BHP Billiton Iron Ore

MINING AREA C

Mine Closure Plan

AML7000281

Revision 3.1

OCTOBER 2017
# Document Amendment Record

<table>
<thead>
<tr>
<th>Version</th>
<th>Change Effected</th>
<th>Date of Change</th>
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<tbody>
<tr>
<td>1.0</td>
<td>Mining Area C Closure Plan submission supersedes Mining Area C Decommissioning and Final Rehabilitation Plan, 2004</td>
<td>July, 2014</td>
</tr>
<tr>
<td>2.0</td>
<td>Mining Area C Closure Plan revised to align with the activities described and data gathered to inform in Mining Area C Environmental Management Plan rev 6</td>
<td>October, 2015</td>
</tr>
<tr>
<td>3.0</td>
<td>Mining Area C Closure Plan revised to include Southern Flank Development Area (Draft for regulator feedback)</td>
<td>November, 2016</td>
</tr>
<tr>
<td>3.1</td>
<td>Plan updated to accommodate feedback from DMIR and OEPA, submitted to DMIR for approval</td>
<td>October 2017</td>
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# SUBMISSION DETAILS

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<th>Company Name: BHP Billiton Iron Ore</th>
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<tr>
<td><strong>Title of Project</strong></td>
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<tr>
<td><strong>Document Title</strong></td>
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<td><strong>Document ID No.</strong></td>
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<td><strong>Document Version No.</strong></td>
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<td><strong>Catalogue No.</strong></td>
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<tr>
<td><strong>Date of Submission</strong></td>
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<td><strong>Mineral Tenements:</strong></td>
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**Contact Details:**

<table>
<thead>
<tr>
<th>Manager Closure Planning</th>
<th>Ms Rebecca Wright – Manager Closure Planning – Minerals Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Business address: Level 30, City Square 125 St Georges Terrace Perth WA 6000</td>
</tr>
<tr>
<td></td>
<td>Mailing address: PO Box 7122 Cloisters Square Perth WA 6850</td>
</tr>
<tr>
<td></td>
<td>Telephone: +61863215468</td>
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</table>

<table>
<thead>
<tr>
<th>Registered Manager Mine Area C General Manager</th>
<th>Andrew Buckley – (Acting) Mining Area C General Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business address:</td>
<td>City Square 125 St Georges Terrace Perth WA 6000</td>
</tr>
<tr>
<td>Mailing address:</td>
<td>Executive Office PO Box 655 Newman WA 6753</td>
</tr>
<tr>
<td>Telephone:</td>
<td>+61891268919</td>
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<table>
<thead>
<tr>
<th>Tenement Holder</th>
<th>C/- WAIO Land Tenure Team</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO Box 7474 Cloisters Square Perth WA 6850</td>
</tr>
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</table>
Executive Summary

The Mining Area C operation is located approximately 100 kilometres (km) northwest of Newman, Pilbara region, Western Australia, within ML281SA which is operated by BHP Billiton Iron Ore as the authorised manager on behalf of the Mount Goldsworthy Joint Venture.

The Mount Goldsworthy Joint Venture partners are as follows:

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

Operations at Mining Area C focus on enriched areas of both the Brockman and Marra Mamba Iron Formations, for mining purposes the area has been sub-divided into a series of deposits. An Environmental Impact Assessment (EIA) to mine 14 iron ore deposits at Northern Flank was submitted in 1997 via the Public Environmental Review (PER) process and approved under Ministerial Statement No. 491 (MS 491) in 1998 under Part IV of the Environmental Protection Act, 1986 (EP Act).

This Mine Closure Plan supersedes previous versions prepared to satisfy conditions in MS 491 and submitted for additional approvals at Northern Flank. This revision was updated to include the Proposed Southern Flank Development Envelope Area (Southern Flank).

The closure strategy has been incorporated into this Mine Closure Plan based on current knowledge including regional eco-hydrological science and third party neighbouring mine considerations. Management measures will be implemented to achieve guiding closure principles for rehabilitation and water management.

At a regional and local level BHP Billiton Iron Ore is committed to ensuring that the ecological and cultural values of Weeli Wolli Spring, Coondewanna Flats, Ben's Oasis and the Fortescue Marsh are appropriately managed to minimise any impacts arising from the Mining Area C operation.

Executive Summary Table 1 discusses the key risks and issues by technical area and also provides a summary of the activities and actions that will be undertaken prior to closure and post-closure to enable the closure outcomes described. Improvement activities, as identified by the knowledge gaps in the analysis of data, are also provided in summary.

Full descriptions and context are provided in the relevant sections of this Mine Closure Plan.
## Executive Summary Table 1 – Summary of Key Risks and Management Approaches

<table>
<thead>
<tr>
<th>Technical Area</th>
<th>Key Risks and Issues</th>
<th>Management Response</th>
<th>Tools (processes, plans &amp; guidelines)</th>
<th>Improvement Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sustainability</strong></td>
<td></td>
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<tr>
<td>Flora and Vegetation; Terrestrial Fauna (including Short Range Endemic species); and Soil Characteristics</td>
<td>Revegetation establishment</td>
<td>Growth media management in accordance with the BHP Billiton Iron Ore’s (BHPBIO) Growth Media Management Procedure (SPR-IEN-LAND-009)</td>
<td>BHPBIO Rehabilitation Standard (Controlled Document ID 0001074)</td>
<td>Further studies will be completed to address the knowledge gaps</td>
</tr>
<tr>
<td></td>
<td>Standing water attracts fauna</td>
<td></td>
<td>Growth Media Management Procedure (SPR-IEN-LAND-009)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Growth media management in accordance with the BHP Billiton Iron Ore’s (BHPBIO) Growth Media Management Procedure (SPR-IEN-LAND-009)</td>
<td></td>
<td>Progressive Rehabilitation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Local provenance native seed (from the local area, but as a minimum from within 100 km of site within the Pilbara Biogeographic Region)</td>
<td></td>
<td>Topsoil stockpiling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• WAIO approach: Implementation of the WAIO Rehabilitation Standard and undertake progressive rehabilitation as per Corporate Alignment Planning (CAP) cycle – business as usual</td>
<td></td>
<td>Seed collection and storage (supported by studies regarding propagation)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• WAIO Rehabilitation Standard (Controlled Document ID 0001074)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Growth Media Management Procedure (SPR-IEN-LAND-009)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Progressive Rehabilitation</td>
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<td></td>
<td>• Topsoil stockpiling</td>
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<td></td>
<td>• Seed collection and storage (supported by studies regarding propagation)</td>
<td></td>
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<tr>
<td></td>
<td>• Further studies will be completed to address the knowledge gaps</td>
<td></td>
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<tr>
<td></td>
<td>• WAIO Growth Media Atlas to identify suitable growth media for use in rehabilitation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Assessment of rehabilitation areas as providing suitable habitat for fauna</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• WAIO Growth Media Atlas to identify suitable growth media for use in rehabilitation.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Research on how to re-create habitat on rehabilitated OSAs and pits for terrestrial fauna, including Antichiropus ‘DIP007’ and ghost bat.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Area</td>
<td>Key Risks and Issues</td>
<td>Management Response</td>
<td>Tools (processes, plans &amp; guidelines)</td>
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</tr>
<tr>
<td><strong>Landforms</strong></td>
<td>Landform instability (pit voids)</td>
<td>Design of an integrated landforms across all domains taking account final landform design as developed</td>
<td>BHPBIO Mines Closure Design Guidance Procedure.</td>
<td>Mine Planning analysis to determine ultimate pit void extents and waste balance for final landform detailed designs</td>
</tr>
<tr>
<td></td>
<td>Landform instability (OSAs)</td>
<td>In-pit dumping of waste material, where practicable, to reduce OSA footprint</td>
<td>Ongoing detailed OSA rehabilitation planning within the annual five year mine planning cycle and detailed closure landform designs (integrating all domains) to be developed based on outcomes of technical studies and assessments when there is less than two years to closure</td>
<td>Develop the conceptual and detailed closure management and design tools (including application timing) to identify the optimal closure overburden storage area design and mine void outcomes.</td>
</tr>
<tr>
<td></td>
<td>In-pit Storage Areas</td>
<td>At Northern Flank, all below water table (BWT) pits to be backfilled to 5 m above water table (AWT) at closure</td>
<td>Rehabilitation earthworks in accordance with the BHP Billiton Iron Ore’s Earthworks for Rehabilitation Procedure (SPR-EN-LAND-010)</td>
<td>Undertake further waste characterisation, modelling and analysis to refine the Waste Class classification on an ongoing basis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implement OSA design principles from WAIO Mines Closure Design Guidance Procedure. Particular attention to the OSA design (including conservative slope angles) and construction techniques used to provide a stable landform for Marra Mamba wastes</td>
<td>Waste characterisation and erosion potential modelling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Execute progressive rehabilitation in accordance with annually refreshed five year mine plan</td>
<td>Geological model informs pit design</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abandonment bunds controls at Highway Deposit</td>
<td>Mine waste balance and design updates</td>
<td></td>
</tr>
<tr>
<td><strong>Terrestrial</strong></td>
<td>Potential acid and saline drainage forming materials</td>
<td>Avoid exposure (mine plan optimisation dependent) of potential acid forming (PAF)</td>
<td>Ongoing monitoring in accordance with BHPBIO AMD Management Standard (2014)</td>
<td>Further studies will be completed to determine the mine void closure</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Quality</strong></td>
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<td>Technical Area</td>
<td>Key Risks and Issues</td>
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<td>Tools (processes, plans &amp; guidelines)</td>
<td>Improvement Activities</td>
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</tr>
<tr>
<td>Acid Metalliferous Drainage (AMD)</td>
<td></td>
<td>material (AMD class 1) in final pit walls</td>
<td>• Process and guidance for placement of materials within OSAs and OSA design guidance provided by the BHPBIO Mines Closure Design Guidance Procedure.</td>
<td>strategy (including consideration of backfill) to manage AMD risks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If avoidance is not possible, backfilling exposed pit wall PAF (AMD class 1) with non-acid forming (NAF) or neutralising material (dependent of groundwater recovery)</td>
<td>• Targeted analysis of key lithologies to increase geochemical characterisation testing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Contain mined PAF (AMD class 1) material within OSAs to minimise oxidation</td>
<td>• Update the AMD Risk Assessment with additional analytical data and updated in-pit block model for PAF waste by 2019.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Class AMD 2 and AMD 3 material to be treated with caution and ensure it is not generally dumped within 10 m of any final landform surface</td>
<td>• On the basis of ongoing AMD studies assess the need to update the existing Mining Area C PAF waste and other AMD risk classification, resource model coding and management systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Verification of OSA compliance to 'as dumped' design</td>
<td></td>
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</tbody>
</table>
### Technical Area | Key Risks and Issues | Management Response | Tools (processes, plans & guidelines) | Improvement Activities |
--- | --- | --- | --- | --- |
**Hydrology**<br>Surface water | Surface water flow and quality do not meet acceptable limits offsite | Specific management strategies that could be used by BHP Billiton Iron Ore to meet the management objectives for the proposed indicative developments include:  
- Avoiding drainage line intersection;  
- Permanent realignment;  
- Reinstating over backfilled pits; and  
- Intercept (discharge to pit or local capture) | Design of integrated landforms across all domains taking account of the post closure surface water regime as detailed in Section 7.7 | Investigation of the suitability of operational surface water controls and the required modifications to meet closure requirements  
Develop design principles and details for structures remaining post mining that will be exposed to surface drainage including P3 and P1 east drainage re-alignments, two years prior to realignment  
Where overburden storage areas encroach in the flood zones, additional studies will be completed to determine the 100 year Average Recurrence Interval (ARI) flood event  
Further develop the parameters and design objectives to ensure that surface water drainage requirements are included at the various stages of planning and execution. |
**Hydrology**<br>Groundwater | Groundwater drawdown at key receptors  
Poor quality groundwater enter water resources | Implementation of Central Pilbara Water Resource Management Plan  
Pit voids management: At Northern Flank pits BWT will be backfilled during operations as part of a waste management program and also post operations to a level which prevents impacts to water quality & allows for | Implementation of the Central Pilbara Water Resource Management Plan  
Ongoing modelling and monitoring of water levels for Coondewanna Flats | Further studies will be completed to determine the mine void closure strategy (including consideration of backfill) to manage groundwater risks  
Review and update the Mining Area C conceptual model (as more data becomes available)  
Finalisation of the numerical model and then continuous update and
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>aquifer recovery at the key receptors. Backfilling of BWT pit voids at South Flank to above pre-mining water is an option available and will be considered where unacceptable impacts to water quality or quantity are likely as a result of pit lakes</td>
<td>calibration as required to refine and validate the predictions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If following further study unacceptable impact to Condewanna Flat is considered likely, mitigation controls such as the infiltration and injection into the aquifer, will be implemented.</td>
<td>• Modelling mitigation measures (using the numerical model) to offset any identified groundwater changes at the receptors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No implementation measures have been considered for Weeli Wolli Spring as impacts are subject to further study.</td>
<td>• Impacts at Condewanna Flats: Review of the hydrology and potential impacts and the finding discussed with the Regulators in the event that modelling and monitoring of water levels indicates they are likely to fall below the investigation thresholds at time of closure.</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Impacts at Weeli Wolli Spring: Once Hope Downs groundwater affecting activities have ceased and closure has commenced, the cumulative impacts resulting from Mining Area C operations will be reconsidered</td>
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## Checklist

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<th>Page No.</th>
<th>Comments</th>
<th>Changes from previous version (Y/N)</th>
<th>Page No.</th>
<th>Summary</th>
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<tr>
<td>1 Has the Checklist been endorsed by a senior representative within the tenement holder/operating company? (See bottom of Checklist.)</td>
<td>Y</td>
<td>xii</td>
<td>Corporate endorsement at the end of this section</td>
<td>Y</td>
<td>Updated signatures</td>
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### Public Availability

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<th>2 Are you aware that from 2015 all MCPs will be made publicly available?</th>
<th>Y</th>
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</thead>
<tbody>
<tr>
<td>3 Is there any information in this MCP that should not be made publicly available?</td>
<td>Y</td>
</tr>
<tr>
<td>4 If Yes to Q3, has confidential information been submitted in a separate document / section?</td>
<td>N</td>
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### Cover Page, Table of Contents

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<th>5 Does the cover page include;</th>
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<td>Contact Details (including telephone numbers and email addresses).</td>
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<td>Document ID and version number.</td>
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<td>Date of submission (needs to match the date of this checklist).</td>
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### Scope and Purpose

| 6 State why the MCP being submitted (as part of a Mining Proposal or a reviewed MCP or to fulfil other legal requirements). | Y | Section 1 | Y | Update of information relating to addition of Southern Flank |

### Project Overview
### Mine Closure Plan checklist

<table>
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<tr>
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<tbody>
<tr>
<td>Y</td>
<td>Section 2</td>
<td></td>
<td>Y</td>
<td></td>
<td>Figures updated to cover additional deposits (South Flank)</td>
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</table>

**Land ownership details (include any and management agency responsible for the land / reserve and the purpose for which the land / reserve [including surrounding land] is being managed).**
- Location of the project.
- Comprehensive site plan(s).
- Background information on the history and status of the project.

