts are not considered significant and therefore the application of offsets is not warranted.

BHP Billiton Iron Ore also considers that general chemical and contamination risks can be managed as part of its standard Pilbara-wide Health, Safety and Environment Management System.

11.5.6 Proposed management approach
Sediment management has been successful to date at Mining Area C. Sediment traps and retention ponds have been installed along the main drainage channels which have prevented any significant sediment loads leaving site. Monitoring of water leaving site has shown sediment levels to be consistently below licence requirements. Due to similarities in sediment source material (Marra Mamba ore) and runoff volumes it is expected that the use of sediment ponds and monitoring will also be successful when applied to the Southern Flank mining areas.

BHP Billiton Iron Ore considers that this environmental factor can be addressed by actions outlined in Table 60, those discussed in Section 11.5.5 and outlined in the Mine Closure Plan (Appendix 12).

11.5.7 Predicted outcome
This Proposal meets the EPA’s objective for the inland waters environmental quality factor, with potential impacts not considered significant and it is therefore not considered to be a key environmental factor. BHP Billiton Iron Ore considers that this factor can be addressed under Part V of the EP Act.

11.6 Heritage

11.6.1 Introduction and EPA objective
The EPA applies the following objectives, according to the EAG 8 for Environmental Factors and Objectives (EPA, 2013a) in its assessment of proposals in relation to heritage:

To ensure that historical and cultural associations are not adversely affected.

11.6.2 Relevant guidelines and approvals
The following guiding document is relevant in the consideration of impacts to Aboriginal heritage:

- EPA Guidance Statement No. 41, Assessment of Aboriginal Heritage (EPA 2004d); and
- Aboriginal Heritage Act (1972) (AH Act).

Table 7 details the relevant EPA documents as identified in the Mining Area C – Southern Flank Environmental Scoping Document (OEPA, 2016) and their relevance to this Proposal.

11.6.3 Existing environment
The Proposed Mining Area C Development Envelope is situated within the determined Native Title of the Banjima People. BHP Billiton Iron Ore is committed to working cooperatively with the Banjima People and have formalised this commitment through a comprehensive Indigenous Land Use Agreement (ILUA) executed on the 28 October 2015. The BHP Billiton Iron Ore Banjima ILUA covers the entire Banjima Native Title determination area, which spans an area of 8,263 square kilometres (826,300 hectares).
The ILUA governs the delivery of Native Title and associated indigenous approvals and facilitates long term collaboration and outlines how BHP Billiton Iron Ore works in partnership with the Banjima People to manage cultural heritage. The Heritage Protocol outlined in Annexure A of the BHP Billiton Iron Ore Banjima ILUA includes detailed processes and provisions about the way in which heritage surveys, consultations and submissions are conducted. As part of these agreements, BHP Billiton Iron Ore and the Native Title groups have agreed to specific cultural heritage commitments in relation to the management of heritage sites, including the recognition, mapping and capture of places of ethnographic importance (referred to as ‘confidential areas’). BHP Billiton Iron Ore will seek to avoid impacts to these confidential areas in line with its obligations under the agreements.

The heritage values of the Proposed Mining Area C Development Envelope have been determined by BHP Billiton Iron Ore, heritage consultants and members of the Banjima by conducted over 200 ethnographic and archaeological heritage surveys within the Proposed Mining Area C Development Envelope. BHP Billiton Iron ore have specifically consulted with these stakeholders regarding the Proposal. BHP Billiton Iron Ore has spent over 2,000 working days in the field undertaking survey works in relation to the Proposal. The methodology of the survey is based on pedestrian transects that cover the entire Proposed Mining Area C Development Envelope. All heritage places have been mapped and recorded (Figure 40). The information is then managed in a spatially enabled database. All surveys were conducted by qualified archaeologist and anthropologists in partnership with Banjima participants. Over 7 million dollars has been spent on heritage surveys and heritage research in the Proposed Mining Area C Development Envelope.

The general significance of heritage places range from being:

- External (Government) Protected Areas:- are heritage places that have been identified through legislative or regulatory processes. These places have been gazetted or officially set aside by either a legislative or regulatory body under a specific Act of Parliament (e.g. section 19 of the AHA) at either State or Commonwealth level. This type of heritage place therefore may be included on either a State or Federal Heritage List or Register and are protected by legislation;
- Agreement exclusion zones:- these are heritage places where BHP Billiton Iron Ore has made a commitment to avoid via land use agreement ranging from a contractual commitment to rights reserved;
- Actively managed areas:- these are heritage place where agreement on significance has not been reached or where there is an agreed high culture value (but do not warrant an exclusion zone or are not externally protected) or areas where BHP Billiton Iron Ore consider site may be listed as protected in the future. These sites are considered to have higher cultural heritage value than those classed as sites under section 5 of the AHA;
- Section 5 heritage sites:- as determined by the ACMC under the AHA; and
- Other places:- these are considered to be of low cultural heritage value and or are yet to be assessed under the AHA.

Further detail on significance is provided in the Draft Cultural Heritage Management Plan in Appendix 8. Archaeological surveys have identified over 1,500 places within the Proposed Mining Area C development envelope that show evidence of past human occupation and interaction with the environment and these have been discussed with the relevant Aboriginal People. These places are classed as other places until such time as they are assessed and or classified with the traditional owners or by the ACMC.

The Proposed Mining Area Development Envelope specifically avoided the Mount Robinson significant site, as agreed with the traditional owners as an exclusion zone (see Section 11.6.5).
The places located within the Proposed Mining Area Development Envelope include Rockshelters (~20%), Rockshelters containing artefacts (~65%), Stone Arrangements/Man made Structures (~7%), Artefact Scatters (~6%), Scarred Trees (2%), quarry (<1%) and one Engraving. None of the places located in the development envelope are externally protected areas or exclusion zones. Two actively managed areas (Jandaru Jibalba and Stone Arrangement Relocation) are present within the Proposed Mining Area C Development Envelope, one (Jandaru Jibalba) is within the Mining Area C EMP Revision 6 Impact Assessment Area. The management strategy for this site is that it will be avoided and will be managed via the PEAHR process. Further information for this site is not included here or in the Cultural Heritage Management Plan (CHMP) as the site is considered culturally sensitive by the Banjima people. Information pertaining to the second actively managed site (Stone Arrangement Rockshelter) is included in the CHMP, except for the specific location which is withheld in line with the ILUA.

To date, 18 sites within the Proposed Mining Area C Development Envelope have been classed as section 5 heritage sites (see Figure 40a). All of these and the remaining heritage places are very common in the central Pilbara and widely distributed across the broader landscape (see Section 11.6.4.1).

One of the sites is a registered ethnographic site, DAA 25664 (Djadjiling) is within the Proposed Mining Area C Development Envelope. Djadjiling was initially referenced as part of Native Title preservation evidence in June 2007 (Canning, 2008). The reference provided little detail as to why and on what basis the range was recorded as an ethnographic site and how it relates to any other places of significance in the area. During ethnographic surveys undertaken by John Gleason with the Banjima people in 2008 where Senior Lore Men such as David Stock and Gordon Yuline attended, no mention was made of the Djadjiling being an ethnographic site.

The assessment of whether these places are formally nominated as heritage sites under the AHA is undertaken by the Aboriginal Cultural Material Committee (ACMC) with support from the DAA. To be formally nominated as a site under the AHA these places have to meet criteria under section 5 of the AHA. The ACMC makes this assessment. The ACMC advises the Minister on the significance of the relevant sites and give recommendations on the project and potential mitigation. The Minister considers this guidance and other relevant factors before giving conditional approval or rejecting the proposal under s18.

In a consent letter dated the 24 August 2009 (Our Ref 25-05661) Minister Kim Hames (Minister for Indigenous Affairs) granted consent under s18 of the AH Act for portions of the Additional Development Envelope and DAA 25664 (Djadjiling Ethnographic Site) to be impacted for the purpose of exploration activities for identifying and delineating iron ore mineralisation to facilitate the later development of iron ore operations. Under this consent, BHP Billiton Iron Ore has conducted significant exploration activities as part of the Southern Flank study, which includes but is not limited to >2,000 drill holes and clearing for access tracks. The approximate current disturbance footprint from exploration activities is approximately 274 ha. BHP Billiton Iron Ore is compliant with the conditions outlined in this consent.

As part of this Ministerial consent, BHP Billiton Iron Ore is required to include information on any archaeological places which may be impacted in any subsequent s18 (under the AH Act) application. A s18 application that has been submitted and approved as part of this Proposal is in line with the Ministerial consent. BHP Billiton Iron Ore submitted 79 places within the Proposed Mining Area C Development Envelope to the DAA under s18 of the AHA and 18 of these were found to meet the criteria outlined in section 5 of the DAA (see Appendix 8).
11.6.4 Potential impacts

The extents, or boundaries, used to assess the potential impacts of this Proposal, of the Revised Proposal (that is this Proposal plus the existing Mining Area C operations) and cumulative or regional extents vary for each factor. Table 61 details the impact assessment area for the heritage factor.

Table 61: Impact assessment areas for Heritage

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heritage</td>
<td>Proposed Mining Area C Development Envelope</td>
<td>As for Proposal Extent plus Approved Mining Area C (Northern Flank) Development Envelope and Mining Area C EMP Revision 6 Impact Assessment Area</td>
<td>As for the Revised Proposal extent with consideration of cultural significance regionally.</td>
</tr>
</tbody>
</table>

Within the Proposed Mining Area C Development Envelope BHP Billiton Iron Ore identified over 1500 potential heritage places, 25 of these have been fully impacted under s18 approval by the Mining Area C development and 17 sites have been partially impacted. The Proposal may potentially impact ~1200 potential archaeological places and partially impact (~30%) one ethnographic site DAA 25664 (Djadjilling) (Figure 40). Note that the majority of these potential heritage places are classed as “other places” under the significance classifications, although some are yet to be assessed by the ACMC. It is likely that the majority of these potential places will remain at the “other places” significance level based on recent application (see below). The significance of impact to the ethnographic site is not considered significant particular as the ethnographic surveys undertaken by John Gleason with the Banjima people in 2008 where Senior Lore Men such as David Stock and Gordon Yuline attended, made no mention of the Djadjilling being an ethnographic site and did not highlight this site as being of significance to the Banjima people.

Rockshelters, with or without walls and or artefacts, constitute the main (~85%) potential heritage places within the Proposed Mining Area C Development Envelope. Twenty five percent (~25%) of these places are located outside of the Indicative Impact Areas (Additional and EMP Revision 6). Many of the other types of sites (in total ~420 potential places) are also located outside of the proposed impact areas: stone arrangements (25%), artefacts (25%), engraving (0%), quarries (57%), and scarred tree (27%).

Within surveyed areas, BHP Billiton Iron Ore is aware of the spatial location of each heritage place and, where practical, adopt engineering solutions to avoid them. Requirements around the management and minimising impacts to significant heritage places and values are embedded within the BHP Billiton global Indigenous people’s policy.

An application was tabled at the ACMC on 14 December 2016 with regard to the heritage places that will be impacted within the first five years of the Proposal. The places have been recorded to a detailed level to mitigate against their loss. The detailed recording is considered a mitigation as it preserves the information contained in the heritage place. Additionally BHP Billiton Iron Ore has conducted an extensive excavation project in partnership with the relevant Aboriginal People to better understand the cultural landscape and the sequence of early occupation of the area. Approvals under the AH Act, in relation to subsequent impacts of further sites will be sought in line with legislative and ILUA contractual requirements.
On 24 January 2017 BHP Billiton Iron Ore received ministerial consent under s18 of the AHA to use the land for the purpose of all things associated with open cut iron ore mining. Of the 78 places submitted the ACMC and the Minister, it was assessed that 18 places (i.e 23% of those submitted) met Section 5 of the AHA and The Minister gave consent to impact these sites. No specific mitigation or management conditions formed part of the consent. BHP Billiton Iron Ore is currently working with the local Aboriginal elders to evaluate and establish salvage and mitigation options.

Baseline and targeted flora and fauna surveys are undertaken to inform environmental approvals and management. These surveys are undertaken in line with the Western Australian EPA's Guidance Statement No. 51 (EPA, 2004a), as well as other relevant EPA position statements, and are generally in line with the recently released Technical Guide - Flora and Vegetation Surveys for EIA (EPA & DEC, 2015). BHP Billiton Iron Ore will engage with relevant Native Title groups in identifying indigenous considerations relevant to these surveys, including bush food and bush medicine as part of its ongoing consultation undertaken as part of the ILUA. BHP Billiton Iron Ore is working closely with the Banjima Aboriginal group on their care for country plan, which includes identification and management of things such as bush medicine and traditional food.

Detailed heritage site investigations and EIA have shown that potential environmental impacts of the Proposal do not cause a significant impact to any identified heritage site. The past surveys with Banjima and Nyiyaparli participation have not indicated a direct link between identified heritage sites and the presence or absence of certain biophysical attributes of the environment.

Based on the above, BHP Billiton considers that there is no significant impacts to heritage sites as a result of any predicted biological impacts arising from the Proposal.

11.6.4.1 Cumulative impacts

BHP Billiton Iron Ore has completed numerous research projects focusing on cumulative impact within BHP Billiton Iron Ore operations and the wider Pilbara region. These projects have focused on increasing the understanding of cumulative impact in the Pilbara region and include projects focused on rare site types. All projects have been undertaken in collaboration and partnership with traditional owners, contractors and academic institutions.

Figure 41 shows the overall context for cumulative heritage site impacts in the central Pilbara based on BHP Billiton Iron Ore’s comprehensive data set.

BHP Billiton Iron Ore has undertaken surveys across ~15% of the full Banjima claim area. BHP Billiton currently manages approximately 4,085 known potential heritage sites with the Banjima Claim. Approximately 40% of these places are located within the Proposed Mining Area C Development Envelope. Figure 41 shows that most of these sites are currently avoided by BHP Billiton Iron ore operations.

The assessment of potential regional cumulative impacts from a regional perspective were based on the current potential places known by BHP Billiton Iron Ore within the Banjima claim area (826,300 hectares). On a regional scale the Proposal may impact the following potential heritage places:

- Rockshelters – 40% of the known potential places in the Banjima claim area are within the indicative impact areas.
- Stone Arrangements – 58% of the known potential places in the Banjima claim area are within the indicative impact areas.
- Artefacts - ~8% of the known potential places in the Banjima claim area are within the indicative impact areas.
- Engravings - ~3% of the known potential places in the Banjima claim area are within the indicative impact areas
- Quarries - ~4.5% of the known potential places in the Banjima claim area are within the indicative impact areas
- Scarred trees – 25% of the known potential places in the Banjima claim area are within the indicative impact areas

It should be noted that due to the fact that more survey work has been undertaken within the Proposed Mining Area C Development Envelope than elsewhere in the Banjima claim area impact statistics are likely overestimated.

Noting that the majority of the potential places in the Proposed Mining Area C Development Envelope are classed as ‘other places’ or may be section 5 sites (pending assessment) it is concluded that the cumulative impact of the Proposal does not represent a significant impact to heritage sites regionally.
Heritage Places

- Artefacts
- Djadjiling (DAA Site 25664)
- Engraving
- Man Made Structure
- Modified or Scarred Tree
- Mythological
- Painting
- Quarry
- Rockshelter

Proposed Mining Area C Development Area

Southern Flank Section 18 The Land

Heritage Survey Areas

- BHP Billiton Rail
- Rio Tinto Rail
- Great Northern Highway

MINING AREA C - SOUTHERN FLANK
Heritage Survey Areas, Places and Approvals

Scale @ A4: 1:150,000
Prepared: S. TRINDER
Project No: A780053 REV B
Figure: 40
Date: 3/05/2017
Checked: R. GREGORY
Reviewed: S. WILLIAMSON
Revision: Rev B

BHP BILLITON IRON ORE
BHP BILLITON IRON ORE

MINING AREA C - SOUTHERN FLANK
Heritage Survey Areas, Places and Approvals

Heritage Places
- Artifacts
- Djadjiling (DAA Site 25664)
- Engraving
- Man Made Structure
- Modified or Scarred Tree
- Mythological
- Painting
- Quarry
- Rockshelter
- Proposed Mining Area C Development Area
- Southern Flank Section 18 The Land
- Heritage Survey Areas

- BHP Billiton Rail
- Rio Tinto Rail
- Great Northern Highway
- Indicative Additional Impact Assessment Area
- Mining Area C EMP Rev 6 Impact Assessment Area
- Modified Indicative Additional Impact Assessment Area

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11.6.5 Mitigation and residual impacts

Where technically possible, BHP Billiton Iron Ore works to avoid sites through early planning and engineering solutions. For the Southern Flank development optimisation of the mine plan has resulting in a reduction in the potential impact to heritage sites for the 10 year mine footprint and optimisation of the mine plan and design will continue during detailed planning process to ensure best practice is continuously applied to reduce any impacts.

Subject to BHP Billiton Iron Ore’s land use agreement with the relevant Native Title group (ILUA), BHP Billiton Iron Ore only seeks approval to disturb potential sites under the AHA where this is not avoidable. Hence the approvals process under s18 is progressively developed with the 5 year mine planning circle. Current avoidance activities have shown that most of the heritage places have been avoided (Figure 42).

Changes to the mine design (Modified Indicative Impact Assessment Area) has resulted in a reduction in impact to potential heritage places of approximately 15% (in addition to the ~25% located in the Development Envelope but not within the impact assessment areas). By site type this reduction is as follows:

- Rockshelters – a reduction of ~17%;
- Scarred Trees – a reduction of 4%; and
- Artefacts – a reduction of ~13%.

The DAA has undertaken an assessment of the 76 places subject of the current s18 submission to inform the ACMC process and has concluded that only 18 heritage places met the requirements of section 5 of the AH Act. It is likely that subsequent s18 applications will not elevate all current potential heritage places within the Proposed Mining Area C Development Envelope.

During the original definition of the Proposed Mining Area C Development Envelope BHP Billiton Iron Ore specifically avoided inclusion of Mount Robinson which is classed as an exclusion zone.
The residual impact to heritage sites as a result of potential impacts to the biophysical environment is not considered significant as ongoing avoidance of impacts to heritage sites through mine planning and design modifications will continue to occur.

It is believed that impacts to heritage sites can be managed through BHP Billiton Iron Ores standard management as detailed below and therefore this factor does not warrant application of offsets.

![Figure 42: Mitigation of impact of Heritage places within the Proposed Mining Area C Development Envelope](image)

### 11.6.6 Proposed management approach

BHP Billiton Iron Ore manages and protects Aboriginal heritage in compliance with the State and Federal legislation. Potential impacts to heritage sites are managed through BHP Billiton Iron Ore’s internal heritage management processes, including via the PEAHR process. These processes are based on guidelines drafted by the DAA and include measures to identify significant heritage sites during planning phases so as to avoid or minimise potential heritage impacts. If any heritage site cannot practically be avoided, BHP Billiton Iron Ore will consult with the relevant Aboriginal group and seek consent from the Minister under s18 of the AH Act prior to undertaking any activities that may disturb the site.

As part of the ILUA agreements, a structured engagement framework between BHP Billiton Iron Ore and the agreement signatories on how Indigenous considerations are incorporated into future proposals has been agreed. BHP Billiton Iron Ore has committed to early engagement starting at project inception, linking to key project and approval milestones, and continuing through until closure and rehabilitation. These issues go beyond those typically considered during project approvals, including things such as bush food, bush medicine and ephemeral rock pools. These agreements require consultation between parties prior to disclosure of culturally sensitive information on specific sites that are subject of approvals under AH Act or EP Act. The engagement framework forms part of BHP Billiton Iron Ore’s overall approach to manage and protect Aboriginal heritage in compliance with the AH Act and the EP Act.
This holistic approach to management of archaeological, ethnographic and environmental considerations address the fundamentals of the mitigation hierarchy and are based around the ILUA agreements including those with the Nyiyaparli and Banjima peoples.

For this Proposal, BHP Billiton Iron Ore has commenced, and will continue, to work with relevant Aboriginal groups to identify Indigenous considerations and to incorporate these in project development. A key part of this engagement will be consultation on how the mitigation hierarchy is applied to these considerations. Management of these issues will be tracked and reported to the groups through the existing committee structures established under the relevant land use agreements.

A mine closure plan has been prepared and will provide completion criteria and closure options for the Proposal supported by preliminary mine designs, geochemical waste characterisation, and conceptual and numerical hydrological modelling. Throughout the operations phase, iterations of the mine closure plan will progressively refine the closure options with available data, enabling detailed designs and completion criteria to be developed and progressive rehabilitation works to occur. As mining draws to a close, the detailed closure designs will be executed, and the site will move into the post-closure period of monitoring, reporting, completion and sign off. In all cases, the focus for the application of the relevant controls is on achieving the defined completion criteria and following the mitigation hierarchy of control.

Relevant Native Title parties will be consulted in the development of management plans and Indigenous considerations will be incorporated into the plan as appropriate. This may include the identification and inclusion of appropriate bush food and bush medicine plants into the rehabilitation seed mix.

The proposed management provisions for heritage are outlined in Table 62.

11.6.7 Predicted outcome

Significant heritage and environmental survey work has been undertaken with the relevant people to understand, record and (where practical) design around the heritage values present. The Proposal will impact a number of archaeological sites and places and partially impact one ethnographic site. The sites have been recorded to a detailed level to mitigate against their loss.

Additionally, BHP Billiton Iron Ore has conducted an extensive excavation projects in partnership with local Aboriginal people to better understand the cultural landscape and the sequence of early occupation of the area.

This Proposal meets the EPA’s objective for the heritage factor, and it is not considered that potential impacts to biophysical environment as a result of the proposal will result in significant impacts to any heritage sites. Therefore BHP Billiton Iron Ore considers that this factor is not a key factor and can be addressed under the provisions of the EP Act and AH Act.
### Table 62: Proposed Environmental Management Plan Provisions - Heritage

<table>
<thead>
<tr>
<th>EPA Factor and objective:</th>
<th>Heritage – To ensure that historical and cultural associations are not adversely affected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key environmental values:</td>
<td>Cultural heritage value of local indigenous people</td>
</tr>
<tr>
<td>Objective:</td>
<td>Minimise impacts to heritage places, as far as practicable.</td>
</tr>
<tr>
<td>Outcome:</td>
<td>Maintain cultural heritage in the Development Envelope.</td>
</tr>
<tr>
<td>Key impacts and risks:</td>
<td>Direct impact to cultural heritage places.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management-based provisions</th>
<th>Management Actions</th>
<th>Management Targets</th>
<th>Monitoring</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A s18 approval in place to impact the site.</td>
<td>No heritage place impacted prior to s18 approval in place</td>
<td>Regular site audits to verify no clearing outside of s18 approved area.</td>
<td>Notification to the regulatory authority and relevant parties, upon confirmation of unauthorised clearing or ILUA commitment not met.</td>
</tr>
<tr>
<td></td>
<td>PEAHR must be in place prior to land disturbance.</td>
<td>No clearing without PEAHR approval in place.</td>
<td>PEAHR verifications to verify no unauthorised clearing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ongoing consultation and survey with Banjima people to detail, record and conduct cultural salvage of all heritage places potentially impacted where possible and practical.</td>
<td>Consultation at a minimum every 6 months Active participation of Banjima people in relevant surveys.</td>
<td>Recording of outcomes of consultation and tracking of commitments with Banjima people in line with ILUA.</td>
<td></td>
</tr>
</tbody>
</table>
11.7 Rehabilitation and decommissioning

11.7.1 Introduction and EPA objective

BHP Billiton Iron Ore is committed to environmental stewardship. This section discusses the potential post-closure impacts of the Proposal on the environment and describes BHP Billiton Iron Ore’s approach to rehabilitation and decommissioning.

The EPA applies the following objective, according to the EAG 8 for Environmental Factors and Objectives (EPA, 2013a), in its assessment of proposals in relation to rehabilitation and decommissioning:

To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.

11.7.2 Relevant legislation, guidelines and approvals

As part of the preparation of this assessment of the rehabilitation and decommissioning preliminary key environmental factor, all applicable EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

Other relevant guidelines that have informed the assessment for this factor include:

- Planning for Integrated Mine Closure: Toolkit (ICMM, 2008);
- Mine Void Water Issues in Western Australia (Johnson & Wright, 2003);
- Strategic Framework for Mine Closure (ANZMEC & MCA, 2000);
- EPA Guidance Statement No. 33: Environmental Guidance for Planning and Development (EPA, 2008);
- EPA Position Statement No. 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (EPA, 2004e);
- EPA EAG No. 8: Environmental principles, factors and objectives (EPA, 2013a); and
- EPA Position Statement No. 8: Environmental Protection in Natural Resource Management (EPA, 2005b).

Studies, investigations and surveys undertaken to date, the study area covered, and the relevant guidelines referred to and any limitations of the studies have been previously listed in Table 9.

11.7.3 Existing environment

BHP Billiton Iron Ore is working towards implementing a hub-based management approach for its mining operations as opposed to managing each deposit separately. Currently, a Mine Closure Plan has been developed in consultation with the DMP. This documents the proposed rehabilitation and closure strategy for existing Mining Area C operations, inclusive of all 14 deposits. Table 63 lists the areas included in the current Mine Closure Plan, the additional new areas included in this proposal that require a Mine Closure Plan. Closure planning for the additional areas that form part of this Proposal are now addressed in the updated in Appendix 12 which includes additional detail on rehabilitation and decommissioning to the sections below.

Assessment of rehabilitation against completion criteria will be applied throughout the various stages of rehabilitation planning, operations and management as part of BHP Billiton Iron Ore’s adaptive
management practices. Assessment of progressive rehabilitation during the early years of ecosystem development ensures that corrective actions can be carried out if necessary without disturbing older rehabilitation, and while mining operations are still nearby.

Completion criteria standards and milestones will be formally reviewed at regular intervals in accordance with DMP/EPA guidelines. Where necessary they will be revised by mutual agreement between BHP Billiton Iron Ore, key stakeholders and regulatory authorities to adopt any significant advances in cost-effective rehabilitation techniques. More frequent reviews can take place where improvement opportunities are identified through ongoing research and development programs including landform trials, improved knowledge on the ecosystem development derived from rehabilitation monitoring programs, greening initiatives and collection of additional site specific data. These activities are all normal ‘business as usual’ practices within BHP Billiton Iron Ore.

Table 63: Existing and proposed areas subject to a Mine Closure Plan

<table>
<thead>
<tr>
<th>Areas subject to the Current Approved Mining Area C Mine Closure Plan (BHP Billiton Iron Ore, 2016m).</th>
<th>Additional new areas subject to this Revised Proposal that require a Mine Closure Plan</th>
<th>Total areas now addressed under the updated Mining Area C Mine Closure Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>The area currently known as the Multiple Iron Ore Development Mining Area C Northern Flank (deposits A, B, C, D, E, F, R, P1, P2, P3, P4, P5, P6 and the Brockman Detrital Deposit) as approved under MS 491. This approved management plan applies to 5,385 ha of disturbance within the Approved Mining Area C Development Envelope of 25,815 ha.</td>
<td>The development of the new satellite deposits, OSAs and associated infrastructure at Southern Flank. An additional 19,671.2 ha of native vegetation in Good or above condition, (5992 ha of which is located in the EMP Revision 6 Mining Area C Impact Assessment Area) will potentially be disturbed and require progressive rehabilitation.</td>
<td>A total of 25,053.2 ha of disturbed vegetation in Good or above condition will require progressive rehabilitation in the Revised Proposed Development Envelope of 36,032 ha. The objective of the new Mine Closure Plan is to create a safe, stable and non-polluting landscape consistent with surrounding environmental values.</td>
</tr>
</tbody>
</table>

11.7.4 Potential impacts

The extents, or boundaries, used to assess the potential impacts of this Proposal, of the Revised Proposal (that is this Proposal plus the existing Mining Area C operations) and cumulative or regional extents vary for each factor. Table 64 details the impact assessment area for this factor.

Table 64: Impact assessment areas for rehabilitation and decommission factor

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation and Decommissioning (integrating factor).</td>
<td>Indicative Additional Impact Assessment Area and Additional Development Envelope. Mining Area C EMP Revision 6 Impact Assessment Area.</td>
<td>As for Proposal Extent plus Approved Mining Area C (Northern Flank) Development Envelope.</td>
<td>As for Proposal Extent but considered in regional context where relevant (e.g. hydrological processes).</td>
</tr>
</tbody>
</table>

The key closure aspects investigated when updating closure strategy and the Mine Closure Plan were:
A M D;  
soil management and landform engineering;  
OSA rehabilitation and erosion control; and  
BWT pit voids and pit lake assessment.