### Legal Obligations and Commitments

<table>
<thead>
<tr>
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<td>Y</td>
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### Stakeholder Consultation

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<td>N</td>
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| Y   | Section 4|          | Updated with consultation since last submission |
| Y   | Section 4|          | Minor amendments |

### Post-Mining Land Use(s) and Closure Objectives

<table>
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<td>N</td>
<td></td>
<td></td>
<td>Update of information relating to addition of Southern Flank</td>
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| Y   | Section 7|          | Update of information gathered to inform Mining Area C EMP Rev 6 |

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BHP Billiton Iron Ore
Mining Area C Mine Closure Plan
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<tbody>
<tr>
<td>14 Has any soil or groundwater contamination that occurred, or is suspected to have occurred, during the operation of the mine, been reported to DER as required under the <em>Contaminated Sites Act 2003</em>?</td>
<td>Y</td>
<td>Section 7</td>
<td>N</td>
<td></td>
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</table>

**Development of Closure Criteria**

| 15 Does the MCP include an appropriate set of specific closure criteria and closure performance indicators? | Y | Section 6 | N | | | |

**Collection and Analysis of Closure Data**

| 16 Does the MCP include baseline data (including pre-mining studies and environmental data)? | Y | Section 7 | Y | Update of information relating to addition of Southern Flank | | |
| 17 Has materials characterisation been carried out consistent with applicable standards and guidelines (e.g. GARD Guide)? | Y | Section 7 | Y | Update of information relating to addition of Southern Flank | | |
| 18 Does the MCP identify applicable closure learnings from benchmarking against other comparable mine sites? | N | | | | | |
| 19 Does the MCP identify all key issues impacting mine closure objectives and outcomes (including potential contamination impacts)? | Y | Section 8 | Y | Update of information relating to addition of Southern Flank | | |
| 20 Does the MCP include information relevant to mine closure for each domain or feature? | Y | Section 9 | Y | Update of information relating to addition of Southern Flank | | |

**Identification of Management of Closure Issues**

<p>| 21 Does the MCP include a gap analysis/risk assessment to determine if further information is | Y | Section 7; Section 8 | Y | Update of information relating to addition of | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>required in relation to closure of each domain or feature?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Southern Flank</td>
</tr>
<tr>
<td>22 Does the MCP include the process, methodology, and has the rationale been provided to justify identification and management of the issues?</td>
<td>Y</td>
<td>Section 8</td>
<td>Y</td>
<td></td>
<td></td>
<td>Update of information relating to addition of Southern Flank</td>
</tr>
</tbody>
</table>

**Closure Implementation**

<table>
<thead>
<tr>
<th>23 Does the reviewed MCP include a summary of the closure implementation strategies and activities for the proposed operations or for the whole site?</th>
<th>Y</th>
<th>Section 9</th>
<th>Y</th>
<th></th>
<th></th>
<th>Update of information relating to addition of Southern Flank</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Does the MCP include a closure work program for each domain or feature?</td>
<td>Y</td>
<td>Section 9</td>
<td>Y</td>
<td></td>
<td></td>
<td>Update of information relating to addition of Southern Flank</td>
</tr>
<tr>
<td>25 Does the MCP contain site layout plans to clearly show each type of disturbance as defined in Schedule 1 of the MRF Regulations?</td>
<td>Y</td>
<td>Section 1</td>
<td>Y</td>
<td></td>
<td></td>
<td>Update of information relating to addition of Southern Flank</td>
</tr>
<tr>
<td>26 Does the MCP contain a schedule of research and trial activities?</td>
<td>Y</td>
<td>Section 8</td>
<td></td>
<td></td>
<td></td>
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<td>27 Does the MCP contain a schedule of progressive rehabilitation activities?</td>
<td>Y</td>
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<td>Y</td>
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<td>Y</td>
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**Closure Monitoring and Maintenance**

<p>| 31 Does the MCP contain a framework, including methodology, quality control and remedial strategy for closure | Y   | Section 10 |          |                                   |          | N       |</p>
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**Closure Financial Provisioning**

| 32 | Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring? | Y | Section 11 | N | | |
| 33 | Does the MCP include a process for regular review of the financial provision? | Y | Section 11 | N | | |

**Management of Information and Data**

| 34 | Does the mine closure plan contain a description of management strategies including systems and processes for the retention of mine records? | Y | Section 12 | N | | |
BHP Billiton Iron Ore
Mining Area C Mine Closure Plan

Corporate Endorsement:

"I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan and checklist is true and correct and addresses all the requirements of the Guidelines for the Preparation of a Mine Closure Plan approved by the Director General of Mines and Petroleum."

Name: ___________________________ Signed: ___________________________

Position: _________________________ Date: ___________________________

NB: The corporate endorsement section must be given by tenement holder(s) or a senior representative authorised by the tenement holder(s), such as a Registered Manager or Company Director.
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# Abbreviations

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<td>AMD</td>
<td>acid and metalliferous drainage</td>
</tr>
<tr>
<td>ANC</td>
<td>Acid-neutralising capacity</td>
</tr>
<tr>
<td>ARI</td>
<td>Average Recurrence Interval</td>
</tr>
<tr>
<td>AWT</td>
<td>Above Water Table</td>
</tr>
<tr>
<td>BHPBIO</td>
<td>BHP Billiton Iron Ore</td>
</tr>
<tr>
<td>BIF</td>
<td>Banded Iron Formation</td>
</tr>
<tr>
<td>BOCO</td>
<td>Base of complete oxidation</td>
</tr>
<tr>
<td>BWT</td>
<td>Below Water Table</td>
</tr>
<tr>
<td>CAP</td>
<td>Corporation Alignment Planning</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DEC</td>
<td>Department of Environment and Conservation (now the Department of Environment Regulation and the Department of Parks and Wildlife)</td>
</tr>
<tr>
<td>DER</td>
<td>Department of Environment Regulation</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>DPaW</td>
<td>Department of Parks and Wildlife</td>
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<tr>
<td>EC</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<td>EMP</td>
<td>Environmental Management Plan</td>
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<tr>
<td>EMS</td>
<td>environmental management system</td>
</tr>
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<td>EPA</td>
<td>Western Australian Environmental Protection Authority</td>
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<td>EPBC Act</td>
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<td>Geological Database</td>
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<td>Group Level Document</td>
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<td>Ground Well Licence</td>
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<td>IBRA</td>
<td>Interim Biogeographical Regionalisation of Australia</td>
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<td>MCP</td>
<td>Mine Closure Plan</td>
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<tr>
<td>ML/a</td>
<td>Megalitres per annum</td>
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<td>Meaning</td>
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<td>mg/L</td>
<td>milligrams per litre</td>
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<td>Metres in Australian Height Datum</td>
</tr>
<tr>
<td>mbgl</td>
<td>Metres below ground level</td>
</tr>
<tr>
<td>MS</td>
<td>Ministerial Statement</td>
</tr>
<tr>
<td>Mtpa</td>
<td>Million tonnes per annum</td>
</tr>
<tr>
<td>NAF</td>
<td>non-acid forming</td>
</tr>
<tr>
<td>NAPP</td>
<td>net acid production potential</td>
</tr>
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<td>NMD</td>
<td>neutral and metalliferous drainage</td>
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<td>OHP</td>
<td>Ore Handling Plant</td>
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<tr>
<td>OSA</td>
<td>overburden storage area</td>
</tr>
<tr>
<td>PAF</td>
<td>potentially acid forming</td>
</tr>
<tr>
<td>PEAHR</td>
<td>Project Environmental Aboriginal Heritage Review</td>
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<td>PEC</td>
<td>Priority Ecological Community</td>
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<td>PER</td>
<td>Public Environmental Review</td>
</tr>
<tr>
<td>RC</td>
<td>Reverse Circulation</td>
</tr>
<tr>
<td>SRE</td>
<td>short range endemic</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>TEC</td>
<td>Threatened Ecological Community</td>
</tr>
<tr>
<td>TSF</td>
<td>Tailings Storage Facility</td>
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<td>WWTP</td>
<td>Wastewater Treatment Plant</td>
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1. Scope and purpose

1.1. Purpose of plan

This Mine Closure Plan addresses how Mining Area C will be rehabilitated and closed in a manner that satisfies Ministerial Statement of Approval Number (No.) 491 (Appendix A) and in accordance with the Department of Mines and Petroleum (DMP)/Environmental Protection Authority (EPA) Guidelines for Preparing Mine Closure Plans (DMP/EPA, 2015) and BHP Billiton corporate requirements.

This Mine Closure Plan will be used by BHP Billiton Iron Ore and its contractors in the implementation of appropriate rehabilitation and mine closure strategies at the Mining Area C, inclusive of proposed modifications. Where there is any conflict between the provisions of this Mine Closure Plan and other statutory requirements (i.e. licences, permits, consent conditions and relevant laws) the statutory requirements are to take precedence.

The Mine Closure Plan will be revised at intervals of five years. This revision timeline is consistent with the DMP/EPA Guidelines, and with Western Australian Iron Ore’s (WAIO) strategic approach to closure planning across its Pilbara assets.

1.2. Document history

The Mining Area C Mine Closure Plan history is described in Table 1 below.

Table 1: Mining Area C Mine Closure Plan history

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<th>Revision Number</th>
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<td>2004</td>
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<td>Decommissioning and Final Rehabilitation Plan</td>
<td>Activities described in various revisions of the Mining Area C EMP</td>
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<td>2014</td>
<td>1</td>
<td>Mining Area C Mine Closure Plan</td>
<td>Mining Area C EMP Rev 5a (BHP Billiton Iron Ore, 2014)</td>
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<td>2015</td>
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<td>Mining Area C Mine Closure Plan</td>
<td>Mining Area C EMP Rev 6 (BHP Billiton Iron Ore, 2015)</td>
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<td>2016</td>
<td>3</td>
<td>Mining Area C Mine Closure Plan</td>
<td>Mining Area C EMP Rev 6 (2015a) and the Public Environmental Review (PER) submission for additional deposits at Southern Flank (BHP Billiton Iron Ore, 2016a)</td>
</tr>
<tr>
<td>2017</td>
<td>3.1</td>
<td>Mining Area C Mine Closure Plan</td>
<td>Mining Area C EMP Rev 6 (2015a) and the Mining Area C – Southern Flank Response to Submissions – Part 2 (BHP Billiton Iron Ore, 2017) for additional deposits at Southern Flank</td>
</tr>
</tbody>
</table>
1.3. Other relevant Mining Area C management plans

Current mining operations at Mining Area C are conducted in accordance with the ML281SA and current Ministerial Statement of Approval No. 491 (MS 491) (Appendix A) implementation conditions and commitments, which includes the implementation of a number of environmental management plans. These include the:

- Mining Area C Environmental Management Plan Revision 6 (2015a); and
- Central Pilbara Water Resource Management Plan (BHP Billiton Iron Ore, 2016c); and
- Mining Area C Decommissioning and Final Rehabilitation Plan (2004)

1.4. BHP Billiton Iron Ore Business Guidance

BHP Billiton’s Our Charter articulates the corporate vision and core values and what BHP Billiton stands for as an organisation. The first value in the Our Charter is:

Sustainability: putting health and safety first, being environmentally responsible and supporting our communities.

This commitment provides the starting point from where the mine closure and rehabilitation policies and procedures begin. The remaining values are integrity, respect, performance, simplicity and accountability.

A series of Group Level Documents (GLDs) ‘Our Requirements’ that underpin the Charter have been developed, which describe the performance requirements and accountabilities for definitive business obligations, processes, functions and activities. Compliance with the GLDs ensures reputations are managed and minimum standards are met for all BHP Billiton operations.

‘Our Requirements’ are the foundation for developing and implementing management systems. The GLDs considered relevant to Mine Closure include:

- Environment and Climate Change - establishes the performance requirements for the management of land, biodiversity, water, air, greenhouse gases, hydrocarbons and wastes; the latter including waste rock and tailings (BHP Billiton 2016a);
- Risk Management - establishes the performance requirements for the assessment, control, monitoring and reporting of material risks that could impact the purpose and business plans. It includes risk rankings for both environmental and community aspects (BHP Billiton 2016b);
- Corporation Alignment Planning - represents an annual cycle of key activities (known as the CAP cycle) designed to focus the organisation on achieving Our Purpose and Our Strategy by facilitating robust debate, informed decision-making and the disciplined delivery of quality planning outcomes. Mine closure planning is specifically addressed in the annual cycle ensuring closure liabilities, risks and requirements are appropriately managed (BHP Billiton 2016c); and
- Major Capital Projects (Minerals) - defines the performance requirements for the initiation, development, execution, close out and transition to operations phases of minerals (including iron ore) major capital projects. It sets out the minimum study requirements for each of these phases including studies specifically related to closure and rehabilitation planning (BHP Billiton, 2016d).

From the Charter and GLDs flow various business level documents and procedures that provide a framework for the application of the corporate vision and values with respect to mine closure planning and rehabilitation. These include for example:

- WAIO Closure and Rehabilitation Management Strategy, Version 001 (BHP Billiton Iron Ore 2013);
- WAIO Rehabilitation Standard [0001074], Version 2.0 (Appendix F);
- WAIO Closure Provision Procedure [005144], Version 5.0 (BHP Billiton Iron Ore, 2015b);
- WAIO Acid and Metalliferous Drainage Management Standard [0096370], Version 4.0 (BHP Billiton Iron Ore, 2015c);
BHP Billiton Iron Ore
Mining Area C Mine Closure Plan

- BHP Billiton Iron Ore Biodiversity Strategy [0120098], Version 1.0 (BHP Billiton Iron Ore, 2016b);
- WAIO Environment Water Management Standard [0045280], Version 1.0 (BHP Billiton 2012a);
- WAIO Rehabilitation Planning and Execution [SPR-IEI-LEI-13], Version 5.0 (BHP Billiton Iron Ore, 2016f).
- MAu Closure Planning Standard [0133179] Version 1.0 (BHP, 2017),
- Earthworks for Rehabilitation Procedure, [SPR-IEI-LEI-100] version 4.0 (BHP Billiton Iron Ore, 2014a)
2. Project Summary

2.1. Mining Area C overview

Mining Area C open pit iron ore mine (Mining Area C) is located approximately 100 kilometres (km) to the north-west of the town of Newman in the Pilbara region of Western Australia (WA) (Figure 1). Within this Mine Closure Plan, Mining Area C refers to the Proposed Mining Area C Development Envelope (Figure 2). This area contains both the Current Approved Development Envelope (Northern Flank) and the Additional Development Envelope (Table 1). When required these are referenced separately in this document as Northern Flank and Southern Flank, respectively.

An Environmental Impact Assessment (EIA) of BHP Billiton Iron Ore’s proposal to mine 14 iron ore deposits at Northern Flank, Mining Area C (i.e. A, B, C, D, E, F, P1, P2, P3, P4, P5, P6, R and the Brockman Detrital Deposit) was conducted in 1997 via the PER process. The PER (Woodward-Clyde, 1997) provided a detailed EIA of the mining of two of the 14 deposits (i.e. C Deposit and the Brockman Detrital Deposit). The PER was assessed by WA Environmental Protection Authority (EPA) Bulletin No. 913 in 1998, and MS 491, see Appendix A) was issued by the Minister for the Environment in December 1998 under Part IV of the Environmental Protection Act, 1986 (EP Act). The PER and MS 491 specified that mining of additional deposits at Mining Area C would be contingent on review and revision of the Area C Life of Mine Environmental Management Plan (EMP).

Mining operations at Northern Flank, Mining Area C commenced in August 2003 operating under MS 491 (Figure 2). BHP Billiton Iron Ore prepared an initial draft EMP which was appended to the PER (Woodward-Clyde, 1997). To date, there have been six revisions of the EMP to mine a further eight deposits: A, B, D, E, F, R, P1, P2, P3, P4, P5 and P6. BHP Billiton Iron Ore has submitted a PER in order to access the additional deposits at Southern Flank (Highway, Grand Central, and Vista), including additional overburden storage areas (OSAs) and development of associated infrastructure to support mining operations within the Proposed Mining Area C Development Envelope (Figure 2). The long-term strategy for Mining Area C is to continue operations to 2073.

Table 2: Terminology for the Mining Area C Approved and Proposed Development Envelopes

<table>
<thead>
<tr>
<th>Lease</th>
<th>Description</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 Approved Mining Area C (Northern Flank) Development Envelope and the Additional Development Envelope and will constitute the boundary of the new Ministerial Statement, if approved</td>
</tr>
<tr>
<td>Approved Mining Area C (Northern Flank) Development Envelope</td>
<td>This spatial area is the boundary of the currently approved area defined as the Development Envelope under MS 491</td>
</tr>
<tr>
<td>Approved Impact Assessment Area</td>
<td>This is the spatial area that was assessed and approved in line with Condition 7 of MS 491 via EMP Revision 6 in January 2016</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>
</tbody>
</table>
Figure 1: Mining Area C regional location
Figure 2: Mining Area C overview and proposed development
2.1.1. Ownership

The Mining Area C mine is situated within ML281SA which is operated by BHP Billiton Iron Ore as the authorised manager on behalf of the Mount Goldsworthy Joint Venture, details of this tenement are provided in Table 2. The Mount Goldsworthy Joint Venture operates in relation to the rights and benefits granted under the Iron Ore (Mount Goldsworthy) Agreement Act 1964 (WA).

The Mount Goldsworthy Joint Venture partners are as follows:

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

The contact details for BHP Billiton Iron Ore are:
BHP Billiton Iron Ore Pty Ltd
City Square
125 St Georges Terrace
PERTH WA 6000
Phone: 6321 6000

Table 3: Tenements applicable to the Mining Area C mining operations

<table>
<thead>
<tr>
<th>Lease</th>
<th>Description</th>
<th>Grant date</th>
<th>Expiry date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML281SA</td>
<td>Mineral Lease 281SA</td>
<td>26 April 2002</td>
<td>4 August 2028</td>
</tr>
</tbody>
</table>

2.1.2. Overview of operations

BHP Billiton Iron Ore uses open pit mining techniques, ore processing methods, and supporting mine infrastructure (with allowance for ongoing maintenance and replacement of worn-out components) over the life of the Mining Area C. It is currently licenced to produce 65 million tonnes per annum (Mtpa) of iron ore and undertaking the approval process to expand production up to 150 Mtpa, which is blended into stockpiles and railed to Port Hedland for shipping to overseas customers.

The main components of the mine based on the current life of mine plan are as follows:

- mining of ore from orebodies using conventional, progressive, open pit mining methods;
- mine dewatering in order to access ore located below the water table;
- Reverse Circulation (RC) and diamond exploration drilling;
- disposal of overburden from the open pits into adjacent ex-pit overburden storage areas (OSA) and as infill in mined out sections of the pits;
- crushing and screening of ore at two ore handling plants (OHP1 and OHP2) and up to two additional ore handling plants at Southern Flank;
- lump and fine product transfer via conveyors into stockpiles located in stockyard areas (i.e. Stockyard Nos. 1 and 2);
- use of rail load-out facilities and a railway spur to Mining Area C;
- groundwater abstraction using a network of bores and in-pit sumps to meet the water demand for the site;
stormwater management transfer and storage facilities (currently the eastern and western sediment control ponds);
water disposal infrastructure;
domestic waste water treatment plants (WWTPs) including the Packsaddle Treatment Ponds;
waste management facilities (including inert, putrescible and rubber dumps);
Camps and associated infrastructure including Packsaddle Accommodation Village and Mulla Mulla Village;
Coondewanna Aerodrome;
electricity delivered to site via overhead transmission lines with backup power supplied by an onsite diesel power generation facility;
construction and operation of internal access roads, service roads and haul roads;
use of workshops (Central and Eastern), consumable storage areas, offices, and other service facilities (such as the bulk ammonium nitrate and explosive storage facility) and infrastructure required (including fuel storage areas, refuelling stations and washdown facilities) for the operation of the mine;
continued use of ore processing facilities; and

Fly-in / fly-out workforce of approximately 1,800 workers when operating at expanded capacity.

Further details on the overview of operations are provided in EMP Revision 6 (BHP Billiton Iron Ore, 2015a) and the Southern Flank PER (BHP Billiton Iron Ore, 2016a). The proposed layout of the Mining Area C project is provided in Figure 2 showing the locations of key components of the project.

2.2. Closure features and domains

To facilitate effective mine closure planning, the Mining Area C mining operations have been divided into a number of physically distinct domains and features (Table 4 and Figure 2). The domains are comprised of features that have similar rehabilitation and closure requirements.

Table 4: Domains and features of the operations

<table>
<thead>
<tr>
<th>Domain</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overburden Storage Areas</td>
<td>OSA 1 to OSA 14 (Northern Flank); and OSA 31-41 (Southern Flank)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Administration offices; fuel storage facilities; refuelling stations; washdown facilities; light and heavy vehicle workshops; warehouses; aerodrome; ammonia nitrate storage facilities; train load-out; ore crushing and processing facilities (including conveyors); camps, WWTPs; putrescible landfill; inert landfill; rubber dump; fibrous material dump; and contaminated soil stockpiling.</td>
</tr>
<tr>
<td>Mine Voids</td>
<td>A, B, C, D, E, F, P1, P2, P3, P4, P5, P6, R, Brockman Detrital deposits (Northern Flank); and Highway, Grand Central, and Vista deposits (Southern Flank)</td>
</tr>
<tr>
<td>Roads and Rail</td>
<td>Main access road; haul roads; access tracks; railway</td>
</tr>
</tbody>
</table>

2.3. Proposed Mining Area C expansion

The 14 mining deposits for Northern Flank under EMP Revision 6 (BHP Billiton Iron Ore, 2015) are A, B, C, D, E, F, P1, P2 P3, P4, P5, P6, R, the Brockman Detrital deposits, and for Southern Flank through the PER process are Highway, Grand Central and Vista (Table 5). Open pits that are currently being
developed (active mining) include A, B, C, D, E, F, P1, P3 and P4, where deposits are yet to be developed.

Table 5: Mining Area C approved and proposed deposits

<table>
<thead>
<tr>
<th>Approved deposits described under EMP Revision 6 (above / below water table)</th>
<th>Proposed Southern Flank Development (above / below water table)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (above water table (AWT)/below water table (BWT))</td>
<td>Highway (AWT/BWT)</td>
</tr>
<tr>
<td>B (AWT/BWT)</td>
<td>Grand Central (AWT/BWT)</td>
</tr>
<tr>
<td>C (AWT/BWT)</td>
<td>Vista (AWT/BWT)</td>
</tr>
<tr>
<td>D (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>E (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>F (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>R (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>P1 (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>P2 (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>P3 (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>P4 (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>P5 (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>P6 (AWT/BWT)</td>
<td></td>
</tr>
<tr>
<td>Brockman Detrital (AWT)</td>
<td></td>
</tr>
</tbody>
</table>

The development plans for each of the 17 pits for construction include:

- dedicated ex-pit OSAs, ore stockpile locations and a strategy for backfill (where available and required to sustain ecohydrological receptors);
- progressive construction of haul roads and light vehicle access roads to the open pits, OSAs and mine infrastructure;
- installation of flood protection bunds and surface water management infrastructure, where required; and
- progressive formation of mine closure structures such as closure safety bunds and profiling of OSAs.
3. Closure obligations and commitments

The management measures contained within this Mine Closure Plan have been developed with reference to State government rehabilitation requirements, policies and guidance statements, which are summarised below.

3.1. Environmental Protection Act 1986

Mining Area C has been issued an environmental licence to operate under Part V of the EP Act, for the regulation of prescribed premises (prescribed premises listed under Schedule 1 of the Environmental Regulations 1987). Mining Area C environmental operating licence L7851/2002/6 recognises seven categories under Schedule 1 of the Environment Protection Regulations 1987, for regulation (listed below):

- Category 5: Processing or beneficiation of metallic or non-metallic ore;
- Category 6: Mine dewatering;
- Category 54: Sewage facility;
- Category 63: Class I inert landfill site;
- Category 73: Bulk storage of chemicals;
- Category 85B: Water desalinisation plant; and
- Category 89: Putrescible landfill site.

Mining Area C has been provided with a disturbance boundary, assessed in accordance with Part IV of the EP Act. This disturbance boundary and indicative pits and OSAs are depicted in Figure 2.

The EPA provides guidance notes and position statements relevant to mine closure including:

- EPA Position Statement Number 2: Environmental Protection of Native Vegetation in Western Australia (2000).
- EPA Position Statement Number 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (2004a).

3.1.1. Ministerial Statement

Legally binding commitments for Mining Area C in MS 491 (provided in Appendix A) that are of particular importance to this Mine Closure Plan are shown in Table 6.
Table 6: Ministerial Conditions related to Closure and Rehabilitation

<table>
<thead>
<tr>
<th>Commitment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Development of a “Life of Project” Environmental Management Plan</td>
</tr>
<tr>
<td>The proponent will prepare and implement a &quot;Life of Project&quot; Environmental Management Plan (EMP) for mining operations within the Northern Flank of Mining Area C. The proponent will address and manage the following environmental factors:</td>
<td></td>
</tr>
<tr>
<td>2. Vegetation and topsoil</td>
<td>10. Dust</td>
</tr>
<tr>
<td>3. Overburden storage</td>
<td>11. Waste and hazardous materials</td>
</tr>
<tr>
<td>4. Surface water</td>
<td>12. Rehabilitation</td>
</tr>
<tr>
<td>5. Groundwater</td>
<td>13. Decommissioning</td>
</tr>
<tr>
<td>6. Flora</td>
<td>14. Contracting; and</td>
</tr>
<tr>
<td>8. Aboriginal heritage</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Additional Surveys</td>
</tr>
<tr>
<td>The proponent will undertake additional surveys on areas other than Deposit C and Brockman Detrital Deposit to assess potential environment impacts. The proponent will address and manage the following environmental factors:</td>
<td></td>
</tr>
<tr>
<td>2. Vegetation and topsoil</td>
<td>10. Dust</td>
</tr>
<tr>
<td>3. Overburden storage</td>
<td>11. Waste and hazardous materials</td>
</tr>
<tr>
<td>4. Surface water</td>
<td>12. Rehabilitation</td>
</tr>
<tr>
<td>5. Groundwater</td>
<td>13. Decommissioning</td>
</tr>
<tr>
<td>6. Flora</td>
<td>14. Contracting; and</td>
</tr>
<tr>
<td>8. Aboriginal heritage</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pyritic Shales</td>
</tr>
<tr>
<td>The proponent will manage any potentially reactive pyritic shales as part of the EMP within overburden storage areas and/or in-pit to prevent acid generation processes occurring.</td>
<td></td>
</tr>
</tbody>
</table>

Commitments 1 and 2, relating to Life of Project EMP and additional surveys respectively include rehabilitation and decommissioning specifically. Also included in these commitments are various other factors, of which are all encompassing to closure.