11.7.4.1 Acid and metalliferous drainage

Acid drainage

AMD has the potential to degrade surface water and groundwater resource quality if not properly managed, including interaction with ecohydrological receptors. Potential environmental impacts associated with AMD include groundwater contamination, surface water contamination and the exposure of ecosystems to toxic substances.

A preliminary Acid Metalliferous Drainage Risk Assessment Study (BHP Billiton Iron Ore, 2016b) was carried out for the Proposal, which is available in Appendix 12 and a summary of outcomes detailed below. This assessment concluded that Southern Flank ore body and the 14 deposits at Mining Area C has a low to very low risk of AMD release to groundwater, surface water or soil material. The assessment was based on geochemical assay data from over 80,000 drill hole samples, results of which were incorporated into the resource model. An assessment of net acid production potential (NAPP) was undertaken which subsequently allows an AMD code/classification to be assigned.

Calculation of NAPP values within the Southern Flank and Mining Area C resource models use standard exploration geochemical analytes (S, MgO, CaO and LOI) results. A NAPP value of greater than or equal to three (3 kg sulfuric acid per tonne (H₂SO₄/tonne)) was considered the threshold for being potentially acid forming rock. The NAPP values were validated through acid base accounting tests of 236 drill hole samples from the Additional Development Envelope. The resource models determined that there is no areas of waste rock considered potential acid-forming (PAF) material, classified as AMD 1 (NAPP>=3).

Less than 3.5% of waste rock material planned to be mined consists of weathered bedrock and detrital material with NAPP>=3, sulphur in this material is likely oxidised and unlikely to have acid generating capacity. Applying the precaution principle, these materials will not be exposed in the outer layer of the final OSA rehabilitation surface. As part of normal closure activities and investigations additional geochemical assessment will be undertaken of these weathered waste rock types to further update any storage requirements within OSAs.

Sulphide bearing lignites are known in the area within some detrital units and potentially present an AMD risk. Only five drill holes from over 4,300 drill holes drilled at Southern Flank have intersected lignite clays, these clays occur within the Tertiary Detrital 2 unit. The lignite clay horizons intersected have limited lateral continuity, depths >90 m below ground surface and are located >180 m from any proposed pit boundary. Lignite clays at Southern Flank are assessed as presenting a very low AMD risk.

Metalliferous drainage

To date, 25 samples collected from Southern Flank ore body have been analysed for total elemental composition as well as for water leachable component. The results of multi-element chemical analyses, including the calculated global abundance indicators (GAI), can provide a very conservative indication of how the measured elemental abundances compare to average ‘crustal’ abundances. Results for total elemental data indicate potential enrichment of arsenic, chromium, lead, antimony and selenium in
some of the samples. Leach testing data indicate that none of the potentially enriched metals and metalloids leach at concentrations exceeding Australian drinking water or stock water guidelines. These results demonstrate that there is a low risk of waste rock and pit wall rock adversely impacting environmental conditions within the Proposed Mining Area C Development Envelope.

In addition to the AMD testing data for Southern Flank samples, BHP Billiton Iron Ore has collected AMD testing data for similar deposits across the BHP Billiton Iron Ore operations. The regional AMD geochemistry database is used to assess data trends within and across geographical areas for common stratigraphic units. The results for other deposits are consistent with the data collected from ore deposits within the Proposed Mining Area C Development Envelope.

BHP Billiton Iron Ore have collected an extensive geological assay database for total metals for exploration and mine planning. This assay database contains data collected by x-ray fluorescence analysis for:

- Standard assay suite – Fe, SiO2, Al2O3, TiO2, CaO, P, S, MgO, Mn, K2O, Na2O, and LOI 1000; and
- Extended assay suite – As, Ba, Cl, Co, Cr, Cu, Ni, Pb, Sn, Sr, V, Zn, and Zr.

The geological assay database is compared to results of specific AMD geochemistry testing. Correlations are developed to provide indications of material variability. Also, AMD risk is modelled in geological models based on assay and other geological data such as weathering characteristics. Model assumptions are tested using the results of detailed static and kinetic AMD geochemical testing.

BHP Billiton Iron Ore’s ongoing sampling and analysis program, which forms part of the AMD Management Framework, utilises multi-disciplinary drilling programs all across the BHP Billiton Iron Ores operations to continually strengthen the regional environmental geochemical database. This allows capitalisation on pre-planned drilling programs to target deposits of specific importance as well as deposits and stratigraphies to improve the current database.

BHP Billiton Iron Ore will use planned drilling programs, including a targeted Southern Flank drilling program planned for the first two quarters of 2017, to continue building on existing databases with respect to the total elemental and static leach data available for Southern Flank. Samples will be collected based on proportional waste tonnages for waste stratigraphic units. Degree of weathering and location with respect to pre-mining water table are also considered when planning sample collection and testing programs.

The geochemical testing program has been and will continue to be based on key industry standard documents, including:

- The Draft Guidance Materials Characterisation Baseline Data Requirements for Mining Proposals (DMP 2016c);
- Leading Practice Sustainable Development Program for the Mining Industry - Preventing Acid and Metalliferous Drainage (DITR 2006);
- Global Acid Rock Drainage (GARD) Guide (INAP 2010); and

11.7.4.2 Soil management and landform engineering

Topsoil management, including stripping, stockpiling and use, are governed by internal BHP Billiton Iron Ore standards and procedures. Soil stripping and the associated scheduling and planning forms part of the ongoing mine planning process. As part of standard progressive rehabilitation practices,
where possible, topsoil and surface vegetation are directly returned to a suitable rehabilitation area, or stockpiled as required. Where direct return is not feasible the length of topsoil storage is minimised to reduce loss of viable seeds and decline of nutrients. Use of individual topsoil stockpiles would be no greater than 25 years. Subsoil can also be stockpiled separately where the material is suitable for rehabilitation. Should the topsoil balance be identified as being in deficit during ongoing works and/or mine planning then further options, including using subsoil, will be investigated and included in regular updates to the Mine Closure Plan.

BHP Billiton Iron Ore’s internal standards require revegetation be conducted to establish plant species on final landforms. The depth and characteristics of newly constructed landforms, surface soils and subsoils are managed to be suitable for plant growth in terms of their structure, water holding capacity, and for establishing target vegetation communities and supporting the agreed final land use.

Post-closure final landform design aims to be safe, stable and non-polluting without requiring ongoing maintenance. The post mining land use will be determined through stakeholder consultation. In advance of the final post mining land use being agreed for Mining Area C, BHP Billiton Iron Ore will assume a native pastoral ecosystem, capable of supporting low intensity grazing as the provisional post mining land use. The provisional land use provides an interim target to which closure and rehabilitation planning can work towards.

For surface water engineering, DMP require consideration of higher order rainfall events for closure design purposes. The 10,000 year ARI was considered appropriate to assess the flood conditions in the Additional Development Envelope post-closure. Modelling of flood events has shown no risk of creek capture by pit voids for Pebble Mouse Creek, the most significant drainage feature within the mine footprint.

Three of the westernmost pits at Southern Flank are located adjacent the Great Northern Highway. Consideration will be given to ensuring pit abandonment bunds not only meet regulatory requirements but adequately mitigate unauthorised public access safety risk post-closure. If necessary other measures, such as buttressing pit walls, will be assessed based on future geotechnical design parameters.

For the purposes of this Proposal, a summary of previously assessed impacts, the proposed change and the proposed extent is provided in Table 65.

### 11.7.4.3 OSA rehabilitation

OSA rehabilitation requires the availability of competent material for use in or on the final landform. A waste characterisation and erosion modelling study of OSA landform stability with Marra Mamba Iron Formation rock (Landloch, 2013), including material from Mining Area C, provides an analogue to Marra Mamba waste characteristics at Southern Flank. This study, along with operational experience from progressive OSA rehabilitation at Mining Area C, reinforces that some Marra Mamba units are susceptible to erosion. Therefore, sheeting or rock armouring of final OSA landforms with competent waste material will be required. Typical design criteria for final OSA landforms in Marra Mamba use a conservative <10 deg slope angle and armouring with competent waste rock to achieve stable landform.

For Southern Flank landforms this will be considered the base case to develop stable landforms, however, as mine planning and design develop over the life of mine use of such conservative slope angles may not be required to achieve stable landforms. BHP Billiton Iron Ore’s procedures will be used to inform final OSA landform design criteria within the Additional Development Envelope.

All mined materials are coded with a waste material (WMAT) class of 1, 2 or 3 in mine models. Each class has the following specifications:
- WMAT class 1 represents competent material suitable for the rock armour component of OSA landform rehabilitation.
- WMAT class 2 material has physical characteristics that potentially make it problematic for use as rock armour.
- WMAT class 3 waste does not have physical characteristics suitable for OSA final landform rehabilitation.

Southern Flank mine planning to date has identified requirements for approximately 50 Mt of rock armour material for OSA rehabilitation, and no WMAT class 1 exists in the vicinity; however, approximately 84 Mt of inert WMAT class 2 was identified. The closure strategy for Southern Flank landforms will be to use a <10deg conservative slope for final landforms, this base case may be modified as part of adaptive management practises over the life of mine (based on ongoing waste characterisation and mine design).

Detailed final OSA landform designs are completed as part of BHP Billiton Iron Ore’s annual five year planning cycle for areas that will become available during the five year timeframe. Experience and outcomes from ongoing testing and progressive OSA rehabilitation work being undertaken at Mining Area C will be used to drive adaptive management practices for OSA rehabilitation at Southern Flank and inform final landform design that meets the closure criteria and objectives.

Ongoing physical waste characterisation will be undertaken to validate the usefulness of WMAT class 2 for rehabilitation. Refinements in waste scheduling and in-pit dumping through iterative mine plan may provide an opportunity to reduce the OSA footprint and volume of rock armour material required for rehabilitation.

During the initial mining stages soil stripping gets undertaken with stockpiles managed as per the BHP Billiton Iron Ore Rehabilitation Standard (BHP Billiton Iron Ore, 2016n) and other procedures. Relevant plans and databases are prepared, updated and maintained. For final OSA landforms topsoil material placed on the outer surface of landforms takes into consideration the growth media characteristics. The depth and characteristics of newly constructed landforms, surface soils and subsoils are managed to be suitable for plant growth in terms of their structure, water holding capacity, and for establishing target vegetation communities and supporting the agreed final land use.

Where available, topsoil is used to provide a suitable medium for plant establishment and a source to regenerate vegetation. Revegetation uses local provenance native seed from the Pilbara IBRA region consistent with vegetation associations and native species recorded in the Additional Development Envelope. Once established, vegetative cover should be self-sustaining and similar to the surrounding undisturbed vegetation.

11.7.4.4 Below water table pit voids and pit lake assessment

Based on preliminary mine planning, the Southern Flank ore body has a number of pits that will have below water table mining activity. Pit lakes may develop in some pit voids, depending on the final depth of the voids after mining and infilling. High evaporation rates and engineered isolation from overland flow means the pit lakes may not recover to pre-mining groundwater levels. Groundwater outflow from the pit lakes will therefore be minimal. Evaporation may cause pit lake salinity to increase over time, it is anticipated salinity levels may reach hypersaline/brackish as defined in ANZECC guidelines as \( >40 \text{gL}^{-1} \). This increase would be expected to be very gradual and occur over century scale timeframes and it is more likely to be similar to other saline water bodies in the area. For example, the Forstecue Marsh has highly variable salinity levels depending on levels of rainfall recharge and evaporation (DEC, 2009b). The potential for density-driven saline plumes for any pit lakes is considered to be low, such
that it is not expected that saline water will be discharged from any pit lakes. Saline water will therefore remain local to the pit as there will be minimal throughflow and therefore it is considered the formation of pit lakes will not produce detrimental impacts on groundwater and surface water quality.

Modelling shows unmitigated drawdown from open pit lakes at Southern Flank has the potential to impact Weeli Wolli Spring at closure, with modelling results suggesting leaving the largest below water table pit void open may have a 0.5-0.7 m drawdown (BHP Billiton Iron Ore, 2016a; 2016m) at the spring. However this risk, if realised, can be mitigated by plausible solutions such as backfill or enhanced recharge. Over time ongoing monitoring, studies, and improved understanding of cumulative regional groundwater impacts, will reduce the range of outcomes thereby enabling adaptive management practices, if warranted, to minimise impacts. Modelling also shows that successful closure at other operations closer to the spring is likely to be the key influence in controlling the risk of long term impact at Weeli Wolli Spring.

BHP Billiton Iron Ore intends to meet ecological objectives and ensure key groundwater dependent receptors are viable at closure by take an adaptive management approach to below water table pit voids and pit lakes. This outcome-based approach takes into consideration surface water quality, groundwater quality and groundwater levels at key ecohydrological receptors (i.e. Weeli Wolli Spring, Coondewanna Flats and Ben’s Oasis) and local systems. Backfilling below water table pits will be undertaken if required as a mitigation option to manage risks at key receptors and to water quality.

Furthermore, preliminary mine plan iterations have shown potential to improve waste management and increase in-pit waste dumping as part of operational waste movement. In this scenario waste dumping can focus on minimising below the water table pit voids. Closure strategy at Southern Flank will drive mine plan revisions towards achieving greater volumes of operational in-pit waste dumping, particularly for below water table pit voids, where practicable.

Post-mining recovery time for aquifer rebound at key receptors may take longer than expected, however, this will be influenced by operational groundwater management strategies. If warranted, a number of options are available to augment recovery and mitigate time lag in aquifer rebound. These options include water injection and enhanced recharge using pit voids or dedicated infiltration basins.

Pit lakes may result in an increase in local levels of groundwater salinity. Other alterations to groundwater chemistry are not anticipated. As this will be a gradual change it is likely that local terrestrial fauna species will adapt to this change over time and will use potential pit lakes similar to other saline water bodies in the region (e.g. Fortescue March).

The presence of saline waterbodies is unlikely to alter local fauna communities, with the exception of migratory birds that may use them when moving through the area. As revegetation will not be undertaken adjacent to the pit lakes, it is unlikely that animals other than birds would access them due to increased exposure and risk of predation. When salinity levels increase, it is unlikely that any animals other than waterbirds would utilise it.