3.1.2. Mining Act 1904

The Mining Area C operation operates wholly within ML281SA (ID AML7000281) issued under the Mining Act 1904, therefore the Mining Act 1978 is not applicable.

3.1.3. State Agreement Act


The State Agreement Acts essentially defer environmental compliance (including closure and rehabilitation) to the applicable environment legislation.

In regards infrastructure; prior to removing the rail rolling stock, equipment and removable buildings BHP Billiton Iron Ore is required to notify the State in writing, giving the option for the State to purchase the infrastructure subject to valuation.

### 3.1.4. Cultural Heritage

The Mining Area C mining lease (ML281SA) predominately (i.e. 99% of total area) falls within the boundary of the Banjima People determined native title area [Claim No. WC2011/006]. Two small portions (0.7 % and 0.3% of ML281SA) fall within the registered claims of Nyiyaparli #3 [Claim No. WC2013/003] and Yinawangka Part A [Claim No. WC2010/016] respectively. At the time of development, due to then overlapping native title claims, BHP Billiton Iron Ore entered into project development agreements with the Inawonga Banyjima Niapaili (IBN) [Claim No. WC 96/061] and the Martu Idja Banyjima (MIB) [Claim No. WC 98/062] respectively. Negotiations have now completed with all native title groups and see the MIB Agreement terminated and replaced with comprehensive agreements between BHP Billiton and Banjima, Nyiyaparli and Yinawangka respectively. The existing IBN Agreement remains in place.

When operations have an impact within the respective native title claim, these Agreements contractually oblige BHP Billiton Iron Ore to consult with the traditional owners in relation to the operation of the Project and, therefore, its eventual closure. Traditional Owner groups, during development of the Pilbara Public Environmental Review Strategic Proposal (BHP Billiton Iron Ore, 2016d), expressed that they are actively seeking engagement and involvement in mine rehabilitation and seek to ensure that the post-mining land use is able to sustain traditional land management and cultural practices (Preston Consulting 2016).

Practical examples of consultation would likely include: providing the earliest reasonable notice of potential mine closure to the Traditional Owners; quantifying the impact this may have on native title royalty payments; providing overviews of proposed environmental or cultural heritage remediation; and identification of appropriate Indigenous involvement or business contracting opportunities.

### 3.2. Closure guidelines and industry standards

BHP Billiton Iron Ore governs closure planning, on a corporate level, by ‘Our Requirements’ Corporation Alignment Planning (BHP Billiton, 2016a). The purpose of this document is to ensure closure planning is included in the Business Planning Processes throughout the life-cycle of a project.

This Mine Closure Plan has been prepared to satisfy the relevant components of BHP Billiton’s Corporation Alignment Planning process, and finalised for external review in line the DMP/EPA Guidelines. In addition, this Mine Closure Plan incorporates relevant aspects from other closure guidelines and industry standards. A list of relevant publications is provided below.

- *Strategic Framework for Mine Closure* (Minerals Council of Australia (MCA), and the Australian and New Zealand Minerals and Energy Council (ANZMEC), (MCA/ANZMEC, 2000).
- *Mine Closure and Completion* (Department of Industry, Tourism and Resources, 2006a)
- *Managing Acid and Metalliferous Drainage* (Department of Industry, Tourism and Resources, 2007).
- *Mine Rehabilitation* (Department of Industry, Tourism and Resources, October 2006b).
- *Global Acid Rock Drainage (GARD) Guide* (Internal Network for Acid Prevention, 2014)
4. Stakeholder consultation

4.1. Objectives

BHP Billiton’s WAIO Stakeholder Engagement Management Plan states that wherever the Company operates it will:

"engage regularly, openly and honestly with our host governments and people affected by our operations, and take their views and concerns into account in our decision making."

BHP Billiton Iron Ore recognises the importance of engaging with relevant stakeholders. The ability to build relationships and work collaboratively and transparently with our host communities is critical to the Company’s long-term success. BHP Billiton Iron Ore has established a comprehensive consultation programme to support ongoing, effective dialogue with stakeholders potentially impacted by, or interested in, the implications of the Company’s operations. This approach is consistent with BHP Billiton Iron Ore’s Charter that states a commitment to supporting communities and the BHP Billiton Code of Business Conduct that articulates how this underpins how the Company does business:

“ Our ability to build relationships and work collaboratively and transparently with our host communities is critical to our long-term success. Our aim is to be the company of choice, valued and respected by the communities in which we operate. We do this by engaging regularly, openly and honestly with people affected by our operations, and by taking their views and concerns into account in our decision-making.”

BHP Billiton Iron Ore is currently undertaking an ongoing consultation programme relating to its Mining Area C operations with government agencies (both State and local), non-government organisations and land-users that have expressed interest in, or are directly impacted by a proposed project. The objectives of the programme are to:

- provide information and the opportunity to comment to government agencies and other stakeholders who may potentially be interested in activities (including closure and rehabilitation) at Mining Area C;
- identify the key issues and concerns of government agencies and other stakeholders in regards to the design and management of activities (including closure and rehabilitation) at Mining Area C;
- discuss objectives for the development of Mining Area C and its ultimate rehabilitation and closure;
- periodically provide updated information and results of the development and closure planning process to government agencies and other stakeholders as more information comes to hand; and
- allow for adjustments to the design and/or management of any proposed activities to accommodate concerns or issues raised by government agencies and other stakeholders, where relevant.

As part of the broad consultation programme for Mining Area C, BHP Billiton Iron Ore consults with identified stakeholders on closure related issues during each project phase (pre-approval, operations, rehabilitation and post closure) to ensure that legal requirements, risks and internal and external stakeholder expectations for closure at Mining Area C are taken into account at the appropriate time and as far as practicable.
4.2. Consultation

BHP Billiton Iron Ore's commitment to community engagement is articulated in the Company’s Code of Business Conduct (BHP Billiton, 2016e), 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.”

In line with DMP/EPA Guidelines (2015), BHP Billiton Iron ore considers the key stakeholders to be post-mining owners or managers and relevant regulators.

The current focus of the Mining Area C closure consultation is primarily with the key stakeholders: Department of Environmental Regulation, Office of the Environmental Protection, Department of Mines and Petroleum, and Traditional Owners (Banjima and Nyiyparli People). Consultation undertaken to date is recorded in Table 7.

As Mining Area C approaches cessation of mining closure specific consultation will increase with broader stakeholder groups such as those listed below.

**State Government agencies:**
- Department of Environment and Regulation;
- Department of Mines and Petroleum;
- Department of State Development;
- Department of Parks and Wildlife;
- Department of Planning;
- Department of Water;
- Main Roads Western Australia;
- Office of the Environmental Protection Authority;
- Department of Aboriginal Affairs;
- Department of Health;
- Heritage Council of WA; and
- Department of Regional Development and Lands: Office of Pilbara Cities.

**Shires, Local Governments and politicians:**
- Shire of East Pilbara;
- Shire of Ashburton
- Pilbara Development Commission;
- Newman Chamber of Commerce and Industry;
- Local Member for the Pilbara;
- Minister for Environment; Water;
- Minister for Mines and Petroleum;
- Minister for Heritage; Local Government; and
- Minister for Regional Development.
Local and regional groups

- Wildflower Society of WA;
- Tourism Operators;
- Greening Australia; and
- Conservation Council of WA.

Traditional owners and community

- Traditional Landowners: Banyjima and Nyiyaparli People;
- Other mining companies;
- Pastoral Station Manager; and
- Newman Community Consultative Group.
Table 7: Summary of recent stakeholder consultation regarding Mining Area C closure management

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Date</th>
<th>Purpose</th>
<th>Issues Discussed</th>
<th>BHP Billiton Iron Ore Follow up/response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional owners (Innawonga Banyjima</td>
<td>12/12/2000</td>
<td>Project development agreement</td>
<td>BHP Billiton Iron Ore entered into a comprehensive project development agreement with Innawonga Banyjima Niyapaili.</td>
<td>-</td>
</tr>
<tr>
<td>Niapaili)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional owners (Martu Idja Banyjima)</td>
<td>26/05/2001</td>
<td>Project development agreement</td>
<td>BHP Billiton Iron Ore entered into a comprehensive project development agreement Martu Idja Banyjima.</td>
<td>-</td>
</tr>
<tr>
<td>Department of Industry and Resources (now DMP)</td>
<td>15/02/2008</td>
<td>Discuss scope of EMP Revision 4</td>
<td>- Numbering of OSAs; Progressive clearing; Waste rock characterisation; Waste rock management; Cumulative visual impacts; Final landforms; Potential dewatering impacts at Weeli Wolli Spring; and Monitoring of Mulga</td>
<td>-</td>
</tr>
<tr>
<td>Shire of East Pilbara</td>
<td>04/05/2012</td>
<td>Mining Area C EMP Revision 5 proposed development</td>
<td>Mining Area C EMP Revision 5 proposed development.</td>
<td>-</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Date</td>
<td>Purpose</td>
<td>Issues Discussed</td>
<td>BHP Billiton Iron Ore Follow up/response</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-----------------------</td>
<td>---------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Newman Community and Consultative Group</td>
<td>16/05/2012</td>
<td>Mining Area C EMP Revision 5 proposed development</td>
<td>Mining Area C EMP Revision 5 proposed development</td>
<td></td>
</tr>
<tr>
<td>OEPA</td>
<td>18/04/2012; 23/04/2012; 16/05/2012; 05/09/2012</td>
<td>Mining Area C EMP Revision 5 proposed development</td>
<td>Mining Area C EMP Revision 5 proposed development.</td>
<td></td>
</tr>
<tr>
<td>DEC (now DER and DPaW)</td>
<td>03/09/2012</td>
<td>Mining Area C EMP Revision 5 proposed development</td>
<td>Mining Area C EMP Revision 5 proposed development.</td>
<td>BHP Iron Ore committed to further consult with DEC prior to disturbance of AC Cave 3 within the P4 footprint and undertake appropriate regional research to better understand Ghost Bat maternity roosts in the Hamersley Ranges.</td>
</tr>
<tr>
<td>DMP</td>
<td>16/12/2013</td>
<td>Closure and rehabilitation update meeting</td>
<td>Closure and Rehabilitation Regional Management Strategy.</td>
<td>None at this stage</td>
</tr>
<tr>
<td>DMP</td>
<td>16/12/2013</td>
<td>Closure and rehabilitation update meeting</td>
<td>BHP Billiton Iron Ore engagement with the DMP regarding Closure Plan submissions.</td>
<td>BHP Billiton Iron Ore will provide a list of the scheduled revisions for Closure Plan updates and coordinate update sessions in advance of the Closure Plan submissions.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Date</td>
<td>Purpose</td>
<td>Issues Discussed</td>
<td>BHP Billiton Iron Ore Follow up/response</td>
</tr>
<tr>
<td>----------------------------</td>
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<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>DMP</td>
<td>17/03/2014</td>
<td>Closure Planning update</td>
<td>Provided Hard copy (pdf soft copy by email) of the Draft Closure and Rehabilitation Management Strategy for DMP consultation.</td>
<td>Not applicable (NA)</td>
</tr>
<tr>
<td>DMP</td>
<td>17/03/2014</td>
<td>Closure Planning update</td>
<td>Provided an overview of upcoming work to be carried out over the next 12 months of closure plans that are anticipated to be submitted to EPA/DMP.</td>
<td></td>
</tr>
</tbody>
</table>
| DER Contaminated Sites Branch | 8/4/2014 | BHP Billiton Iron Ore Contaminated sites debrief | Discussed the risk based management approach adopted by BHP Billiton Iron Ore for its suspected and known contaminated sites at its Pilbara operations. Presentations delivered showing current status of contaminated sites management at the three hubs (i.e. Eastern, Infrastructure and Central). Key issues at Mining Area C discussed:  
  - 20 contaminated sites identified; and | BHP Billiton Iron Ore to arrange annual BHP Billiton Iron Ore Contaminated Sites Debrief with DER.                                                                                           |
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Date</th>
<th>Purpose</th>
<th>Issues Discussed</th>
<th>BHP Billiton Iron Ore Follow up/response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Highest ranked sites still considered to be low when compared with other BHP Billiton Iron Ore sites.</td>
<td></td>
</tr>
<tr>
<td>DOW</td>
<td>14/04/2014</td>
<td>Closure Planning update</td>
<td>Provided an overview of the Closure and Rehabilitation Regional Management Strategy.</td>
<td>NA</td>
</tr>
<tr>
<td>DOW</td>
<td>14/04/2014</td>
<td>Closure Planning update</td>
<td>Mine Area C Closure Strategy (water focus) demonstrating the application of the Regional Management Strategy approach. Overview of upcoming Closure Plan update content. Discussed the maturity of hydrogeology understanding (conceptual modelling vs predictive numerical modelling) for the project, third party and cumulative impact considerations. Noted numerical predictions will not be presented in the upcoming Closure Plan submission with stakeholder engagement on the predictive outcomes planned over upcoming months/years in advance of the next Closure Plan update.</td>
<td>Discussed waste scheduling noting the business improvement in process to characterised waste based on erosion competency and scheduling accordingly.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Date</td>
<td>Purpose</td>
<td>Issues Discussed</td>
<td>BHP Billiton Iron Ore Follow up/response</td>
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<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>OEPA</td>
<td>02/05/14</td>
<td>Closure Planning update</td>
<td>Mine Area C Closure Strategy, demonstrating the application of the Regional Management Strategy approach. Overview of upcoming Closure Plan update. Discussed stakeholder consultation, progressive rehabilitation and closure plan updates related to future EMP updates.</td>
<td>Contaminated sites are addressed in the closure plan and there has been consultation with the DER Contaminated Sites Branch. Closure assessment would be included in EMP update process, updating the closure plan will depend on the extent of the change and timing in relation to schedule closure plan updates.</td>
</tr>
<tr>
<td>DMP</td>
<td>27/8/15</td>
<td>Closure Planning update</td>
<td>Advised on upcoming Closure Plan submission for Mining Area C, BHPBIO offered deep dive presentation for assessing officer</td>
<td>MCP provided to DMP for review</td>
</tr>
<tr>
<td>DOW</td>
<td>19/8/15</td>
<td>Closure Planning update</td>
<td>Overview of Mining Area C Revision 2 Closure Plan update, noting alignment between PWMRS and the closure approach</td>
<td>MCP provided to DoW for review</td>
</tr>
<tr>
<td>Banjima Implementation Committee</td>
<td>26/5/16</td>
<td>Overview of Southern Flank PER 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>Stakeholder</td>
<td>Date</td>
<td>Purpose</td>
<td>Issues Discussed</td>
<td>BHP Billiton Iron Ore Follow up/response</td>
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</tr>
<tr>
<td>OEPA</td>
<td>05/09/16</td>
<td>Southern Flank PER briefing</td>
<td>Preliminary view of BHPBIOs understanding around key environmental issues (groundwater impact, biodiversity setting and AMD/Pit Lake formation) for Southern Flank PER submission</td>
<td>An outcomes based approach for backfilling BWT pit voids Southern Flank is described within the Mining Area C Closure Rev 3.</td>
</tr>
<tr>
<td>Nyiyaparli Environment Subcommittee</td>
<td>7/9/16</td>
<td>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 PER was outlined and discussed.</td>
<td>BHP Billiton Iron Ore committed to supply draft PER and MCP to group and offered additional briefings prior to public submissions period.</td>
</tr>
<tr>
<td>Banjima Environment</td>
<td>14/9/16</td>
<td>Southern Flank PER briefing and 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 PER was outlined and discussed.</td>
<td>BHP Billiton Iron Ore committed to supply draft PER and MCP to group and offered additional briefings prior to public submissions period.</td>
</tr>
<tr>
<td>DMP</td>
<td>13/10/2016</td>
<td>Advising of upcoming Closure Plan update submission</td>
<td>Advised of Mining Area C Closure Plan update to include additional deposits of Southern Flank. Offered briefing to assessing officer as required.</td>
<td>Noted.</td>
</tr>
<tr>
<td>OEPA/DMIR/DoW/DPaW</td>
<td>25/10/2017</td>
<td>Southern Flank PER submission and Response to Submissions</td>
<td>Feedback received regarding: Stakeholder consultation regarding post-mining landuse Rehabilitation schedule Closure objectives developed during life of mine.</td>
<td>MCP updated to address feedback. Specific responses provided in Mining Area C – Southern Flank Response to Submissions – Part 2.</td>
</tr>
</tbody>
</table>
## Stakeholder Meeting Issues

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Date</th>
<th>Purpose</th>
<th>Issues Discussed</th>
<th>BHP Billiton Iron Ore Follow up/response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fauna habitat and monitoring</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OSA placement within flood zones</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vegetation connectivity</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Protection of PEC’s post closure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rehabilitation using <em>Corymbia hamersleyana</em></td>
<td></td>
</tr>
</tbody>
</table>
The Mining Area C operations consultation program has been developed based on the continuity of operations in this area through the utilisation of infrastructure and processing.

An indicative stakeholder consultation program for the Mining Area C consultation in advance of the next update of the Mining Area C closure plan update (five yearly cycle) is shown in Table 8.

**Table 8: Five year forecast stakeholder consultation program**

<table>
<thead>
<tr>
<th>Stakeholder(s)</th>
<th>Timing</th>
<th>Communications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional owners: Nyiyaparli and Banjima</td>
<td>Ongoing as part of regular stakeholder consultation (nominally associated with any new development proposals, at a minimum with each Mine Closure Plan update).</td>
<td>Closure strategy and final land use consultation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mine Closure Plan technical studies update briefings.</td>
</tr>
<tr>
<td>Shire of East Pilbara</td>
<td>Prior to Referral</td>
<td>Advise key stakeholders that the Project is referred to Government</td>
</tr>
<tr>
<td>OEPA, DMIR</td>
<td>Ongoing as part of regular stakeholder consultation (nominally associated with any new development proposals, at a minimum with each Mine Closure Plan update).</td>
<td>Closure strategy and final land use consultation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mine Closure Plan technical studies update briefings.</td>
</tr>
<tr>
<td>DOW</td>
<td>Ongoing as part of regular stakeholder consultation (nominally associated with any new development proposals, at a minimum with each Mine Closure Plan update).</td>
<td>Seek technical review of potential impacts to surface water and groundwater quality and quantity which may arise from the Project and BHP Billiton Iron Ore’s proposed management and mitigation measures.</td>
</tr>
<tr>
<td>DPaW</td>
<td>Consultation will be undertaken as part any new development as needed.</td>
<td>Seek technical review of potential impacts to identified signification species which may arise from the Project and BHP Billiton Iron Ore’s proposed management and mitigation measures.</td>
</tr>
<tr>
<td>Juna Downs Pastoral Station</td>
<td>Ongoing as part of regular stakeholder consultation</td>
<td>Seeking technical input to potential final land use pastoral activities.</td>
</tr>
</tbody>
</table>
5. Post mining land use and closure objectives

In line with BHP Billiton’s Charter, we demonstrate environmental responsibility by minimising environmental impacts and contributing to enduring benefits to biodiversity, ecosystems and other environmental resources (BHP Billiton, 2016).

5.1. Closure and Rehabilitation Standards

BHP Billiton Iron Ore employs the Minerals Australia Closure Planning Standard (BHP, 2017) and Rehabilitation Standard (Appendix F) across its Pilbara sites. The Closure Standard provides the overarching framework for the development of the mine closure strategy and supporting closure provision. The Rehabilitation Standard (Appendix F) provides the overarching framework for successful restoration of areas impacted by BHP Billiton Iron Ore operations in the Pilbara.

The Standards provide a consistent approach for closure and rehabilitation across BHP Billiton Iron Ore’s WAIO operations.

5.2. Objective and guiding principles

The BHP Billiton Iron Ore’s closure and rehabilitation objective is to:

*Develop a safe, stable, non-polluting and sustainable landscape that is consistent with key stakeholder agreed social and environmental values and aligned with creating optimal business value.*

To guide the development and implementation of mine closure and rehabilitation for the Pilbara operations, BHP Billiton Iron Ore has established a set of guiding closure principles which are applied to Mining Area C:

The current Guiding Closure Principles for BHPBIO Pilbara operations are as follows:

- **Final land use:** Stakeholder consultation including government, non-government organisations and community undertaken in the development of post-mining end land use objectives and site specific completion criteria during operations.

- **Land management:** Is compatible with a whole-of-lease sustainable management approach, so that rehabilitated areas can be integrated into local land management practices, and management requirements (e.g. maintenance of access tracks, fire) are not greater than those of areas prior to mining, or where extra management actions may be required, a mechanism has been put in place for addressing these.

- **Safety:** There will be no unsafe areas where members of the general public could inadvertently gain access. Unauthorised public access risk will be managed through the implementation of controls in accordance with regulatory requirements and consideration of industry guidance.

- **Landforms:** Physically interface appropriately with adjacent features, considering natural hydrological linkages and ensuring surface landform stability. Visual impact assessment, mine waste characterisation (physical, geochemical) hydrology and

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1 Key stakeholders refers to post-mining land owners or managers and relevant regulators (DMP and EPA, 2015)
hydrogeological predictive modelling and surface landform stability assessment will inform final landform design (including overburden storage areas, tailings storage facilities, pit void walls and pit lakes) to achieve the closure objective.

**Mine Planning:**
Closure and rehabilitation requirements are integrated into mine plans (directional and delivery horizons) to achieve optimum business value and the guiding principles.

**Ecosystem Sustainability:**
Areas demonstrated to be sustainable, resilient, and capable of meeting objectives relating to agreed final land use in terms of flora, vegetation, fauna, and surface and groundwater hydrology.

**Water:**
Manage the range of potential hydrological changes (groundwater, surface water and/or soil moisture) resulting from operations impacting on receiving receptors to an acceptable level post closure.

** Decommissioning:**
Infrastructure decommissioning and removal is undertaken (where transfer to another party is not agreed). This includes below ground structures and services as applicable to manage post-mining impact.

** Contaminated sites:**
Prevent and manage contaminated sites in accordance with regulatory requirements

** Human Resource:**
Develop and execute a strategy for BHPBIO employees affected by closure. Strategy to include; retention, transition and redundancy programs.

** Community Assets:**
Through consultation with the community, develop and execute a strategy to manage the transition of community assets and programs (owned and managed by BHPBIO) which are affected by closure.

The Objective and Guiding Closure Principles provide the foundation for developing site specific Completion Criteria for Mining Area C (see Section 6).

**5.3. Final land use**
A base case final land use of native pastoral ecosystem, capable of supporting low intensity grazing was established through consultation with stakeholder groups during development of the “Pilbara Public Environmental Review Strategic Proposal” (BHP Billiton, 2016a) for BHP’s suite of mines including Mining Area C. This land use is also consistent with most pre-mining landuse.

This base case land use provides an interim target to which closure and rehabilitation planning can work towards. Notwithstanding, the most likely final land use for the lease area is shown in Table 9.

Further consultation with stakeholder groups will be undertaken during the life of mine to ensure mine closure outcomes remain consistent with stakeholder expectations. Table 8 outlines additional consultation to take place over the next five years.
Table 9: Provisional final land use by site domain

<table>
<thead>
<tr>
<th>Domain</th>
<th>Post closure land use</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSAs</td>
<td>Areas will support native grasslands</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Areas will support low intensity grazing</td>
</tr>
<tr>
<td>Mine Voids</td>
<td>Areas may not support a specific post-closure land-use due to ingress/egress restrictions. Further assessment required as design of mine voids management measures (including in pit OSAs) progresses</td>
</tr>
<tr>
<td>Roads and Rail</td>
<td>Areas will support low intensity grazing</td>
</tr>
</tbody>
</table>
6. Completion criteria

Completion criteria are the measures against which implementation of closure objective and guiding principles can be assessed. As closure objectives and guiding principles cover a broad spectrum of outcomes, so must the completion criteria for example; final land use, safety, landform, sustainability, hydrology, decommissioning, contaminated sites and land management.

BHP Billiton Iron Ore will continue to work with regulators and stakeholders to refine the completion criteria for Mining Area C mining operations in order to produce robust measures for closure completion.

6.1. Basis for development

Working completion criteria for Mining Area C operations have been developed with reference to the following sources of information:

- Relevant guidelines and codes of practice issued by the Australian and WA Governments, which currently includes:
  - Guidelines for Preparing Mine Closure Plans (DMP/EPA, 2015);
  - Rehabilitation of Terrestrial Ecosystems (EPA, 2006); and

- Key guidelines on mine site closure and rehabilitation issued by industry and international councils that are relevant to Mining Area C, including:
  - the Strategic Framework for Mine Closure (Australian and New Zealand Minerals and Energy Council (ANZMEC) and the Minerals Council of Australia (MCA); (MCA/ANZMEC, 2000);
  - International Council on Mining and Minerals (ICMM) - Good Practice Guidance for Mining and Biodiversity (ICMM, 2006);
  - the Planning for Integrated Mine Closure Toolkit (International Council on Mining and Minerals (ICMM), (ICMM, 2008); and

Development of the completion criteria for Mining Area C will integrate a number of key components related to the establishment, monitoring and management of rehabilitation including:

- rehabilitation objectives, including ecological completion criteria, must be achievable and based on the findings of relevant monitoring and research programs;
- rehabilitation performance will be measurable using accepted monitoring and performance indicators;
- rehabilitation must be sustainable under the designated post-mining land use;
- progressive rehabilitation initiated during early mine design stages, involving material chemical and physical characterisation to inform the design of overburden storage areas and plan dumping and rehabilitation operations;
- the principle of progressive signoff will be adopted where applicable, to facilitate the development of rehabilitation to acceptable standards. Criteria that change over time will not be applied retrospectively;
specific features that do not reflect typical land uses for the area (such as mine void pit lakes) will be subject to independent environmental risk audits;

- long-term management operations following mining/closure/signoff (e.g. maintenance of access tracks, fire) to be no greater than those of areas prior to mining, or where extra management actions may be required, a mechanism has been put in place for addressing these; and

- ensuring operational criteria reflect key stages of the mining operation, including planning, operations, early establishment, development and closure.

6.2. Approach

Assessment of rehabilitation against completion criteria will be applied throughout the various stages of rehabilitation planning, operations and management. Assessment of rehabilitation success 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. However, it should be noted that for older rehabilitation, it may not be possible to assess some (perhaps many) of the operational and establishment criteria. For these areas, assessment of rehabilitation success will need to focus on the development stage.

Completion criteria standards and milestones will be formally reviewed every five years, 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 review can take place over the next five to ten years where improvement opportunities are identified through research and development programs.

This process has been refined in consultation with regulators, and is applied on a site-by-site basis across BHP Billiton Iron Ore Pilbara operations to develop site-specific criteria. A timeline illustrating this approach is shown in Plate 1 below.