The presence of pit lakes is unlikely to increase the abundance of introduced (feral) species, particularly if salinity levels render it unsuitable to be used for drinking. Whilst cane toads are known to utilise inland waterbodies, and can tolerate high levels of salinity (Wijethunga et al., 2016), current distribution models suggest it unlikely that they will extend as far south as Mining Area C.

It is therefore considered that the long-term impacts of pit lakes to fauna are minor, but there may be some net positive benefit through the provision of refugia to migratory species. As there will be minimal through flow of saline water out of pits, impacts to adjacent stygofauna and groundwater dependent vegetation communities are considered minor to negligible.
More detailed information pertaining to the potential changes to the surrounding terrestrial and hydrological environment resulting from the Proposal is provided in the new Mining Area C Mine Closure Plan.

A succinct summary of potential impacts of the proposed change and the proposed extent is provided in Table 65.

**Table 65: Potential Impacts for Rehabilitation and decommissioning of the Proposal**

<table>
<thead>
<tr>
<th>Additional Development Envelope</th>
<th>Mining Area C EMP Revision 6 Impact Assessment Area</th>
<th>Proposed Extent (Revised Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A key aspect is the alteration of the landform that will occur for Mining Area C through the creation of OSAs and overland infrastructure. The integrity and stability of built landforms is a relevant aspect for the proposed development for operational, closure and post-closure phases of the project. The potential risk of AMD and impacts on groundwater, surface water and soil quality is considered low to negligible. The Mining Area C Mine Closure Plan describes management of the site post-operations phase.</td>
<td>Addition of the Proposed Southern Flank Development Envelope expands the footprint of landform disturbance but is not considered significant from an alteration of landforms perspective due to current mining activities in the area. The potential risk for AMD impacts on groundwater, surface water and soil quality is considered low to negligible. Pit lakes may occur as a result of the Southern Flank Development but impacts on key receptors is anticipated to be managed through backfill (if required) and/or augmentation of aquifer recovery. Water quality within pit lakes is anticipated to be saline but due to hydrological characteristics in the area there will no significant impact on regional surface or groundwater. The Mining Area C Mine Closure Plan has been updated and describes the management of the site post-operations phase.</td>
<td>AMD risk is low to negligible. Potential Impacts to key receptors are expected to be managed through adaptive management practices, in particular backfill and/or augmenting aquifer recovery being used as a mitigation option, if required.</td>
</tr>
</tbody>
</table>

**11.7.5 Mitigation and residual impacts**

BHP Billiton Iron Ore has carried out a review of the Western Australian Government’s ‘Mitigation Process’, which is detailed in Section 3 of the *WA Environmental Offsets Guideline* (Government of Western Australia, 2014). The four steps are:

- avoid;
- minimise;
- rehabilitate; and
- offset.

Following consideration of all data gathered during baseline surveys, additional targeted surveys and the outcomes of EIAs, BHP Billiton Iron Ore has revised its indicative Proposal designs to ensure that these designs address the first two steps of the Mitigation Process, i.e. the designs have ‘avoided’ or
'minimised,' and plans are also in place to address the third step ‘rehabilitate’ to meet the rehabilitation and decommissioning factor.

Actions taken are summarised in Table 66.

Table 66: Actions taken for rehabilitation and decommissioning factor to reduce impacts post-operations

<table>
<thead>
<tr>
<th>Action Taken</th>
<th>Step in the ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure pit abandonment bunds adequately control unauthorised pit access post-closure for pits adjacent the Great Northern Highway. Following detailed geotechnical assessment, if required, removing open-pit edges by backfilling material to buttress pit walls may be necessary.</td>
<td>Avoid and Minimise</td>
<td>This action has the potential to minimise proximity and safety risk to the public and liability to the state post-closure.</td>
</tr>
<tr>
<td>Armouring component of OSA rehabilitation based on using local competent material and adaptive management to achieve erosionally stable final OSA slope angles.</td>
<td>Rehabilitate</td>
<td>Rock armour and conservative landform design criteria decrease the likelihood of erosion of rehabilitated landforms.</td>
</tr>
<tr>
<td>Final landform revegetation - topsoil material placed on the outer surface of landforms with consideration of growth media characteristics and depth required for suitable plant growth for establishing the target vegetation community and supporting agreed final land use.</td>
<td>Rehabilitate</td>
<td>Allows establishment of target vegetation communities on rehabilitated landforms which are similar to the surrounding undisturbed vegetation and supports the agreed final land use.</td>
</tr>
<tr>
<td>Backfilling of below the water table pit voids to above the pre-mining water table at Mining Area C to above historic water table level. Backfilling of below the water table pits at Southern Flank, as required, based on ongoing monitoring of drawdown at key ecohydrological receptors and groundwater and/or surface water quality impacts.</td>
<td>Minimise and Rehabilitate</td>
<td>Reduce groundwater drawdown and quality impact to key ecohydrological receptors.</td>
</tr>
<tr>
<td>Augmentation of aquifer recovery should aquifer recovery time lag post-closure be greater than predicted as part of this, and any additional, assessments undertaken as part of adaptive management practises.</td>
<td>Minimise and Rehabilitate</td>
<td>Minimise spike in post-mining peak aquifer drawdown.</td>
</tr>
</tbody>
</table>

Following application of these actions and regulation under the MS of a Mine Closure Plan the residual impacts are not considered significant and do not warrant application of offsets for this factor.
11.7.6 Proposed management approach

11.7.6.1 Internal management approach
The proposed mine closure strategy will take an adaptive management approach for the Proposed Mining Area C Development Envelope. Southern Flank is not expected to be operational until at least 2020 with mine schedules and sequencing at a preliminary stage and yet to be finalised. Iterative mine planning and deposit sequencing will continue throughout the active mine life. BHP Billiton Iron Ore undertakes progressive rehabilitation and ongoing performance assessment in areas where mining operations have been completed and further disturbance is unlikely.

Recognising the importance of mine planning in facilitating the success completing of rehabilitation has been critical in achieving successful rehabilitation. Embedding closure and rehabilitation planning in the Life of Asset and 5 Year Planning process has resulted in rehabilitation being included as part of the mining process rather than being considered an add on or separate part of mining. This allows identification of areas available for rehabilitation so that plans for executing final landform earthworks and rehabilitation within the subsequent five year timeframe are integrated with mine plans. To allow appropriate landform design, planners now use waste characterisation information and with site input, model design options to identify the most appropriate rehabilitation plan for any given situation. An adaptive approach to rehabilitation has allowed learnings from work carried out over the past five years at Mining Area C, and other BHP Billiton Iron Ore sites to improve rehabilitation outcomes. For example, slopes at Mining Area C are being reworked to improve rehabilitation success using information from ongoing studies and research.

Outcomes from ongoing research and studies will provide further validation of prediction and impact and therefore drive the closure strategy for the Mining Area C hub. This outcome-based strategy will, where required, mitigate impacts on receptors by backfilling below the water table pit voids with inert waste material to above pre-mining groundwater levels, minimise legacy issues associated with empty pits post mining and reduce final OSA landform area for rehabilitation through operations dumping waste material in-pit, as much as practicable.

The current approved Mining Area C Mine Closure Plan has been updated to reflect this Proposal and provides more detail on closure strategy. As such, BHP Billiton Iron Ore considers that the updated Mining Area C Mine Closure Plan (Appendix 12) satisfactorily addresses the rehabilitation and decommissioning factor.

11.7.6.2 Regulatory management approach
The rehabilitation and decommissioning factor is managed by the following regulatory processes:

- MS
- Iron Ore (Mount Goldsworthy) Agreement Act 1964; and

This management approach will continue under this Proposal. It is proposed that management will be formalised through regulation of Mine Closure Plan via the Ministerial Statement and the BHP Billiton Iron Ore’s standard Pilbara-wide Health, Safety and Environment system. A draft of the closure plan is located in Appendix 12.

11.7.7 Predicted outcome
BHP Billiton Iron Ore is obliged under the tenure requirements of the Mining Lease, issued under the Iron Ore (Mount Goldsworthy) Agreement Act 1964, to ensure that premises are closed,
decommissioned and rehabilitated in a manner consistent with current government standards and without unacceptable liability to the state. To support this, the updated Mining Area C Mine Closure Plan has been updated to include the Proposal. Based on the discussions above, the residual impact of the Proposal on Rehabilitation and Decommissioning is not considered significant.

BHP Billiton Iron Ore proposes that the EPA’s objective for the Rehabilitation and Decommissioning factor can be met and managed via a condition as part of a new MS which requires the implementation of the Mine Closure Plan.
11.8 Offsets

11.8.1 Introduction and EPA objective
The EPA applies the following objective, according to the *EAG 8 for Environmental Factors and Objectives* (EPA, 2013a), in its assessment of proposals in relation to offsets:

> To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.

As part of the preparation of this assessment against the offsets preliminary key factor, all applicable EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

Studies undertaken for the Proposal are summarised in Table 9 and detailed information provided in relevant subsections in Section 11 and Appendix 4 to Appendix 11.

As discussed previously in Section 10, an integral component of adaptive management is the application of the mitigation hierarchy consistent with the guiding principles outlined in the *WA Environmental Offsets Guidelines* (Government of Western Australia, 2014). The mitigation hierarchy of ‘avoid, minimise, rehabilitate and offset’ has been considered in this Proposal and will be implemented during the implementation phases to ensure, as far as reasonably practicable, that impacts are first avoided, then minimised, rehabilitated and finally offset if significant residual impacts are unavoidable. This approach is consistent with the EPA guidance and state government policy.

11.8.2 Existing environment
Currently, MS 491 authorises 5,385 ha of native vegetation clearing, which is not subject to offsets. This Proposal is seeking an additional clearing allocation of 19,671.2 ha.

Table 67 details the impact assessment area for this factor.

**Table 67: Impact assessment areas for offsets factor**

<table>
<thead>
<tr>
<th>EPA Environmental Factor</th>
<th>Proposal Extent</th>
<th>Mining Area C Revised Proposal Extent (Cumulative Impacts)</th>
<th>Regional Extent (i.e. incl. Third-Party and BHP Billiton Iron Ore Strategic Proposal)</th>
</tr>
</thead>
</table>

11.8.3 Mitigation and residual impacts
A summary of all proposed actions identified to reduce the residual impact of the Proposal is presented in Table 68.
Table 68: Summary of proposed actions to reduce the Proposal residual impacts