Criteria have been defined based on successive stages of closure:

- **Stage 1 Planning:** Describes the criteria that must be met to confirm that the necessary planning and operating procedures have been developed and agreed with regulators and other stakeholders.

- **Stage 2 Rehabilitation Operations:** Describes criteria that must be met to confirm that rehabilitation operations have been implemented according to the above agreed planning and operating procedures. The assessment method for this will be by reviewing and auditing rehabilitation plans and records, and site inspections as required. Note that for older existing rehabilitation a simplified approach to setting agreed criteria may be developed.

- **Stage 3 Early Establishment Rehabilitation:** Assesses whether completed rehabilitation has established with no early problems (e.g. erosion, exposed dispersive material) apparent. The early establishment assessment provides confidence that vegetation is establishing and developing, and identifies where corrective work may be required. Assessment is initially by site inspection, followed by broad scale vegetation establishment monitoring. Note that for older existing rehabilitation, it may not be possible to determine whether some revegetation criteria have been met; nevertheless, rehabilitation records should help determine likely stability and performance.

- **Stage 4 Rehabilitation Development:** Determines whether the rehabilitation is developing appropriately towards the designated final land use and has reached or exceeded various development standards and milestones. Assessment is by site inspections, monitoring (both detailed monitoring of typical rehabilitation, and broad scale monitoring of other sites), and research projects where required.

- **Stage 5 Closure:** Addresses final closure stage management and land capability issues.
MINING AREA C ECOLOGICAL COMPLETION CRITERIA DEVELOPMENT TIMELINE

Agreed BHPBIO Guiding Principles 2005
2013 Guiding Principles Update
Agreed Draft Completion Criteria 2018

2003 – 2073
PROGRESSIVE MINING & REHABILITATION

2012 – 2018
DRAFT COMPLETION CRITERIA

Draft Completion Criteria Stages 1 - 4
Regulator Review, Implement, Monitor, Review, Realign criteria as required

2018 - MONITORING PERFORMANCE

Completion Criteria Stages 1 - 4
Execution, Monitoring of Rehabilitation Work, Continuous Feedback

MONITORING & MAINTENANCE

Completion Criteria Stages 2 - 5
Execution, Monitoring of Rehabilitation Work, Continuous Feedback

CLOSURE & RELINQUISHMENT
(Final Decision)

Completion Criteria Stages 4 - 5
Final Sign-off

Plate 1: Mining Area C Completion Criteria Development Timeline
6.3. Development of criteria

Closure and rehabilitation objectives are based on the land uses applicable to the particular area, in recognition of the fact that the land is altered fundamentally from its pre-existing condition. The completion criteria for the operations are designed to confirm that the objectives have been met. They provide both BHP Billiton Iron Ore and government with clear direction for the planning, establishment and management of mine rehabilitation at the site. They also provide a detailed understanding of the desired state of lands influenced by mining operations, at the time when any obligation for ongoing financial input or legal responsibilities by the mining companies effectively ceases, i.e. at signoff.

The purpose of the completion criteria is to ensure areas will display self-sustaining characteristics of surrounding areas and give Government regulators confidence that, to the maximum possible extent, they can be managed in the long term according to the intended land use (or uses), using normal management practices without the input of additional resources.

Completion criteria will continue to be developed by BHP Billiton Iron Ore over the next five years to integrate findings from ongoing research and development programs including landform trials, improved knowledge on the ecosystem development derived from rehabilitation monitoring programs and greening initiatives. Future revisions of the criteria will focus on developing measurable metrics based on site specific data.

The completion criteria for the Mining Area C mining operations are presented in Table 10. For clarity, column headings are defined as follows:

- **Criterion Objective**: The purpose or objective of the particular criterion.

- **Criterion Standard or Milestone**: An agreed standard or level of performance which demonstrates successful closure of a site for that particular objective.

- **Verification Procedure**: How BHP Billiton Iron Ore will demonstrate that the criterion has been met. This will generally require either reporting in the Annual Environmental Report when a specific criterion is met, or production of a separate rehabilitation monitoring report addressing one or more criteria, e.g. development of vegetation.

- **Domain**: Areas of similar operational land uses and closure requirements. Additional information relating to closure implementation for each closure domain is provided in Section 9.2.
### Table 10: Mining Area C Completion Criteria

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criterion objective</th>
<th>Domain</th>
<th>Criterion standard or milestone</th>
<th>Verification procedure</th>
<th>Closure Plan section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Final land use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Final Land Use</td>
<td>Agreed final land use has been determined in consultation with relevant stakeholders.</td>
<td>All</td>
<td>End land use for the area is considered likely to revert to low intensity cattle grazing on the underlying Juna Downs Pastoral Lease, or the inclusion in some form of natural conservation area, however this would be determined in consultation with stakeholders, and approved by the administering authority during the life of the mine. Specific rehabilitation objectives have been developed to ensure that, when met, areas will fulfil the post-mining land use requirements.</td>
<td>Land use objectives are documented in the Area C Mine Closure Plan as reviewed and agreed by the key stakeholders</td>
<td>5.3 Final land use</td>
</tr>
<tr>
<td><strong>2. Safety</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Safety</td>
<td>There are no unsafe areas where members of the general public could gain inadvertent access</td>
<td>All</td>
<td>All hazards that could endanger the safety of any person or animal have been identified and eliminated where practical.</td>
<td>All relevant regulatory guidelines have been met unless otherwise agreed with the regulator. All sites are assessed as acceptable with regards to</td>
<td>8.2 Risk Management 10.1.9 Public safety monitoring</td>
</tr>
<tr>
<td>Criterion</td>
<td>Criterion objective</td>
<td>Domain</td>
<td>Criterion standard or milestone</td>
<td>Verification procedure</td>
<td>Closure Plan section</td>
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<td>---------------------</td>
</tr>
<tr>
<td>All residual safety and health hazards have been identified and controlled in accordance with regulatory requirements and consideration of industry guidance.</td>
<td>Safety by the District Mines Inspector</td>
<td>2.2 Landform Safety</td>
<td>Final landforms are safe.</td>
<td>All Landforms are designed and constructed to address safety risks as described in criterion 2.1. They conform to DMP guidelines for structural stability, with no significant slumping or failure of accessible constructed slopes or berms. No unacceptable hazards to humans or wildlife have developed thorough erosion, subsidence, AMD or otherwise.</td>
<td>Report on landform construction methods, and any additional maintenance works undertaken. Rehabilitation inspections (including undertaken on maintenance earthworks) confirm earthworks have met final landform designs. Rehabilitation monitoring results (including erosion monitoring) Report on performance in relation to design criteria and DMP/EPA Guidelines. Inspections of the rehabilitated landforms have been conducted to monitor their stability over time, with monitoring conducted after each significant rainfall season.</td>
</tr>
<tr>
<td>Criterion</td>
<td>Criterion objective</td>
<td>Domain</td>
<td>Criterion standard or milestone</td>
<td>Verification procedure</td>
<td>Closure Plan section</td>
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</tr>
<tr>
<td>3. Landforms</td>
<td>3.1 Visual Amenity</td>
<td>Visual amenity of constructed landforms is compatible with that of local Pilbara landforms.</td>
<td>All except mine voids</td>
<td>Within the constraints imposed by aspects such as the physical nature of the materials available, tenement boundaries, and proximity to water courses, landforms have been constructed to blend into the surrounding landscape. Landforms are consistent with the agreed final land use (criterion 1.1).</td>
<td>Report on rehabilitation works confirms landform construction undertaken according to BHP Billiton Iron Ore relevant procedure. Rehabilitation inspections confirm earthworks have met final landform designs.</td>
</tr>
<tr>
<td>3.2 Waste Characterisation</td>
<td>Materials with poor physical or chemical properties do not compromise rehabilitation (landforms stability and revegetation)</td>
<td>Anywhere problem materials present</td>
<td>An overburden storage plan for any new OSA is developed and incorporated into the life of mine plan prior to the commencement of ex-pit dumping activities. All overburden placement in new OSAs has been undertaken in accordance with this plan. Mine waste material likely to provide a poor growth medium (e.g. dispersive and incompetent material), has been placed appropriately in the OSA.</td>
<td>Waste characterisation report available for review. Report on landform construction methods. Rehabilitation inspections confirm earthworks have met final landform designs.</td>
<td>8.4 Landforms 9.1 Standard closure and rehabilitation strategies</td>
</tr>
<tr>
<td>Criterion</td>
<td>Criterion objective</td>
<td>Domain</td>
<td>Criterion standard or milestone</td>
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<td>Closure Plan section</td>
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</table>
| 3.3 Landform Stability            | Constructed landforms are structurally stable.                                        | All    | Post-mining landforms have been designed and constructed taking into account waste characteristics affecting stability (physical and chemical). The design and construction methods conform to DMP guidelines for structural stability. Detailed landform design standards include:  
- Voids have been backfilled where practicable;  
- Residual pit voids have been left as run-of-mine (ROM) where geotechnically stable | Report on rehabilitation works at construction confirms safety and geotechnical Guidelines have been met and sites constructed according to BHP Billiton Iron Ore relevant procedure. Rehabilitation Inspections confirm earthworks have met final landform designs. | 8.4 Landforms  
9.1 Standard closure and rehabilitation strategies                                                                                                                  |
<table>
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<th>Criterion</th>
<th>Criterion objective</th>
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<th>Criterion standard or milestone</th>
<th>Verification procedure</th>
<th>Closure Plan section</th>
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</thead>
<tbody>
<tr>
<td>3.4 Surface Stability</td>
<td>The constructed surface is stable and showing no signs of significant erosion.</td>
<td>All</td>
<td>Post-mining landforms have been designed and constructed taking into account waste characteristics (physical and chemical). Slope surfaces are stable, with no dispersive material on the surface. Rock armouring is present as required. No areas are exposed to the risk of significant erosion which may be defined as having: • channelised flow resulting in extensive active gullies; • failure of banks, berms or bunds; and • evidence of ongoing significant sheet erosion (including large accumulation of silt at base of slope, exposed subsoil, poor seedling establishment).</td>
<td>Report on landform construction methods, and any additional maintenance works undertaken. Rehabilitation inspections (including undertaken on maintenance earthworks) confirm earthworks have met final landform designs. Visual assessment and monitoring, taking into account slope, available materials and vegetation cover, and relevant research projects on surface stability of comparable rehabilitated landforms. Rehabilitation monitoring results (including erosion monitoring) indicate gullies and rills are stabilising.</td>
<td>8.4 Landforms 9.1 Standard closure and rehabilitation strategies</td>
</tr>
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</table>
## 3.5 Landform Surface

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<th>Criterion</th>
<th>Criterion objective</th>
<th>Domain</th>
<th>Criterion standard or milestone</th>
<th>Verification procedure</th>
<th>Closure Plan section</th>
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</thead>
<tbody>
<tr>
<td>3.5 Landform Surface</td>
<td>Landform surface material promotes water infiltration and reduces erosion and crusting.</td>
<td>All (exc. mine voids and Potentially Acid Forming material encapsulation OSA’s)</td>
<td>Surface treatments (including ripping) undertaken to rehabilitated surfaces to maximise water infiltration, to reduce erosion potential, and support establishment of vegetation.</td>
<td>Report on landform construction methods. Rehabilitation inspections confirm earthworks have met final landform designs.</td>
<td>8.4 Landforms 9.1 Standard closure and rehabilitation strategies</td>
</tr>
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</table>

## 4. Sustainability

### 4.1 Sustainability

Rehabilitation is sustainable and the land capability and groundwater are suitable for the agreed end land use.

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<thead>
<tr>
<th>Domain</th>
<th>Criterion standard or milestone</th>
<th>Verification procedure</th>
<th>Closure Plan section</th>
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<tbody>
<tr>
<td>All where relevant</td>
<td>Monitoring, research data and site inspections indicate that the rehabilitation will be sustainable and will continue to fulfil rehabilitation objectives relating to the agreed final land use in terms of flora, vegetation, fauna, and surface and groundwater hydrology.</td>
<td>Documented in relevant monitoring and research reports; site inspections.</td>
<td>8.4.5 Sustainability; 10.1 Monitoring programme overview</td>
</tr>
</tbody>
</table>

### 4.2 Resilience

Vegetation is sustainable and resilient to likely impacts such as fire, drought and grazing (where applicable, if managed according to agreed guidelines).

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<tr>
<th>Domain</th>
<th>Criterion standard or milestone</th>
<th>Verification procedure</th>
<th>Closure Plan section</th>
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</thead>
<tbody>
<tr>
<td>All where relevant</td>
<td>Monitoring and/or research results have shown that recruitment of native perennial species is occurring or is likely to occur on the site (e.g. evidence of flowering, fruiting, soil seed bank or second generation seedlings).</td>
<td>Review of progress and performance of Rehabilitation Development Monitoring results, and related rehabilitation monitoring procedures.</td>
<td>8.4.5 Sustainability; 10.1 Monitoring programme overview</td>
</tr>
<tr>
<td>Criterion</td>
<td>Criterion objective</td>
<td>Domain</td>
<td>Criterion standard or milestone</td>
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<td></td>
<td>Research trials in rehabilitation representative of the same age and technique have demonstrated its ability to regenerate following burning (in terms of key parameters such as cover, richness and density); rehabilitation has reached the age where plants are likely to tolerate fire or regenerate/reseed. Monitoring has shown that the rehabilitation can survive one or more seasons of low rainfall.</td>
<td>All where revegetation is planned</td>
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<tr>
<td>4.3 Growth Media</td>
<td>A suitable growth medium has been constructed to facilitate plant establishment and growth.</td>
<td>All where revegetation is planned</td>
<td>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 suitable for plant growth in terms of their structure, water holding capacity, and lack of materials that might affect plant growth or survival (i.e. they are suitable for establishing target</td>
</tr>
</tbody>
</table>

Note: The table above outlines the criteria, objectives, domains, and verification procedures for monitoring and evaluating the closure plan of Mining Area C Mine as per BHP Billiton Iron Ore. It highlights the importance of growth media, research trials, monitoring, and the role of database information in ensuring the sustainability and standardization of the closure and rehabilitation strategies.
Vegetation communities and supporting the agreed final land use).
Soil stripping has been undertaken in accordance with the BHP Billiton Iron Ore Rehabilitation Standards and Procedures.
Topsoil stockpiles have been managed following the BHP Billiton Iron Ore Rehabilitation Standard and Procedures, and the relevant plans and databases have been prepared, updated and maintained.
Where available, topsoil has been used to provide a suitable medium for plant establishment and a source of propagules.

4.4 Provenance

Vegetation is locally endemic.

Revegetation at Mining Area C has used local provenance native seed from the Pilbara Interim Biogeographical Regionalisation of Australia (IBRA) region consistent with vegetation associations and native species recorded in the Seed Database. Rehabilitation monitoring results.

<table>
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<tr>
<th>Criterion</th>
<th>Criterion objective</th>
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<th>Closure Plan section</th>
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<tr>
<td></td>
<td>Vegetation is locally endemic.</td>
<td>All</td>
<td>Revegetation at Mining Area C has used local provenance native seed from the Pilbara Interim Biogeographical Regionalisation of Australia (IBRA) region consistent with vegetation associations and native species recorded in the Site Rehabilitation Report including seed mix summary. Seed Database. Rehabilitation monitoring results.</td>
<td>to determine suitability of growth medium.</td>
<td>8.4.5 Sustainability 9.1.3 Revegetation</td>
</tr>
<tr>
<td>Criterion</td>
<td>Criterion objective</td>
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<td>Mining Area C area prior to.</td>
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<td>Significant flora species of</td>
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<td>conservation significance</td>
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<td>have been incorporated into the</td>
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<td>revegetation programme (where</td>
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<td>practicable) in the event that</td>
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<td>planned disturbance areas affect</td>
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<td>known populations (i.e. where</td>
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<td>the disturbance cannot</td>
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<td>otherwise be avoided).</td>
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<td>The practicalities of</td>
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<td>propagation and revegetation</td>
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<td>techniques for these species</td>
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<td>have been investigated where</td>
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<td>appropriate in conjunction with</td>
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<td>standard revegetation/rehabilitation</td>
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<td>trials and in consultation</td>
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<td>Criterion</td>
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<tr>
<td>4.5 Vegetation Development</td>
<td>Vegetation is suited to the agreed final land use.</td>
<td>All with revegetation</td>
<td>Established vegetative cover should be self-sustaining and similar to the surrounding undisturbed vegetation. Monitoring of rehabilitated areas has been undertaken until it can be demonstrated that the landscape and vegetation is progressing towards a self-sustaining state. Rehabilitation Development stage density or cover target to be developed.</td>
<td>Monitoring of rehabilitation development vegetation using BHP Billiton Iron Ore Rehabilitation Monitoring Procedures. Monitoring results reported in Annual Environmental Report. Report on performance in relation to rehabilitation methods, using site inspection and rehabilitation monitoring sites to assess whether criteria have been met.</td>
<td>9.1.3 Revegetation 10.1.1 Rehabilitation monitoring methodology</td>
</tr>
<tr>
<td>4.6 Weeds</td>
<td>Potential for rehabilitation to meet the agreed post-mining use is not limited by the presence of weeds.</td>
<td>All with revegetation</td>
<td>All requirements of the BHP Billiton Iron Ore Weed Management Procedure have been implemented. No Declared Pests (as defined under the Biosecurity and Agriculture Management Act 2007) are present in greater abundance than baseline surveys indicate. Populations of environmental weeds have been monitored and controlled; weed abundance does not</td>
<td>Review weed monitoring and control undertaken to ensure compliance with the BHP Billiton Iron Ore Weed Management Plan. Report on weed monitoring and control records. Measurement of weed abundance compared to representative reference sites, using cover or counts (as appropriate according to the species). Monitoring and visual inspection of vegetation</td>
<td>10.1.2 Weed monitoring</td>
</tr>
<tr>
<td>Criterion</td>
<td>Criterion objective</td>
<td>Domain</td>
<td>Criterion standard or milestone</td>
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</tbody>
</table>
| 4.7 Fauna Recolonisation | There is evidence that local native fauna are colonising the rehabilitation. | All where opportunities exist | As per the BHP Billiton Iron Ore Rehabilitation Standard and Procedures include, where practical, the creation of habitat features similar to those found in the Mining Area C area prior to mining. Habitat creation initiatives may include, but are not limited to the following:  
- Creation of rock piles in OSAs and/or mine void areas to provide potential habitat opportunities for reptiles and mammals;  
- Return of vegetation debris, logs and rocks to areas which have been disturbed to provide microhabitats for recolonising fauna; and | Rehabilitation inspections confirm earthworks have met final landform designs. Fauna habitat assessment using site inspection and evaluation of vegetation monitoring results. Vertebrate fauna surveys using standard methods have been undertaken and reviewed in representative rehabilitation areas. Vertebrate pest species have been controlled as required. | 9.1 Standard closure and rehabilitation strategies  
9.1.3 Revegetation  
10.1.1 Rehabilitation monitoring methodology  
10.1.3 Fauna monitoring of rehabilitation areas |
## 5. Hydrology

### 5.1 Surface Water

<table>
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<tr>
<th>Criterion</th>
<th>Criterion objective</th>
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<th>Criterion standard or milestone</th>
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<tbody>
<tr>
<td>Construction of artificial bat roosts.</td>
<td></td>
<td></td>
<td>• Construction of artificial bat roosts.</td>
<td>Documents reviewed and signed off as required.</td>
<td>7.8 Surface water</td>
</tr>
<tr>
<td>Vegetation includes locally endemic species of known importance to fauna, including the mallee eucalypt <em>Corymbia hamersleyana</em> and snappy gum, <em>Eucalyptus leucophloia</em>.</td>
<td></td>
<td></td>
<td>• Vegetation includes locally endemic species of known importance to fauna, including the mallee eucalypt <em>Corymbia hamersleyana</em> and snappy gum, <em>Eucalyptus leucophloia</em>.</td>
<td>Review compliance through the Regional</td>
<td>8.4.3 Surface water</td>
</tr>
<tr>
<td>Vertebrate fauna surveys have been conducted in representative, rehabilitated areas; these demonstrate that local bird, mammal and reptile species are recolonising in typical rehabilitated sites.</td>
<td></td>
<td></td>
<td>• Vertebrate fauna surveys have been conducted in representative, rehabilitated areas; these demonstrate that local bird, mammal and reptile species are recolonising in typical rehabilitated sites.</td>
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<tr>
<td>Signs of vertebrate and invertebrate fauna recolonisation are apparent.</td>
<td></td>
<td></td>
<td>• Signs of vertebrate and invertebrate fauna recolonisation are apparent.</td>
<td></td>
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</tr>
<tr>
<td>Vertebrate pests (rabbit and cat) have been controlled where necessary.</td>
<td></td>
<td></td>
<td>• Vertebrate pests (rabbit and cat) have been controlled where necessary.</td>
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</table>

**5.1 Surface Water**

Rehabilitation drainage patterns have been established and impacts on natural surface water flows are acceptable at key receptors.

All where relevant

There are no significant, physical off-site impacts at key receptors as a result of BHP Billiton Iron Ore’s operations.

Documents reviewed and signed off as required.

Review compliance through the Regional

7.8 Surface water

8.4.3 Surface water
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criterion objective</th>
<th>Domain</th>
<th>Criterion standard or milestone</th>
<th>Verification procedure</th>
<th>Closure Plan section</th>
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<tbody>
<tr>
<td>Baseline conditions for surface water quality and flow regimes in the Coondewanna Flats Catchment, Pebble Mouse Creek and Weeli Wolli Creek have been maintained to an acceptable level. Sediment traps have been installed downslope of the OSAs in order to control downstream sedimentation which may occur whilst slopes are revegetating (e.g. in the first 10 to 20 years of revegetation) Constructed waterways, sumps and other water management structures are functioning as designed. Surface water quality should fall within guidelines for specific-end</td>
<td>monitoring programme against BHP Billiton Iron Ore’s nominated trigger values as defined in Mining Area C Environmental Management Plan. Monitoring results reported in the Annual Environmental Report and Annual Aquifer Review (as required). Site inspection to verify no unplanned impacts on surrounding natural drainage patterns.</td>
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</table>

2 the hydrological conditions that prevailed before BHP Billiton Iron Ore mining operations commenced, including natural variation (BHP Billiton Iron ore, Pilbara Water Resource Management Strategy 2013)

3 site specific water quality guidelines will be developed in line with the ANZECC Guidelines (ANZECC 2013).
### 5.2 Groundwater

**Criterion objective**: Mining-related impacts on groundwater (levels, quality and soil moisture) have been minimised.

**Domain**: All where relevant

**Criterion standard or milestone**: There are no significant, physical off-site impacts at key receptors as a result of BHP Billiton Iron Ores operations. Baseline conditions\(^6\) for groundwater regime (levels, quality and soil moisture) in the Coondewanna Flats (including Lake Robinson), Ben’s Oasis and Weeli Wolli Spring have been maintained to an acceptable level. Water resource quality is managed within predetermined criteria based on ANZECC 2013. Acceptable levels defined as closure thresholds in Mining Area C EMP.

**Verification procedure**: Review compliance through the Regional monitoring programme against BHP Billiton Iron Ore’s nominated trigger values as defined in Mining Area C EMP and ultimately the Central Pilbara Water Resource Management Plan when adopted. Monitoring results reported in the Annual Environmental Report and Annual Aquifer Review (as required).

**Closure Plan section**: 7.8 Groundwater, 8.4.2 Groundwater

### 6. Decommissioning

#### 6.1 Infrastructure

**Objective**: Infrastructure has been decommissioned and removed where transfer to a third party is not agreed

**Domain**: All where infrastructure exists

**Verification procedure**: Agreement has been reached with Government regarding whether any infrastructure is required to remain post-mine closure. Infrastructure not required has been Site inspection and documentation of infrastructure removal and rehabilitation operations.

**Closure Plan section**: 9.2.3 Infrastructure, road and rail
BHP Billiton Iron Ore

Mining Area C Mine Closure Plan

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criterion objective</th>
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<td>removed (and recycled/reused</td>
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<td>where practicable) and the site</td>
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<td>rehabilitated.</td>
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<td>7. Contaminated sites</td>
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<tr>
<td>7.1 Contaminated Sites</td>
<td>Contaminated sites have been documented and addressed</td>
<td>All where relevant</td>
<td>All commitments relating to the identification and management of contaminated sites, as per Contaminated Sites Act (2003) have been fulfilled.</td>
<td>Report documenting compliance with specific requirements.</td>
<td>9.1.5 Site contamination</td>
</tr>
<tr>
<td>8. Land management</td>
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<tr>
<td>8.1 Land Management</td>
<td>Long-term management requirements have been addressed.</td>
<td>All</td>
<td>At the time mine closure is considered complete, site land management requirements will be no greater than those of areas prior to mining (or comparable unmined areas); alternatively, where additional management actions are required, these will be identified in agreement with regulators, and BHP Billiton Iron Ore will make adequate provisions so that this additional management can be undertaken.</td>
<td>Reports into sustainability and long-term management requirements identified in the monitoring and research carried out as per Criterion 4.</td>
<td>10.1 Monitoring programme overview</td>
</tr>
</tbody>
</table>
7. Collection and analysis of closure data

The following section provides a summary of details on the physical and biological environment at Mining Area C including:

- local climatic conditions and projected future climate change for the area;
- local physical conditions - topography, geology and hydrogeology, hydrology, seismicity and geotechnical data;
- soil and waste materials characterisation – soil structure and stability (e.g. erodibility), growth medium type and block modelling of waste materials; solubility, mobility and bioavailability of hazardous materials (e.g. radioactive materials, heavy metals and materials with potential to produce contaminated drainage);
- local and regional biodiversity information on flora, fauna, ecology, communities and habitats;
- local water resources details – type, location, extent, hydrology, quality, quantity and environmental values (ecological and beneficial uses); and
- local social and cultural aspects of the surrounding environment.

Consistent with the adaptive management approach in the DMP/EPA Guidelines (2015), BHP Billiton Iron Ore has commissioned a number of studies to inform relevant considerations during mine closure planning as described in the closure guideline, such as materials characterisation, consideration of contaminant pathways and potential impacts to environmental receptors. The studies and trials are progressive and will be refined over a number of years through stages of testing and field trials, data analysis and implementation planning. This information provides a basis to refine completion criteria and performance indicators for closure monitoring and performance.

The proposed preliminary closure management of Mining Area C the mining operations is based on understanding the surrounding environment and the outcomes of monitoring and research trials.

7.1. Climate

7.1.1. Existing Climate

The Mining Area C mine is located in the Pilbara region of WA which has an arid climate and experiences regular cyclonic activity during November to March. Characteristic climatic features of the region include seasonally low rainfall with high temperatures, high evaporation rates and a high daily temperature range (Bureau of Meteorology, 2013).

Further information can be sourced from the closest operating Bureau of Meteorology (BOM) station at Newman (BOM station number 007176).

7.1.2. Climate change

BHP Billiton accepts the Intergovernmental Panel on Climate Change’s (IPCC, 2014) current view that warming is unequivocal, human influence is clear and physical impacts are unavoidable. BHP Billiton recognises a responsibility to take action by focusing on greenhouse gas emissions reduction, including the use of low emissions technology and increasing our resilience to physical climate change impacts.

We have worked with the CSIRO to obtain regional analyses of climate change science and understand that climate change will amplify existing risks in BHP Billiton Iron Ore mining and associated port and rail operations in the Pilbara region.