<table>
<thead>
<tr>
<th>EPA Factor</th>
<th>Action Taken</th>
<th>Step in the WA Environmental Offsets Guidelines ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flora and vegetation</td>
<td>Modification of Indicative Additional Impact Assessment Area</td>
<td>Avoid/ Minimise</td>
<td>If clearing is restricted to within the Modified Indicative Additional Impact Assessment Area it will reduce the impact to the following conservation species and vegetation associations:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Rhagodia sp. Hamersley – impacts reduced from 11 populations to 4 populations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Rostellularia adscendens var. latifolia – impacts reduced from 5 populations to 4 populations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If clearing is restricted to within the Modified Indicative Additional Impact Assessment Area it will reduce reduced clearing of vegetation of Very Good or higher condition as follows:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Excellent – clearing reduced from 9,473 ha to 8,581 ha</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Very Good – clearing reduced from 1,464 ha to 512 ha</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If clearing is restricted to within the Modified Indicative Additional Impact Assessment Area it will reduce fragmentation of a number of locally significant vegetation associations and those that had more than 50% of their total mapped area in the Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Ongoing Rehabilitation</td>
<td>Rehabilitate</td>
<td></td>
<td>BHP Billiton Iron Ore undertakes progressive rehabilitation and ongoing performance assessment in areas where mining operations have been completed and further disturbance is unlikely. Further details are outlined in the Mine Closure Plan (Appendix 12).</td>
</tr>
<tr>
<td>EPA Factor</td>
<td>Action Taken</td>
<td>Reduction in Impact</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| Terrestrial fauna                      | Modification of Indicative Additional Impact Assessment Area                 | Modification of the Indicative Additional Impact Assessment Area has reduced the impact to the following conservation species:  
  - ghost bat – the number of caves retained in the Proposed Mining Area Development Envelope will be increased from 12 to 27 (11 high value), and the removal of foraging habitat has been reduced by 173 ha.  
  Modification of the Indicative Additional Impact Assessment Area has reduced clearing of Medium and High value fauna habitats as follows:  
    - Gorge/Gully – clearing reduced from 465 ha to 383 ha.  
    - Crest/Slope – clearing reduced from 6,427 ha to 6,414 ha.  
    - Major Drainage Line – clearing reduced from 21 ha to 0 ha.  
    - Mulga – clearing reduced from 874 ha to 496 ha.  
    - Sand Plain – clearing reduced from 429 ha to 135 ha.  
  Note there will be a slight increase to clearing of Drainage Area/ Floodplain habitat (from 703 ha to 705 ha) as previously detailed in Section 11.2.5 and Table 35. |
| Research into ghost bat ecology in the Pilbara | Minimise/offset                                                               | Continued study of the ecology of the ghost bat in the Pilbara will provide more information to assist in identifying key habitats (roosting and foraging) for the species that can be considered in mine plans.  
  This work will be published so that it is available to third-party operators in the Pilbara and for future mining developments undertaken by BHP Billiton Iron Ore.  
  The ongoing study has already commenced and it is intended that the current study will continue for a minimum of 12 months.  
  Following this, a review of results will be undertaken and further studies may continue for up to 2 additional years. |
<p>| Reduce impact of clearing on Antichoropus ‘DIP 007’ | Minimise                                                                      | Rehabilitation of SRE habitat areas with Corymbia hamersleyana. |</p>
<table>
<thead>
<tr>
<th>EPA Factor</th>
<th>Action Taken</th>
<th>Step in the WA Environmental Offsets Guidelines ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffers around ghost bat roosts outside impact assessment areas</td>
<td>Avoid/ minimise</td>
<td></td>
<td>BHP Billiton Iron Ore will commit to retaining a 150 m buffer around all ghost bats roosts that occur outside the Mining Area C EMP Revision 6 Impact Assessment Area and the Modified Indicative Additional Impact Assessment Area.</td>
</tr>
<tr>
<td>Inclusion of preferred habitat species of <em>Antichiropus ‘DIP007’</em> into rehabilitation</td>
<td>Rehabilitation</td>
<td></td>
<td>Rehabilitation of disturbed areas using <em>Corymbia hamersleyana</em>.</td>
</tr>
</tbody>
</table>
| Subterranean fauna | Modification of Indicative Additional Impact Assessment Area | Avoid | Modification of the Indicative Additional Impact Assessment Area has:  
- reduced the number of potentially restricted species by seven;  
- one species of uncertain status has been removed from potential disturbance areas; and  
- three species added to the Modified Indicative Additional Impact Assessment Area, but all are considered unlikely to be restricted to habitats within it. |
<p>| Retention of potential troglofauna habitat suitable for five potentially restricted species outside pit shells | Avoid/ minimise | | Minimise impacts to habitats considered to be potentially suitable for potentially restricted troglofauna. |</p>
<table>
<thead>
<tr>
<th>EPA Factor</th>
<th>Action Taken</th>
<th>Step in the WA Environmental Offsets Guidelines ‘Mitigation Process’</th>
<th>Reduction in Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrological processes</td>
<td>Implementation of the Proposal in accordance with the DoW Western Australian Water in Mining Guideline (DoW, 2013b).</td>
<td>Minimise</td>
<td>Impacts on the groundwater resource and regional ecohydrological receptors will be reduced by:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Proactive dewatering volumes will continue to be used as a process supply when dewatering rates fall below water demand requirements;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• continuing to preferentially return groundwater to the aquifer through managed aquifer recharge and/or infiltration ponds, effectively storing water into the dolomite and alluvial aquifers for use later in the mine life;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Surplus water is planned to be introduced into the proposed Camp Hill borefield from about 2018 onwards, as well as Juna Downs, effectively storing water into the dolomite and alluvial aquifers; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• diverting surface water around the mining footprint to the extent practicable to minimise the loss of surface water flow in the natural drainage systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Restrict clearing to the modified impact assessment area to reduce impact to the Weeli Wolli subcatchment area as previously detailed in Table 56.</td>
</tr>
<tr>
<td>Inland Waters Environmental Quality</td>
<td>Installation of Sediment Traps</td>
<td>Avoid</td>
<td>The installation of sediment traps will ensure that water quality is not impacted by sediment run-off from mining operations</td>
</tr>
<tr>
<td>Backfill of Below Water Table Pits</td>
<td>Mitigate</td>
<td></td>
<td>All mine pits at the 14 deposits at Mining Area C will be backfilled to above historic water table level. Backfilling of below the water table pit voids to above the pre-mining water table at the Southern Flank ore body will be implemented, if required, to maintain suitable groundwater and surface water quality.</td>
</tr>
<tr>
<td>Heritage</td>
<td>Modification of Indicative Additional Impact Assessment Area</td>
<td>Avoid</td>
<td>Implementation of the modified impact assessment area may result in an average of 15% reduction (17% for Rockshelters, 4% for Scarred Trees and 13% for Artefacts) in the number of heritage places potentially impacted by the Proposal.</td>
</tr>
<tr>
<td>EPA Factor</td>
<td>Action Taken</td>
<td>Step in the WA Environmental Offsets Guidelines ‘Mitigation Process’</td>
<td>Reduction in Impact</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Rehabilitation and Decommissioning</td>
<td>Minimising post-operational environmental legacy issues</td>
<td>Avoid and minimise</td>
<td>The key closure aspects investigated will reduce post-operational impacts by:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensure pit abandonment bunds adequately control unauthorised pit access post-closure for pits adjacent the Great Northern Highway. Following detailed geotechnical assessment, if required, removing open-pit edges by backfilling material to buttress pit walls may be necessary;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Armouring component of OSA rehabilitation based on using local competent material and adaptive management to achieve erosionally stable final OSA slope angles;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Final landform revegetation - topsoil material placed on the outer surface of landforms with consideration of growth media characteristics and depth required for suitable plant growth for establishing the target vegetation community and supporting agreed final land use;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Backfilling of below the water table pit voids to above the pre-mining water table, as required, based on impacts to key ecohydrological receptors; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Augmentation of aquifer recovery should aquifer recovery time lag post-closure prove unacceptable.</td>
</tr>
<tr>
<td>Amenity</td>
<td>Modification to Mine Layout</td>
<td>Avoid and minimise</td>
<td>Mine design and, in particular, the relocation of OSAs to reduce amenity impacts to the Great Northern Highway. See Section 12.4.5 for further details.</td>
</tr>
</tbody>
</table>

The evaluation of residual impacts was detailed in factor specific sections within Section 11. This evaluation resulted in financial offsets for Flora and Vegetation (due to the net loss of vegetation rated as good or above) and for terrestrial fauna (due to potential impacts to the ghost bat habitat). For all other factors, residual impact was not considered significant enough to require the application of offset, however, as a precautionary measures a commitment is made in Section 11.3.5 relating to troglobifana.

It should be noted that modification of the Indicative Additional Impact Assessment Area was driven by the requirement to reduce the significance of impact to ghost bat and troglobifana habitat, as these elements of the potential impacts as a result of implementation of the Proposal, were assessed as being the most significant. BHP Billiton Iron Ore commit to where practical restrict clearing to the modified impact assessment area. As detailed in Section 11.2.5, BHP Billiton Iron Ore as a minimum will retain 150 m buffer around the ghost bat caves located outside of the Modified Indication Additional Impact Assessment Area and the Mining Area C EMP Revision 6 Impact Assesment Area. Therefore there will
be a corresponding impact reduction to flora and vegetation, habitats and heritage places within these buffers.

The offsets proposed for ghost bats (and proactive commitment for troglofauna) is a research offset, as defined in the offset guidelines. The offset value is that data obtained will advance the knowledge of the ecology of the ghost bat species (and troglofauna) habitats and distribution and assist in quantifying the potential impacts of individual or cumulative mining operations on the these species within the Hamersley region. The majority of information will be obtained prior to significant implementation of the Southern Flank satellite ore body and hence will help inform ongoing management measures, triggers, thresholds and contingency measures that will be implemented via the Condition Environmental Management Plan.

As with all major development projects, this Proposal will progress through a series of design stages (which BHP Billiton Iron Ore refers to as Investigation, Selection, Development) prior to the start of construction. Detailed mine planning also occurs iteratively as greater resource definition becomes available through infill drilling and geotechnical analysis. Whilst a range of mitigation measures have been identified, the ability to commit to these actions (except the commitment to retain buffers around ghost bat caves as noted above) will be subject to the final mine design.

As a consequence, BHP Billiton Iron Ore has adopted a conservative approach in identifying the Proposal offset obligation. Whilst the extent of native vegetation clearing may be reduced from 19,671.2 ha to 15,693 ha if all actions are implemented, for the purpose of this PER it has been assumed that the disturbance area defined in the Proposal referral (19,671.2 ha) represents an upper limit to the area to which offsets will apply. BHP Billiton Iron Ore is confident that mitigation measures will be implemented to reduce this footprint and associated impacts to key environmental factors and that application of these measures can be considered as part of offset accounting obligations anticipated within any approval conditions. This is represented in Table 69.

Table 69: Total clearing to which financial offsets will apply

<table>
<thead>
<tr>
<th>Disturbance Area approved under MS 491</th>
<th>Additional New Areas subject to this Proposal to which Offsets will apply</th>
<th>Total Clearing to which Offsets Apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,385 ha</td>
<td>19,671.2 ha</td>
<td>19,671.2 ha</td>
</tr>
</tbody>
</table>

### 11.8.4 Proposed management approach

11.8.4.1 Internal management approach

A BHP Billiton Iron Ore Offsets Strategy is currently being developed and will continue to be developed throughout 2016 in parallel to the EPA's update of the *WA Environmental Offsets Guideline* (Government of Western Australia, 2014) 'to include further information on the use of metrics in determining offsets and on the determination and application of offsets for cumulative impacts', through avenues such as established strategic working groups.

In August 2016, BHP Billiton Iron Ore, along with other regulators and industry representatives, was invited to take part in the Pilbara Strategic Conservation Fund (the Fund) working group meeting, an initiative of the OEPA to determine how financial offset contributions will be used. BHP Billiton Iron Ore is pleased to be part of this group and contribute to the development of this new fund, and other supporting initiatives, such as contribution agreements, regional strategies and implementation plans over the next year.
In the meantime, as the Fund further develops, the Regulatory requirement offsets form has been compiled to support this Proposal and is attached at Appendix 13.

11.8.4.2 Regulatory management approach

The offsets environmental factor is managed by the following regulatory process: MS condition.

11.8.5 Predicted outcome

BHP Billiton Iron Ore proposes that the objective of the offsets factor can be met to counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.

Where significant residual impacts are identified following rehabilitation, BHP Billiton Iron Ore will provide environmental offsets via the Pilbara Conservation Fund, or alternatively, delivered consistent with contemporary offset guidance. With the application of mitigation measures, it is likely that the total vegetation clearing can be reduced to 15,693 ha, however a conservative offset amount of 19,671.2 ha is proposed.

BHP Billiton Iron Ore further proposes:

- Continued study of the ecology of the ghost bat in the Pilbara will be undertaken to contribute to the current understanding of this species.
- Funding additional studies on troglofauna habitats and taxonomy to further understand of species and their distribution in the Pilbara. This may include environmental DNA studies and taxonomic study of Diplurans.
12. Other environmental factors

12.1 Landforms

12.1.1 Introduction and EPA objective

The following section discusses the existing environment and impact assessment as it relates to the landforms in the Proposed Mining Area C Development Envelope and surrounds.

The EPA applies the following objective, according to Statement of Environmental Principles, Factors and Objectives (EPA, 2016), in its assessment of proposals that may affect landforms:

*To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected.*

12.1.2 Relevant guidelines and approvals

As part of the preparation of this assessment of the landforms environmental factor, all EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

The following guiding documents were also relevant in the consideration of impacts to landforms:

- Guideline for Mining Proposals in Western Australia (DoIR, 2006).
- Environmental Protection Bulletin No. 23: Guidance on the EPA's Landforms Factor (EPA, 2015a)
- Leading Practice Sustainable Development Program for the Mining Industry (DITR, 2006)
- Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA, 2006)

Studies, investigations and surveys undertaken to date, the study area covered, and the relevant guidelines referred to and any limitations of the studies have been previously listed in Table 9.

12.1.3 Existing environment

Environmental Protection Bulletin No. 23: Guidance on the EPA's Landforms Factor (EPA, 2015a) includes five criteria, which are applied as the basis for determining the significance of a landform. An overview of these and their applicability to the Proposal is below:

1. Variety – the nine landforms identified within the Proposed Mining Area C Development Envelope (previously discussed in Section 5.5: Hill crests, Gorges and Gullies, Hill slopes, Foot slopes, Calcrete plains, Major drainage lines, Major drainage lines, and Minor drainage lines) are not considered to be important examples of their type within the Pilbara Region.

2. Integrity – the existing Mining Area C Development Envelope has been impacted by development activities related to the existing Mining Area C Proposal. Within the Additional Development Envelope, activities carried out to date include mineral and hydrogeological exploration.

3. Ecological importance – while the landforms within the Proposed Mining Area C Development Envelope form part of the Fortescue Marsh catchment area (also known as the Upper Fortescue River catchment area), they are not considered to play an integral role in maintaining existing ecological and physical processes. Nearby areas of ecological importance are the Coondewanna Flats, which occur to the west of (but outside of) the Proposed Mining Area C Development Envelope and the Weeli Wooli Creek (and Ben's Oasis), which occur to the east of (but outside of) the Proposed Mining Area C Development Envelope.
4. **Scientific importance** – The landforms area not of recognised to be of scientific interest as a reference site or an example of where important natural processes are operating

5. **Rarity** – the landforms are not considered to be rare or relatively rare, nor are they considered to be one of the few of its type at a national, regional or local level.

A Soil and Landform Assessment has been carried out across the majority of the Additional Development Envelope (Outback Ecology, 2012a) to provide baseline information and assist in the planning of soil resource management and future rehabilitation activities. The soils and landforms that encompass the Additional Development Envelope are, for the most part, similar to those that encompass the Approved Mining Area C Development Envelope, recorded in both 2011 and 2014 by Outback Ecology.

A land system includes a number of land-units and is classified by the recurring pattern of topography, soils and vegetation. Land systems have been mapped in the Additional Development Envelope as part of Technical Bulletin No. 92 (Van Vreeswyk *et al.*, 2004). These recurring patterns can be seen using aerial photography or other remotely sensed imagery and are typically ground-truthed with field surveys. The Additional Development Envelope encompasses five land systems, four of which are also found in the Approved Mining Area C Development Envelope. These are illustrated in Figure 43 and are as follows:

- Newman\(^{13}\);
- Boolgeeda\(^{5}\);
- Platform\(^{5}\);
- Wannamunna\(^{5}\); and
- Pindering.

Surface soil profiles recorded in the Additional Development Envelope have been divided into five major soil management units (SMUs) (Outback Ecology, 2012), four of which were also recorded in the Approved Mining Area C Development Envelope (with two combined and presented as one SMU) (MWH, 2015). These are as follows:

- ridgelines\(^{14}\);
- scree slopes\(^{6}\);
- undulating stony plains;
- drainage lines; and
- hardpan washplains.

As for the soil materials recorded in the Approved Mining Area C Development Envelope, the physical and chemical properties of the soil materials from the SMUs in the Additional Development Envelope are relatively similar, with the major difference between the soils present being the amount of coarse material present (Outback Ecology, 2012a).

\(^{13}\) Newman, Boolgeeda, Platform and Wannamunna land systems are also recorded in the Approved Mining Area C Development Envelope.

\(^{14}\) These two SMUs were combined and recorded as one SMU in the current Approved Mining Area C Development Envelope due to limited differences between the physical and chemical properties of the soil materials.
The soil material from ridgelines is typified by a large amount of coarse material. These soils are considered suitable for rehabilitation purposes, with the high percentage of coarse material suitable for application to upper and middle slopes of waste landforms.

The soil material from the scree slopes has similar physical and chemical properties to the material from the ridgelines, except that the depth of the soil profile is greater. These soils and those from ridgelines are suitable for rehabilitation placement on the upper, middle and lower slopes of waste landforms.

The depth of soil from the undulating stony plains is variable and reflects the topography of these areas. These soils have a moderate capacity to retain soil moisture, which will enable them to support a higher amount of plant growth and soil biological activity. They are considered most suitable for rehabilitation of middle and lower slopes of landforms.

The drainage lines in the study area receive a disproportionate amount of moisture and nutrients from the surrounding landscape. The physical and chemical properties are relatively benign and are unlikely to pose any major issues related to the rehabilitation of reconstructed landforms.

The hardpan washplains are the most productive SMU of all the five SMUs. These areas receive runoff from the ridgelines and are broad, diffuse areas with comparatively deep soil profiles. These soils are characterised as being non-sodic, although Emerson Test results indicate that the upper 20 cm may have some material that is unstable. However, given the relatively low clay content of these materials, it is considered unlikely that the partial clay dispersion identified will pose any major issues in terms of its use for rehabilitation purposes.

12.1.4 Potential impacts – Proposal and cumulative

Alteration of the landform will occur through the creation of pits, OSAs and overland infrastructure. The integrity and stability of built landforms has been considered as part of this Proposal.

Project machinery and equipment that disturbs and transports soil has the potential to cause a range of impacts, including:

- Repeated handling of soil by excavation, grading, loading, transporting and dumping can lead to the breakdown of soil structure, increasing susceptibility to erosion and reducing capacity to support vegetation. Surface soil materials contained a relatively high percentage of coarse material but were slightly dispersive and are therefore considered prone to structural decline and erosion.
- Handling of surface soil materials when wet could lead to a decline in structural stability and an increase in impacts associated with clay dispersion.
- Compaction by trafficking of heavy machinery and equipment reduces the soil material’s capacity to capture and store water and to support vegetation, particularly if close to the final surface of a landform.
- Interruption of local surface drainage patterns by stockpiles may cause accelerated erosion of the material within the stockpiles, downstream sedimentation or the dehydration of the soil profile in other areas.
MINING AREA C - SOUTHERN FLANK
Land systems located within the Proposed Mining Area C Development Envelope and surrounds.

Spatial Data - Business Development
BHP BILLITON IRON ORE

Proposed Mining Area C Development Envelope
Approved Mining Area C (Northern Flank) Development Envelope
Additional Development Envelope
BHP Billiton Rail
Rio Tinto Rail
Great Northern Highway

Rangeland Land Systems - WA
- PLA - Platform
- BGD - Boolgeeda
- CAL - Calcrete
- MCK - McKay
- NEW - Newman
- PDG - Pindering
- RIV - River
- ROB - Robe
- ROC - Rocklea
- ROC - Rocklea
- WNM - Wannamunna

Scale @ A4: 1:150,000
Prepared: S. TRINDER
Project No: A780/055 REVA
Date: 30/03/2017
Checked: R. GREGORY
Figure: 43
Revision: Rev A
Reviewed: S. WILLIAMSON

NOTES:

The views and information presented in this map are for illustrative purposes only. The map is not to be used for any economic or legal purposes. When using the map for planning purposes, it is recommended that users consult the relevant state and local authorities to determine the suitability of its use for any particular purpose.

Coordinate System: Central Project Grid (CPG94)
Projection: Transverse Mercator
Datum: GDA 1994

BHP BILLITON IRON ORE does not warrant that this map is free from errors or omissions. BHP BILLITON shall not be in any way liable for loss, damage or injury to the user of this map or any other person or organisation consequent upon or incidental to the existence of errors or omissions on this map. This map has been compiled with data from numerous sources with different levels of reliability and is considered by the authors to be fit for its intended purpose at the time of publication. However, it should be noted that the information shown may be subject to change and ultimately, map users are required to determine the suitability of use for any particular purpose.
BHP Billiton Iron Ore recognises that some soils, derived from different positions within the landscape, will have differing suitability for placement on reconstructed landforms. Based on the abovementioned assessments however, there are few physical or chemical properties that are considered likely to cause concern if the soil materials are used for rehabilitation purposes. BHP Billiton Iron Ore have undertaken waste characterisation and soil assessment to inform closure and rehabilitation planning.

Table 70: Potential landform impacts from the proposal

<table>
<thead>
<tr>
<th>PROPOSAL</th>
<th>Proposed Extent (Revised Proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated with Additional Disturbance at Mining Area C (EMP Revision 6)</td>
<td>Landforms within the Proposed Mining Area C development envelope are not considered rare, of scientific interest or of ecological importance. The variety and integrity of the landforms in the region will not be significantly altered in the region as a result of the Proposal. The predicted change to the landforms and soils as a result of the additional disturbance at Mining Area C is not significant.</td>
</tr>
<tr>
<td>Associated with Southern Flank Development</td>
<td>Landforms and soils within the Additional development envelope are not considered rare, of scientific interest or of ecological importance. The variety and integrity of the landforms in the region will not be significantly altered in the region as a result of the Proposal. The predicted change to the landforms and soils as a result of the Southern Flank development is not significant.</td>
</tr>
</tbody>
</table>

12.1.5 Mitigation and residual impacts

BHP Billiton Iron Ore will implement the internal PEAHR process to minimise impacts to landforms from ground disturbance.

Progressive rehabilitation will also be implemented across the Proposal in accordance with the updated Mining Area C Mine Closure Plan (BHP Billiton Iron Ore, 2016m).

Residual impacts to landforms with implementation of the PEAHR process and rehabilitation will not be significant and will not warrant ministerial conditions or offsets.

12.1.6 Proposed management approach

The landforms factor in the original approval of MS 491 was determined by the OEPA to be a key factor. However, a review of this Proposal against the Environmental Protection Bulletin No. 23: Guidance on the EPA's Landforms Factor (EPA, 2015a) concludes that this Proposal is not considered to be significant impact from a landform perspective due to no significant impacts to landforms resulting from implementation of the Proposal.

BHP Billiton Iron Ore considers that the landforms factor can be managed as part of its standard Pilbara-wide Health, Safety and Environment Management System; it is also addressed under the Mine Closure Plan, which has been developed to support this Proposal.

12.1.7 Predicted outcome

In consideration of the outcomes of the soils and landforms assessment and proposed management measures outlined in the updated Mining Area C Mine Closure Plan (BHP Billiton Iron Ore, 2016m), BHP Billiton Iron Ore considers that the EPA objective for landforms to protect variety and integrity of distinctive physical landforms so that environmental values can be met and that the residual impacts
are not significant with implementation of the Proposal. Landforms is therefore considered not a key factor for this Proposal.

### 12.2 Terrestrial environmental quality

#### 12.2.1 Introduction and EPA objective

This section provides an overview of BHP Billiton Iron Ore’s completed geochemical characterisation studies and investigations in relation to the Proposal during operations. Potential AMD impacts during closure are discussed in Section 11.7.4.1.

BHP Billiton Iron Ore has assessed the potential risk of AMD from the Proposal. A more detailed overview is included in the updated Mining Area C Mine Closure Plan (Appendix 12).

The EPA applies the following objective, according to the *Statement of Environmental Principles, Factors and Objectives* (EPA, 2016), in its assessment of proposals that may affect terrestrial environmental quality:

*To maintain the quality of land and soils so that environmental values are protected.*

#### 12.2.2 Relevant guidelines and approvals

As part of the preparation of this assessment of the terrestrial environmental quality factor, all EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

The materials geochemical characterisation program has also considered the following guiding documents, where practicable:

- *Leading Practice Sustainable Development Program for the Mining Industry - Managing Acid and Metalliferous Drainage* (DITR, 2007);
- GARD Guide (INAP, 2010); and
- *Australian Water Guidelines for Fresh and Marine Waters* (ANZECC/ARMCANZ, 2000) and its updates.

#### 12.2.3 Potential impacts – Proposal and cumulative

A preliminary *AMD Risk Assessment Study* (BHP Billiton Iron Ore, 2016b) has been carried out for the Indicative Additional Impact Assessment Area and the Mining Area C EMP Revision 6 Impact Assessment Area (BHP Billiton Iron Ore, 2015a).

As discussed in Section 11.7.4.1, AMD potential at the Additional Development Envelope has been assessed as low/negligible. No blocks of PAF material (classified AMD 1) have been identified in the resource or mine models, which therefore supports a low to negligible risk of AMD release. Minor amounts of weathered and detrital material, designated AMD 2 and 3, respectively, are present in the resource or mine model and have some potential to be an AMD hazard. These materials will be treated by being placed, where possible, more than 10 m from the final OSA rehabilitation surfaces. Additionally, ongoing geochemical test work will be used to refine the risk presented by AMD 2 and AMD 3 material.

A more comprehensive summary of the potential changes to the surrounding terrestrial environmental quality resulting from the operation of mining in the Additional Development Envelope is provided in the updated Appendix 12. For the purposes of this Proposal, a summary of impacts from the proposed change and the proposed extent (cumulative impacts) is provided in Table 71.
Table 71: Potential impacts to terrestrial environmental quality

<table>
<thead>
<tr>
<th>PROPOSAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated with Additional Disturbance at Mining Area C (EMP Revision 6)</td>
<td>Associated with Southern Flank Development</td>
</tr>
<tr>
<td>Potential impacts from contamination are considered low for Mining Area C operations. Existing waste disposal procedures and practices are considered effective.</td>
<td>A preliminary AMD Risk Assessment Study (BHP Billiton Iron Ore, 2016b) has been carried out for Southern Flank. This study assessed AMD potential as low to very low. Within the Southern Flank resource and mining models, no blocks of fresh rock with acid-forming potential were identified.</td>
</tr>
</tbody>
</table>

12.2.4 Mitigation and residual impacts

Applying the precautionary principle, materials with NAPP >3 will be placed more than 10 m from the final OSA rehabilitation surfaces.

Residual impacts to terrestrial environmental quality with implementation are considered to not be significant and will not warrant ministerial conditions or offsets.

12.2.5 Proposed management approach

Given that the potential impacts from contamination are low to negligible for the Proposal, existing waste disposal procedures and practices are considered effective.

12.2.6 Predicted outcome

Implementation of the Proposal will meet the EPA objective to maintain the quality of land and soils so that environmental values are protected. The inherent and residual impacts are not significant, and therefore Terrestrial Environmental Quality is not considered a key environmental factor.

12.3 Air quality and atmospheric gases

12.3.1 Introduction and EPA objective

BHP Billiton Iron Ore has commissioned Pacific Environment (2015 and 2016) to carry out atmospheric plume modelling to predict the potential impacts of the Proposal on local and regional air quality and atmospheric gases. The outcomes from the modelling are provided in Appendix 9. An assessment of the modelling outcomes is detailed below.

BHP Billiton Iron Ore has predicted the greenhouse gas emissions for the Proposal to assess the potential impact of greenhouse gas emissions associated with the Proposal.

This section presents the a description of the existing environment with respect to air quality, a summary of the outcomes of the latest modelling and impact assessment, which have determined the potential impacts to air quality in the Indicative Additional Impact Assessment and the Mining Area C EMP Rev
6 Impact Assessment Area. This section then presents the potential cumulative impacts of this Proposal and the current Mining Area C operations. And finally it closes with a review of current management actions and any changes to these proposed as part of this Proposal.

The EPA applies the following objective, according to the *EAG 8 for Environmental Factors and Objectives* (EPA, 2013a), in its assessment of proposals that may affect air quality:

> To maintain air quality for the protection of the environment and human health and amenity, and to minimise the emission of greenhouse and other atmospheric gases through the application of best practice.

### 12.3.2 Relevant guidelines

As part of the preparation of this assessment against the Air Quality factor, all EPA, and other relevant, policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

The following guidance documents were also relevant in the consideration of impacts to air quality:

- National Environment Protection Council Act 1994 (Cth) and National Environment Protection Measure for Ambient Air Quality (Air NEPM);
- Guidance Statement No. 18: Prevention of Air Quality Impacts from Land Development Sites (EPA, 2000b);
- Guidance Statement No. 12: Minimising Greenhouse Gas Emissions (EPA, 2002b); and

Below is a review of guidance for air quality that were deemed applicable for this assessment. The Air NEPM sets air quality standards for major air pollutants. The Ambient Air Quality NEPM criteria for the PM$_{10}$ fraction of particulate matter have been established in relation to protection of human health and it represents a threshold that is applied in general throughout Australia, without reference to relevant regionally specific conditions.

The recent health risk assessment undertaken for Port Hedland “confirmed the NEPM for PM$_{10}^{15}$ was intended for an urban setting rich in combustion PM and that it was reasonable to expect that it might not apply to Port Hedland because the particulate matter in Port Hedland was crustal (of natural origin)” and is an area that is subject to naturally elevated levels of background particulate matter (DoH, 2016). Due to similarities in regional particulate matter characteristics (i.e. iron ore mining and processing operations and naturally high background) this conclusion is relevant for inland Pilbara locations where the Proposal is located. Therefore the Ambient air quality NEPM is not deemed as appropriate guidance for this assessment.

Currently the Mt Whaleback operations in Newman have a Part V licence that stipulates a value of 70 µg/m$^3$, averaged over 24 hours for PM$_{10}$. This value is deemed applicable for assessment of significance of potential impacts to air quality from this Proposal, as the particulate matter composition and background regional particulate matter concentrations in this air shed is similar in nature to those expected for the Proposal.

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15 PM$_{10}$ refers to the fraction of particulate matter (PM) with an equivalent aerodynamic equal to or less than 10 µm in diameter.
The predicted total suspended particulates (TSPs) resulting from the Proposal has been deemed the most appropriate on which to base an assessment of potential impacts to visibility and amenity. This aspect of this atmospheric plume modelling is discussed in detail in Section 12.4 of this PER document.

The Mt Whaleback Part V licence values for PM\textsubscript{10} were used as guidance in the assessment of the significance of impacts to air quality resulting from the Proposal to the following nearest sensitive receptors:

- the Packsaddle Accommodation Camp (approximately 1.2 km north of the current Mining Area C and approximately 8.5 km north of the Indicative Additional Impact Assessment Area);
- the Mulla Accommodation Camp (approximately 2.5 km southwest of the current Mining Area C and 3 km north of the Indicative Additional Impact Assessment Area); and
- Great Northern Highway (50 m west of the current and proposed development envelopes).

### 12.3.3 Existing environment

The semi-arid landscape of the Pilbara is a naturally dusty environment with wind-blown dust a significant contributor to ambient dust levels in the region, with background monitoring showing that in many instances the background dust is higher than NEPM criteria, again indicating that this criteria is not appropriate for the region. Ongoing monitoring of background particulate matter levels surrounding Newman have shown that background level are higher than the 70 µg/m\textsuperscript{3} typically around 3-6 times per annum. Previous air quality assessments undertaken for the Mining Area C operation have shown that particulate matter emissions from the operation may result in elevated dust levels at accommodation camps and visible particulate emissions on the highway if not managed with mitigating controls.

### 12.3.4 Potential impacts

The main potential air quality issues resulting from this Proposal are particulate emissions associated with:

- excavating and handling of iron ore and overburden, including blasting;
- wind erosion from iron ore stockpiles and OSAs; and
- vehicle movements associated with the transfer of iron ore and overburden.

BHP Billiton Iron Ore utilised site-specific and national pollution inventory emission estimation techniques to calculate source-specific emission rates (Pacific Environment, 2015 and 2016). Based on the predicted mining schedule, the highest production rate year that is predominately located nearest the sensitive receptors is estimated to be 2031. Therefore, all emission estimations and potential impacts at the nearest sensitive receptors were based on this year as it is representative of a credible worst case scenario. It should be noted that the mine plan utilised for this assessment was accurate at the time of the assessment but is subject to change following optimisation of the mine plan.

Dispersion modelling was conducted by Pacific Environment (2015 and 2016) using the CALPUFF dispersion model combined with the Weather Research and Forecasting (WRF) Model for generation of meteorological inputs. Background particulate emissions were determined from monitoring data collected at a suitable background location near Newman.

The modelling was conducted for a number of scenarios to assess the ground-level impact of the emissions from the Proposal. These included prediction of ground level impact from the Southern Flank development in isolation including background (Pacific Environment, 2016), the predictions of ground level impact of mining the 14 deposits at Mining Area C (Pacific Environment, 2015) and a cumulative
assessment of impacts of operations at Mining Area C, Southern Flank and background (Pacific Environment, 2016).

BHP Billiton Iron Ore routinely designs and implements a number of controls in the fixed plant and mine design of the Proposal as standard practice to minimise impacts to receptors. Therefore, the modelling results presented below can be considered as partly mitigated. The controls are documented in Appendix 9 and include, but are not limited to, fogging systems, water cannons, enclosures and water carts.

Modelling of the mine plan and design associated with the Indicative Additional Impact Assessment Area, predicted the maximum concentrations of the PM$_{10}$ fraction of particulate matter for the scenario one are predicted to be 92 µg/m$^3$ at the Mulla Mulla accommodation village and 31 µg/m$^3$ at the Packsaddle accommodation village. The modelling outputs shows that the ground level concentrations rapidly decrease from the maximum to the fifth highest prediction by between 15 and 50% and therefore the maximums can be regarded as isolated high events. Furthermore, the modelling undertaken is representative of the worst case year where mining occurs nearest the receptors and assumes highest activity of mining equipment. Maximum predictions usually occur during unfavourable but infrequent meteorological conditions. The likelihood that these three aspects occur concurrently is highly unlikely and therefore it is highly unlikely that predicted maximums will eventuate. Therefore the 95th percentile prediction is more relevant for comparison with guidance to evaluate significance.

The 95th percentile prediction for the Southern Flank ore body with background was 41 µg/m$^3$ and 25 µg/m$^3$ for Mulla Mulla and Packsaddle accommodation villages respectively, which are significantly lower than the maximums, and below the 70 µg/m$^3$ guidance for significance. For the 14 deposits at Mining Area C the 95th percentile prediction is 59 µg/m$^3$ at the Packsaddle accommodation village and 44 µg/m$^3$ at the Mulla Mulla accommodation village with standard controls included. Based on these predictions, it can be concluded that implementation of the Proposal will not result in air quality impacts that could be considered significant.

The maximum predicted total suspended particle (TSP) concentrations expected on the Great Northern Highway range from 195 to 412 µg/m$^3$. Again, the modelling shows that the maximums are isolated high events, with the 95th percentile predictions much lower with a range of 138 to 315 µg/m$^3$. These predictions have been used to inform the visibility assessment as outlined in the amenity section.

Greenhouse gas emissions resulting from the Proposal will be generated through the combustion of hydrocarbons, clearing of native vegetation, the use of explosives during blasting operations and the use of electricity.

The maximum annual emission of greenhouse gases for the Southern Flank development over the life of the mine is predicted to be equivalent to 909 kilotonnes of carbon dioxide (CO$_2$-e). This corresponds to 0.22% of Australia’s and 1.09% of Western Australia’s financial year 2014 greenhouse inventory (Department of the Environment and Energy, 2016). The average CO$_2$-e emissions for the Proposal over the life of the mine is predicted to be 385 kilotonnes of CO$_2$-e per annum (or 0.46% of Western Australia’s emissions on average).

12.3.4.1 Cumulative impacts

The cumulative impact of the Proposal with the existing operation at Mining Area C was modelled. The maximum PM$_{10}$ concentration predicted at the Packsaddle and Mulla Mulla camps is 208 and 127 µg/m$^3$ respectively. Like Proposal outcomes, the modelling was undertaken for a worst case foreseeable scenario and it is unlikely that this scenario in reality will occur. Therefore, the maximums can be considered as isolated unforeseeable high events. The 95th percentile predictions for cumulative
modelling are predicted to be 72 and 61 µg/m³ respectively. Background monitoring in the region shows that natural high background events account for between 3 and 6 instances of above 70 µg/m³ and therefore the cumulative prediction are not considered significantly different to natural particulate emissions in the region.

Proactive operational management measures, such as predictive meteorological monitoring, combined with proactive application of water and surfactants to haul roads will mitigate ground level impacts of particulate emissions. These measures have been shown to be effective methods at the existing Mining Area C operations to minimise impacts to camps and residents.

Based on the above, BHP Billiton Iron Ore considered that potential impacts from PM₁₀ emissions are not significant and that the EPA objective can be met.

The maximum predicted cumulative TSP concentrations expected on the Great Northern Highway range from 180 to 415 µg/m³. Again, the modelling shows that the maximums are isolated high events with the 95th percentile predictions much lower with a range of 130 to 315 µg/m³. This impact is similar to that predicted for the Proposal in isolation. The relevance of these prediction on amenity is discussed in Section 12.4.

The maximum annual cumulative CO₂-e emissions is 1,975 kilotonnes of CO₂-e, with the average annual CO₂-e emissions over the life of the mine being 1,200 kilotonnes of CO₂-e. The maximum cumulative emissions represent 0.48% of Australia’s and 2.37% of Western Australia's financial year 2014 CO₂-e inventory.

The predicted greenhouse gas emissions were compared with typical iron ore mining operations, and it was found that the worst-case scenario is less intensive than an average iron ore mine (Norgate & Haque, 2010).

Based on the fact that the Proposal adds low percentages to both Australia’s and Western Australia’s greenhouse inventory and has low intensity compared with other like industries, the impacts are considered minor on a national basis.

### 12.3.5 Mitigation and residual impacts

To reduce the potential impacts from particulate matter emissions resulting from the Proposal a number of OSAs were removed from or relocated in the mine design (Figure 6). During more detailed mine design and optimisation, the location of the conveyors linking the Southern Flank ore body to the existing Mining Area C infrastructure were relocated to the north which resulted in these being located closer to the Mulla Mulla accommodation village.

The predicted impacts were re-modelled with an updated mine plan and design according to the Modified Indicative Additional Impact Assessment Area to determine the effect of the above modifications (Pacific Environment, 2016).

While this optimisation of the mine design and plan, resulted in other environmental benefits, including reduce disturbance and power use, it resulted in a slight increase to predictions of ground level concentrations of particulate matter at the Mulla Mulla accommodation village but resulted in a large reduction in predicted concentrations of TSP and PM₁₀ along the Great Northern Highway adjacent to the Proposed Mining Area C Development Envelope.

The predicted maximum cumulative TSP and PM₁₀ concentrations at potential receptors on the Great Northern Highway reduced by up to 30% (approximately 130 µg/m³) for both scenarios with the movement of the OSAs. The 95th percentile cumulative PM₁₀ concentration at Mulla Mulla and
Packsaddle accommodation villages is predicted to increase by up to 19% (112 µg/m³) as a result of the redesign of the OSAs and the movement of the conveying system. Again, this is not considered significant in comparison with typical regional background particulate levels. The predictions of TSP have been used to inform the visibility assessment discussed in the amenity section.

Overall, with the mitigation discussed above and the additional management measures outlined below, BHP Billiton Iron Ore consider that residual impacts do not constitute a significant impact to the environment. Therefore air quality is not considered to be a key factor for the Proposal.

12.3.6 Proposed management approach

12.3.6.1 Internal management
A number of management tools and mitigation has already been designed and integrated into the assessment of impacts detailed above. This includes but is not limited to the following:

- water sprays or enclosures on crushers;
- transfer chutes, either enclosed or fitted with skirts and dust curtains;
- fogging systems and/or covers or hoods installed in processing plants;
- water cannons on stockpiles;
- bulk ore conditioning sprays installed, where practicable, on conveyors;
- water carts operating on OSAs and run-of-mine pads;
- surfactant application to haul roads; and

Proactive operational management measures, such as predictive meteorological monitoring, combined with proactive application of water and surfactants to haul roads will mitigate the predicted impacts detailed above. These measures have been shown to be effective methods at the existing Mining Area C operations to minimise impacts to camps and residents. The proactive and reactive use of these controls will ensure that dust emissions and potential impacts to the accommodation camps and the highway are minimised.

BHP Billiton Iron Ore has a process for identifying and implementing opportunities to improve energy efficiency across its operations. In addition, the risk to the business due to changing climate is addressed as part of the ongoing business planning processes.

12.3.6.2 Regulatory management
Particulate emissions will be subject to the requirements of the EP Act and greenhouse gas emissions the National Greenhouse and Energy Reporting Act 2007.

12.3.7 Predicted outcome
The Proposal meets the EPA’s objective for the air quality and atmospheric gases factor. BHP Billiton Iron Ore considers that this factor can be managed via the requirements of the EP Act.

12.4 Amenity

12.4.1 Introduction and EPA objective
The following section discusses the existing environment and impact assessment as it relates to the amenity of the Proposed Mining Area C Development Envelope and surrounds.
360 Environmental Consultants (2016) and Urbis (2015) were appointed to carry out Landscape and Visual Impact Assessments to inform this Proposal. Following field investigations, view-shed and photomontage analysis was carried out for several potential sensitive receptor sites to determine potential direct impacts on landscape character and visual amenity. These studies are provided in Appendix 10.

In addition, PEL conducted a visibility risk assessments with respect to the potential for particulate matter (dust) to impair visibility along the section of the Great Northern Highway that is adjacent to the Proposal and to the existing Mining Area C operations.

The EPA applies the following objective, according to the *EAG 8 for Environmental Factors and Objectives* (EPA, 2013a), in its assessment of proposals that may result in impacts to amenity:

> To ensure that impacts to amenity are reduced as low as reasonably practicable.

### 12.4.2 Relevant guidelines

As part of the preparation of this assessment for the amenity factor, all EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

The following guidance documents were also relevant in the consideration of impacts to amenity:

- **Visual Landscape Planning in Western Australia: A Manual for Evaluation, Assessment, Siting and Design** (DPI, 2007);
- **Statement of Planning Policy No. 2: Environment and Natural Resources Policy** (WAPC, 2003);
- **Pilbara Planning and Infrastructure Framework** (WAPC, 2012); and
- **Victoria State Environmental Protection Policy (Ambient Air Quality) No. S19** (EPA VIC, 1999).

An equation developed by Baddock *et al.* (2014) allows conversion of total suspended particulates to visibility in kilometres. The predicted concentrations of TSP from atmospheric plume modelling were utilised to determine visibility distance, which in turn was used to assess visibility risk along the Great Northern Highway. High risk was defined as visibility less than 1 km, medium risk as between 1 and 2 km and low risk as greater than 2 km.

### 12.4.3 Existing environment

Mining and associated infrastructure (e.g. rail, camps) are prominent land features within 20 km of the Proposed Mining Area C Development Envelope. There are also several pastoral leases in this area. Therefore the natural form of the landscape has already been modified. The area has low visitation numbers but is accessible and potential visible from the Great Northern Highway by through traffic.

The Great Northern Highway is located on the western boundary of the Proposed Mining Area C Development Envelope. This highway is one of two main routes available for north–south traffic, and it connects the southwest, midwest and Pilbara regions in Western Australia. It is used by tourists as well as by both national and regional freight and mining-related traffic.

The Governor and Mount Robinson are two elevated locations from which the Proposal may be visible.

The following have been identified by 360 Environmental (2013) or Urbis (2015) as key viewpoints within 20 km of the Proposed Mining Area C Development Envelope:
• Mount Robinson: approximately 500 m from the southern boundary of the Proposed Mining Area C Development Envelope;

• The Governor: 3 km from the southeast corner of the Proposed Mining Area C Development Envelope;

• Hope Down Accommodation Villages;

• Weeli Wolli Springs;

• Mt Meharry; and

• the Great Northern Highway: running along the western boundary of the Proposed Mining Area C Development Envelope.

12.4.4 Potential impacts

360 Environmental (2013) identified 14 preliminary viewpoints, or potential sensitive receptor sites, based on a desktop risk of impact and site significance matrix. The risk and significance of these sites were verified and surveyed in the field with six were determined to be sensitive sites (based on local significance and accessibility) and as such were further assessed during the impact assessment phase as key viewpoints. Urbis as part of the development of Mining Area C EMP Revision 6 identified and assessed nine viewpoints, all of which were also studied by 360 Environmental. All the sites are listed in Table 72. The nine potential sensitive viewpoint sites were identified and analysed for potential impacts. Impacts were assessed on the basis of predicted changes to amenity from current, thereby evaluating if the Proposal will results in a change to an already altered landscape features.

Following the 360 Environmental (2013) visual impact assessment, changes to the footprint and location of pits, OSAs and infrastructure were made in 2016. This included but was not limited to the location of ore handling infrastructure and rail and train loading facilities, which are no longer planned to be located south of the mining area. As a result of the high potential for visual impact from the OSAs that were located adjacent to the Great Northern Highway, these OSAs have been moved to the east to avoid or minimise these impacts.

In light of these changes, a re-assessment of the potential impact at the six key viewpoints identified by 360 Environmental (2013) (and provided in Appendix 10) has been undertaken. The original and updated potential impacts are summarised in Table 72.
Table 72: Viewpoints surveyed in the visual landscape impact assessment

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Great Northern Highway south</td>
<td>Low – screened from operations</td>
<td>Medium – OSA and pit area further from view site.</td>
<td>Medium – overall impact is unchanged. Changes include removal of rail and ore processing facilities but slight increase to height of one OSA visible from this viewpoint.</td>
</tr>
<tr>
<td>2</td>
<td>The Governor</td>
<td>Not assessed</td>
<td>Low – less traffic and view of OSA and pit area shielded.</td>
<td>Low – overall visual impact is unchanged.</td>
</tr>
<tr>
<td>3</td>
<td>Great Northern Highway adjacent to the Proposed Mining Area C Development</td>
<td>Moderate</td>
<td>High – significant use of highway by tourist and mine employees, OSA direct view.</td>
<td>High – overall impact is slightly reduced due to movement of OSA.</td>
</tr>
<tr>
<td>4</td>
<td>Great Northern Highway adjacent to the Proposed Mining Area C Development Envelope #2</td>
<td>High</td>
<td>High – significant use of highway by tourist and mine employees, OSA direct view.</td>
<td>Medium – overall impact is reduced due to movement of OSA.</td>
</tr>
<tr>
<td>5</td>
<td>Great Northern Highway adjacent to Mining Area C Access Road</td>
<td>Moderate</td>
<td>Medium- slightly elevated which allow view of mining and OSA in distance</td>
<td>Medium, overall impact is unchanged.</td>
</tr>
<tr>
<td>6</td>
<td>Mount Robinson</td>
<td>Low</td>
<td>Medium – elevated site but less traffic</td>
<td>Medium – changes have resulted in some OSA being less visible and some more visible; overall impact is unchanged.</td>
</tr>
<tr>
<td>7</td>
<td>Hope Downs Accommodation Villages</td>
<td>Primary Camp – Negligible, Secondary Camp - low</td>
<td>Not Assessed</td>
<td>Low</td>
</tr>
<tr>
<td>8</td>
<td>Weeli Wolli Springs</td>
<td>No Impacts</td>
<td>Not Assessed</td>
<td>Site is 14 km away and lies in a depressed valley, therefore no visual impact is predicted.</td>
</tr>
<tr>
<td>9</td>
<td>Mt Meharry</td>
<td>Very Low</td>
<td>Not to determine to be a key viewpoint</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

The visibility risk from particulate matter emissions prior to the mine design modification was predicted to be high approximately 20% of the time, ranging from 8% to 53% along sections of the highway. The risk was rated as medium for approximately 37% of the time, meaning that the visibility was potentially reduced to less than 2 km for approximately 57% of the time, and greater than 2 km for 43% of the year. Note that the predicted TSP that was utilised for this assessment considered the worst-case year, that is mining activity concentrated at the western area (i.e. nearest Great Northern Highway). Therefore, this risk would not be present for the life of the mine.

Regardless, the mine design was modified to reduce this visibility and visual risk arising from the Proposal (see Section 12.4.5).
12.4.4.1 Cumulative impacts

The visual impact assessment discussed above predicted the potential impact from viewpoints that considered Mining Area C existing operations, and therefore the assessment represents potential cumulative impacts. Impacts were predicted based on a worst case scenario, which is a concentration of mining activity on the western portion of the Proposed Mining Area C Development Envelope.

The visibility assessment was undertaken using predicted cumulative TSP concentrations (see Section 13.4.4.1); and therefore the potential impacts discussed above represent potential cumulative visual amenity impacts resulting from the Proposal.

12.4.5 Mitigation and residual impacts

The scope and footprint of the Proposal have changed over time. The visual impact resulting from the original and modified footprints is shown in Appendix 9. The mine design was modified to reduce the number of OSAs near the highway, which resulted in a reduction of potential visibility impact to the Great Northern Highway. The occurrence of a potential high risk (less than 1 km visibility) on the highway was reduced from 20% to approximately 6% as result of this change, and medium risk (1 to 2 km visibility) was reduced to approximately 28% of the time. Therefore, visibility is predicted to be greater than 2 km more than 66% of the time. Note that this estimation is based, as above, on the scenario where mining is occurring immediately adjacent to the highway, so visibility impacts are expected to be less than this for the majority of the mine life. The movement of OSAs closest (within approximately 50 m) to the Great Northern Highway in the mine design has resulted in a reduction to the visual impacts predicted for the highway adjacent to the Proposal from both a viewpoint and potential impacts from particulate emissions (TSP) perspective.

BHP Billiton Iron Ore will where practical restrict clearing of native vegetation and development of OSAs in line with the indicative modified impact assessment area.

Based on the reduction in potential amenity impacts following application of the mitigation hierarchy the residual potential impacts to amenity as a result of the Proposal are not considered significant.

12.4.6 Proposed management measures

Management measures proposed to minimise particulate emissions were discussed in Section 12.3.6. With respect to management of visual amenity impacts, progressive rehabilitation of OSAs and in-fill of pits will be undertaken to reduce progressively reduce the visibility of large scale mining activities and structures. This should result in minimisation of the visual impact from the viewpoints discussed above.

BHP Billiton Iron Ore also has an existing consultation program that includes a public complaints and response process. In the event that public complaints in relation to amenity impacts are noted, management measures will be reviewed.

12.4.7 Predicted outcome

This Proposal meets the EPA’s objective for the amenity factor. BHP Billiton Iron Ore considers that this factor can be addressed via requirements of the EP Act.

12.5 Human health (noise)

12.5.1 Introduction and EPA objective

BHP Billiton Iron Ore appointed SVT Consultants to carry out noise modelling to determine the potential noise impacts arising from the Proposal (SVT, 2014; 2016). These studies are provided in Appendix 11.
This section presents the assessed impacts to human health (noise) in the Mining Area C EMP Revision 6 Impact Assessment Area as presented in the Mining Area C EMP Revision 6 (BHP Billiton Iron Ore, 2015a). Following this is a summary of the outcomes of the latest modelling and impact assessment, which have determined the potential impacts to noise in the Indicative Additional Impact Assessment Area. This section then presents the potential cumulative impacts of this Proposal and the current Mining Area C operations. Finally it closes with a review of current approved management actions and any changes to these proposed as part of this Proposal.

The EPA applies the following objective, according to the *EAG 8 for Environmental Factors and Objectives* (EPA, 2013a), in its assessment of proposals that may result in impacts to human health:

> To ensure that human health is not adversely affected.

### 12.5.2 Relevant guidelines

As part of the preparation of this assessment for the human health factor, all EPA policies and guidance documents were reviewed. Those policies and guidance considered relevant to this particular factor are summarised in Table 7.

The following guiding documents were also relevant in the consideration of impacts to human health (noise):

- Australian Standard 2107:2000, Acoustics: Recommended Design Sound Levels and Reverberation Times for Building Interiors; and
- EAG 13 Consideration of environmental impacts from noise (EPA, 2014b)

The assigned noise levels used as guidance to assess the significance of the potential outdoor impacts arising from the Proposal are consistent with the *Environmental Protection (Noise) Regulations 1997* and are as follows: Packsaddle and Mulla Mulla Accommodation Villages – 35 dB(A) (decibels a-weighted) (LA10) (noise level exceeded for 10% of the measurement period).

For indoor noise, *Australian Standard 2107:2000* was used as guidance to assess noise with the following criterion: Packsaddle and Mulla Mulla accommodation villages – 25 dB (A) ($L_{Aeq, T}$)

Vibration levels in millimetres per second (mm/s) and linear noise levels from blasting were also modelled for the purpose of informing the terrestrial fauna impact assessment, specifically for potential impacts to ghost bat caves.

### 12.5.3 Existing environment

The nearest noise-sensitive receptors to the Proposal are:

- the Packsaddle Accommodation Village, located in the northwest area of the Proposed Mining Area C Development Envelope; and
- the Mulla Mulla Accommodation Village, located approximately in the midwest area of the Proposed Mining Area C Development Envelope.

### 12.5.4 Potential impacts

Excessive noise and vibration has the potential to impact environmental and social values in the Proposed Mining Area C Development Envelope and surrounds (e.g. residential areas, other land users, fauna and caves).

The main sources of noise from the Proposal are expected to be associated with:
• mobile plant, such as excavators, graders, haul trucks and drill rigs;
• fixed plant, such as conveyors, ore processing facilities and the rail loader; and
• blasting noise.

The noise impact assessment undertaken for the Mining Area C EMP Revision 6 (SVT, 2014) predicted that the noise levels without mitigation at the Mulla Mulla Accommodation Village met the assigned levels and predicted that noise levels without mitigation at the Packsaddle Accommodation Village were slightly above (~0.8 dB) assigned levels. The noise modelling was undertaken with worst case assumptions, that is with all equipment functioning, equipment located at surface level and located nearest the receptors and during worst case meteorological conditions. This scenario is highly unlikely to eventuate in reality meaning the noise predictions are highly conservative and likely to be overestimated. Therefore, the potential and likelihood for noise to be above the criteria is low.

SVT (2016) carried out noise modelling on a number of scenarios including those for cumulative impacts with existing Mining Area C operations (Appendix 11):

• Scenario 1 – the Southern Flank ore body in isolation under maximum fleet configuration;
• Scenario 2 – the Southern Flank ore body in isolation with maximum activity in the pit nearest sensitive locations;
• Scenario 3 – Scenario 1 plus emissions from existing operations at Mining Area C (inclusive of P1E operations) (cumulative assessment)
• Scenario 4 – Scenario 2 plus emissions from existing operations at Mining Area C (inclusive of P1E operations) (cumulative assessment);
• Scenario 5 – Scenario 1 plus emissions from existing operations at Mining Area C (exclusive of P1E operations) (cumulative assessment); and
• Scenario 6 – Scenario 2 plus emissions from existing operations at Mining Area C (exclusive of P1E operations) (cumulative assessment).

In line with meteorological guidance, modelling assumed worst-case meteorological conditions. Also, worst-case mining assumptions were made. These included the following assumptions:

• All mining fleet and fixed plant is operating at once.
• All mining fleet is located at the surface (i.e. noise from equipment is not shielded by pits).
• Mining fleet is located either nearest to the receptor (Scenarios 2, 4 and 6) or represents maximum fleet numbers (Scenarios 1, 3 and 5).

It is unlikely that these conditions will exist concurrently at any point during operation of the mine.

Each of the six scenarios was assessed against relevant assigned noise levels, and noise contour maps were created for the surrounding area.

For the Southern Flank ore body development the assigned noise levels were met at the Packsaddle Accommodation Village. The noise model predicted that the noise levels may be above the assigned levels at the Mulla Mulla Accommodation Village by as much as 4.3 dB(A) when the mining fleet is located closest to the camp. However, given that the modelling undertaken assumed worst-case mining conditions, there is a low probability that the assigned level will be exceeded during normal operations.

The indoor noise levels were found to be well below the criterion outlined in AS2107.
12.5.4.1 Cumulative impacts
The predicted impact for the Proposed Mining Area C Development Envelope shows that the existing Mining Area C equipment operating in the P1E Deposit dominates impacts to the Packsaddle Accommodation Village. The predicted cumulative outcomes at the Packsaddle and Mulla Mulla accommodation villages are similar to those found for the Southern Flank ore body development (Additional Development Envelope) in isolation and it can therefore be concluded that there is it highly likely that noise regulations will be met at the accommodation villages.

Blasting noise and vibration impacts were also modelled by SVT (Appendix 11). These data have been used to assess potential impacts to fauna (see Section 11.2.4.2).

12.5.5 Mitigation and residual impacts
The modelling shows that, in all but the worst case scenario which is highly unlikely to eventuate, noise impacts resulting from the Proposal are predicted to meet relevant criteria. Therefore, no further mitigation is proposed. In the event that noise complaints are received from persons housed in the accommodation, BHP Billiton Iron Ore will ensure that night-time noise impacts (post-7pm) are minimised by managing when and where night time mining activity is undertaken in the vicinity of Mulla Mulla and Packsaddle accommodation villages.

The inherent and residual impacts of noise emissions to key receptors following implementation of the Proposal are not considered significant as it is predicted that noise regulations will be met.

12.5.6 Proposed management measures
12.5.6.1 Internal management
Noise management, including implementation and maintenance of any controls, will be managed via BHP Billiton Iron Ore’s Pilbara-wide Health, Safety and Environment Management System. No complaints regarding noise have been received as a result of current operations, indicating that current noise management measures are effective in minimising impacts from noise.

12.5.6.2 Regulatory management
Potential noise impacts will continue to be managed in line with the Environmental Protection (Noise) Regulations 1997.

12.5.7 Predicted outcome
This Proposal meets the EPA’s objective for the human health factor, and it is therefore not considered a key environmental factor. BHP Billiton Iron Ore considers that this factor can be managed in line with the EP Act and the Environmental Protection (Noise) Regulations 1997.
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13. Conclusion

This document has provided information about the existing environment and potential impacts of implementation of the Proposal. It has also summarised the potential impacts associated with this Proposal and the Mining Area C currently operations. Where possible, a regional impact has also been assessed.

This PER has also explained BHP Billiton Iron Ore’s new regional management approach to potential impacts for each of the EPA’s environmental factors and has suggested potential implementation conditions to address those factors that may be considered key environmental factors.

BHP Billiton Iron Ore has had due regard for the principles of ecological sustainable development of the EP Act. BHP Billiton Iron Ore has extensive regional data sets, and proven current management practices on which the EIAs were based, resulting in a high degree of confidence in impact predictions. Where inherent impacts have been assessed as significant the application of the mitigation hierarchy based on a robust scientific methodology has resulted in a reduction of potential impacts to a level BHP Billiton Iron Ore considers reasonable.

Environmental Impact Assessments undertaken by BHP Billiton Iron Ore have concluded that for all factors outlined in the environmental scoping document that the EPA objective can be met and either the inherent or residual impacts to the environment resulting from the Proposal are not significant. In some cases (e.g. Terrestrial Fauna) the objective is met by the implementation of offsets.

This PER has provided supporting information to the EPA to undertake an assessment of the Proposal against EPA objectives. Billiton Iron Ore considers that the information and assessment presented in this PER adequately identifies and addresses environmental impacts relevant to the Proposal, adequately addresses the environmental scoping document and is suitable to enable the EPA to undertake its EIA of the Proposal.
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15. Appendices
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