For the Pilbara region climate conditions for 2030 and 2050 are forecast by CSIRO to be:

- hotter (both averages and extremes) and drier e.g. in 2050 forecast warming of 1.5°C to 3°C;
- higher sea levels;
- tropical cyclones may decrease in number, but increase in intensity and duration over the same period; and
• more unpredictable characteristics of other climate-related hazards, including flooding, storm surges and wildfires, e.g. in 2050 forecast up to 100% increase expected in days with extreme forest fire danger index - current average 23 days per year, up to 44 days per year.

Given the multi-faceted nature of the challenge, BHP Billiton Iron Ore has undertaken an integrated and system-wide study to identify the climate vulnerabilities in the production system, assess the material climate risks and evaluate the effectiveness of existing controls in the face of a changing climate. Where necessary, new controls have also been identified to strengthen climate resilience.

Climate change is a complex issue, with inherent uncertainty about the timing, pace, and severity of possible impacts. Risks from climate change to the stability of landforms, mobilisation of contaminants and re-vegetation are some of the identified vulnerabilities that have been taken into account in closure planning.

7.1.3. Knowledge Gaps
No knowledge gaps have been identified.

7.2. Overburden characteristics
Overburden materials at BHP Billiton Iron Ore sites are characterised at a high level based on their geological, geochemical, and physical characteristics. This characterisation process allows BHP Billiton Iron Ore to identify waste types and manage their disposal appropriately, including segregation and selective disposal of potentially acid forming (PAF) overburden. This approach is consistent with the Mine Closure and Completion guideline (DTIR, 2006) and Managing Acid and Metalliferous Drainage handbook (DTIR, 2007).

7.2.1. Geological overview
The regional geological sequence and stratigraphic descriptions are summarized below in Table 11.

<table>
<thead>
<tr>
<th>Table 11: Local stratigraphic table</th>
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<tr>
<td>Formation</td>
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<tr>
<td>Surface Scree and Tertiary Sediments (Detritals)</td>
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<td>Brockman Iron Formation</td>
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<td>Mt Sylvia Formation</td>
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<td>Wittenoom Formation</td>
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<td></td>
</tr>
<tr>
<td>Formation</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>West Angela 1</td>
</tr>
<tr>
<td>West Angela 2</td>
</tr>
<tr>
<td>Marra Mamba Iron</td>
</tr>
<tr>
<td>Formation</td>
</tr>
</tbody>
</table>

**Project Geology**

The geology of the Mining Area C bodies is typical of the Pilbara Region. Mineralisation at Mining Area C is located within the early Proterozoic Hamersley Group (Marra Mamba and Brockman Iron Formations) and Tertiary Sediments.

BHP Billiton Iron Ore defines stratigraphic units based on the predominant lithological types within that unit. The stratigraphic units associated with the Mining Area C are shown in Figure 3 from youngest to oldest:

Tertiary Sediments are associated with the Brockman Detrital Deposit and the shallower sections of the Marra Mamba deposits; the Brockman Iron Formation and the Mt McRae Shale are typically associated with the Packsaddle Range deposits; and the Wittenoom Dolomite Formation and the Marra Mamba Iron Formation are typically associated with the Northern Flank valley and Southern Flank Marra Mamba deposits.

Apart from the Packsaddle Range most other deposits have mineralised zones within the Mount Newman Member of the Marra Mamba Iron Formation. The Packsaddle Range deposits are hosted by the Brockman Iron Formation, typically in the Dales Gorge and Joffre Members with Mt McRae Shale underlying these areas.

Mine waste at Mining Area C deposits span across most of these lithological units. Based on available information, lithologies with potential for AMD generation within the project area generally include:

- Proterozoic Formations containing sulphidic material such as the Mt McRae Shale and other black shale horizon associated with, for example, the Mt Sylvia and Marra Mamba Formations;
- Pyritic lignite and ligneous clays within the Tertiary Detritals; and
- Potential acidity stored in sulphate minerals (e.g. jarosite, alunite) within oxidised material located above the water table.

Materials that can provide a local source of acid neutralising capacity include the Wittenoom Formation and Tertiary calcareous horizons developed within fluviol and lacustrine sediments.

AMD generation and acid neutralising capacity are further discussed in Section 7.2.3.

**Project Geological Formations**

A brief description of the main geologic formations in the project area, from youngest to oldest, is presented below (BHP Billiton Iron Ore, 2008b).

**Surface Scree**

Surface Scree represents unconsolidated sediment accumulated through periodic rockfall from adjacent cliff faces at the base of valley shoulders and mountain cliffs. At Mining Area C, Surface Scree overlies Tertiary Detritals along most of the North Flank Valley and low relief areas at South Flank (mainly south of the hills area). BHP Billiton Iron Ore codes this lithology as SZ.

**Tertiary Sediments / Tertiary Detritals**

Tertiary alluvial sediments have been deposited in the North Flank and South Flank valley areas, where they overlie the eroded bedrock mostly of the Wittenoom Formation. The sediments are composed of semi-consolidated and cemented alluvium, colluvium/detritals comprising sands, silts, clays, lignite and
ligneous clays and calcrite deposits up to tens of meters in thickness. BHP Billiton Iron Ore recognised three lithological units within this formation; the lithological code is TDx, with “x” ranging from 1 to 34.

A conceptual cross section of the Tertiary Sediments at Mining Area C is provided in Figure 4.

Pyrite can be associated with these sediments, particularly with lignite and ligneous clays located within the fresh zone. This pyrite is formed as a result of bacteriologically mediated sulphate reduction in the presence of iron and organic carbon. Pyrite from these sediments is ultra-fine grained, frambooidal, and is expected to be far more reactive (i.e. more rapid oxidation rate) than pyrite within the Proterozoic formations. In addition, acidity storing secondary minerals (e.g. alunite and jarosite) within the oxidised portion of the sediments may be present. As a result, these materials have the potential to generate AMD.

Proterozoic Formations

Brockman Iron Formation

Ore mineralisation from the Packsaddle Range deposits is contained within the Brockman Iron Formation, composed of a sequence of interbedded Banded Iron Formation, shales, siltstones and cherts. A conceptual cross section of the Brockman Iron Formation associated with the Packsaddle Range deposits is shown in Figure 5.

The four members comprising the formation have a total thickness of ~520 m and include the following:

Yandicoogina Shale Member – The uppermost member of the Brockman Iron Formation, the Yandicoogina Shale Member is a 60 m thick sequence of interbedded chert and shale with dolerite sills. BHP Billiton Iron Ore codes this member as Y.

Joffre Member – This member is approximately 360 m thick and is dominated by BIF with minor shale bands. BHP Billiton Iron Ore codes this member as Jx with “x” ranging from 1-6 representing distinct subunits; undifferentiated Joffre Member is coded J.

Whaleback Shale – This member consists of 50 m of shale interbedded with chert and BIF and has been sub-divided in two zones: a lower zone of shale and BIF (code WL); and an upper zone of chert and shale (WU). Undifferentiated Whaleback Shale is coded W.

Dales Gorge Member – This member, which is approximately 150 m thick, hosts most of the mineralisation for the Packsaddle Range deposits. The Dales Gorge Member is the basal member of the Brockman Iron Formation and comprises an interlayered sequence of BIF and shale macrobands. BHP Billiton Iron Ore codes this member as Dx with “x” ranging from 1-4 representing distinct subunits. Undifferentiated Dales Gorge Member is coded D.

Significant concentrations of sulphide-bearing minerals can be found within the Brockman Iron Formation, and thus it has the potential to generate AMD.

Mount McRae Shale

The Mount McRae Shale (~30 m thick) consists of alternating bands of black carbonaceous shale and chert and is commonly capped with pyritic chert bands. The Mount McRae Shale forms the basal unit to the ore horizons in the Brockman Iron Formation and contains a limited enriched ore zone. BHP Billiton Iron Ore informally subdivides this lithology into five units based on lithology and pyrite content. The lithology code for the Mt McRae Shale is Rx with “x” representing alphabetical characters U, N, C, and L to represent upper, nodule zone, chert, and lower unit, respectively. Undifferentiated Mt McRae Shale is coded R.

Several zones within the unit contain abundant pyrite nodules, thus, the formation is commonly regarded as a significant AMD risk throughout the Pilbara region.

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4 BHP Billiton Iron Ore numbering protocol for sub-units assigns the highest number to the younger unit. Therefore TD3 is younger than TD1.
Mount Sylvia Formation

The Mount Sylvia Formation (~2.5 Ma) has a thickness of ~50 m in the vicinity of the town of Newman, WA, and consists of three BIFs separated by interlayered shale and dolomite as well as small amounts of chert. BHP Billiton Iron Ore codes this member as Sx with “x” ranging from 1-6 representing distinct subunits. If undifferentiated this formation is coded S.

Wittenoom Formation

The Wittenoom formation is located stratigraphically above and is younger than (2.6 – 2.5 Ma) the Marra Mamba Formation. The Wittenoom Formation has been deeply eroded in the development area and is mostly covered by Tertiary Detritals (Figure 6). The formation is predominantly comprised of calcareous and manganiferous shales, cherts and dolomite and includes the following members:

Bee Gorge Member – This is the uppermost member of the Wittenoom Formation and consists of alternating beds of shale and dolomite with minor cherts, volcaniclastics and BIF. This unit is present, but not planned to be mined at Mining Area C. BHP Billiton Iron Ore codes this member as OD.

- **Paraburdoo Member** – The Paraburdoo Member is the middle unit of the Wittenoom Formation and consists of thin to thick-bedded dolomite with minor amounts of chert and argillite partings. BHP Billiton Iron Ore codes this member as OB.

- **West Angela Member** – This member is a shale unit located at the base of the Wittenoom Formation and contains dolomite, dolomitic argillite, chert and minor BIF. At Mining Area C, the West Angela Member is present as two distinct units (WA1 and WA2.) The basal WA1 overlying the Newman Member is a cherty BIF with interbedded shale. The WA2 Member is a clay rich weathered horizon. Undifferentiated West Angela Member is coded OA.

Carbonate materials within Wittenoom Formation represent a local source for acid neutralisation and are likely to contribute to elevated alkalinity in the local aquifer.

Marra Mamba Iron Formation

The Marra Mamba Iron Formation is approximately 205 m thick and is the oldest formation (2.6 Ma) identified in the project area. It is comprised of a sequence of BIF, shales, siltstones and minor cherts. The Mount Newman Member hosts the bulk of the mineralisation associated with the Marra Mamba Iron Formation Deposits (Figure 6). The formation is divided into the following members:

- **Mt Newman Member** – This uppermost, youngest unit of the Marra Mamba Iron Formation is a sequence of BIF, shales, siltstones and minor cherts containing significant martite-goethite-ochreous goethite mineralisation. This member represents the main host to mineralisation at Mining Area C. BHP Billiton Iron Ore codes this member as Nx, with “x” ranging from 1-3. Undifferentiated Mt Newman Member is coded MN.

- **MacLeod Member** – This member is the middle unit of the Marra Mamba Iron Formation, consisting of interbedded shales and chert. BHP Billiton Iron Ore codes this member as MM.

- **Nammuldi Member** – This is the base unit of the Marra Mamba Iron Formation, comprising yellow weathering chert, cherty BIF and some shale bands. It has a maximum thickness of 100 m. BHP Billiton Iron Ore codes this member as MU.
Figure 3: Stratigraphy of the Hamersley Group (2600-2400 Million Years) - Lascelles (2006)
Figure 4: Conceptual Mining Area C valley cross section detailing the stratigraphic relationship between Tertiary Detrital and bedrock (BHP Billiton Iron Ore, 2012e)
Figure 5: Conceptual Deposit P4 geological cross section illustrating the general stratigraphy for the Packsaddle Range (BHP Billiton Iron Ore, 2012e)
Figure 6: Conceptual Deposit B geological cross section illustrating the general stratigraphy for the Marra Mamba Iron Formation (BHP Billiton Iron Ore, 2012e)
### 7.2.2. Volume and availability

BHP Billiton Iron Ore waste classification based on stratigraphy forms the basis for managing different waste rock types according to the physical and geochemical properties (Table 12). Further information is outlined within this Section 7.2.3 and Section 7.2.4 below.

**Table 12: Waste classification categories based on stratigraphy**

<table>
<thead>
<tr>
<th>Major Waste Classification (based on stratigraphy)</th>
<th>Stratigraphy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potential Acid Forming (PAF)</strong></td>
<td>All BWT, NAPP &gt; 3 (see further detail within section 7.2.3)</td>
<td><strong>Adverse AMD waste rock</strong> for containment within OSAs following specific dumping guidance (see section 4.1) due to the adverse geochemical properties leading to acid and metalliferous drainage.</td>
</tr>
<tr>
<td><strong>Inert Material Class 1</strong></td>
<td>Marillana Formation (UCID), BIF Joffre, BIF Dales Gorge, BIF Nimingarra</td>
<td><strong>Beneficial competent waste rock</strong> for placement on outer OSA surfaces due to inherent hardness and mean rock size (rockiness) physical properties that promote a stable landform surface.</td>
</tr>
<tr>
<td><strong>Inert Material Class 2,3 (MC2, MC3)</strong></td>
<td>Marillana Formation (LCID), BIF Joffre Shaly, BIF Whaleback Shale, McRae Shale, Mt Sylvia, Wittenoom Formation, Marra Mamba, Jeerinah, Nimingarra</td>
<td><strong>Potential (MC2) and Certain (MC3) problematic waste rock</strong> for placement within OSAs, beneath outer surface material due to the unfavorable physical properties (dispersive, fine grained) that promote a highly erosive and unstable landform surface. This can include AMD Class 2 and 3 material as described in Section 8.4.1</td>
</tr>
</tbody>
</table>

The Mining Area C waste classification balance and waste balance summary (mined + planned) are presented within Table 13 and Table 14 respectively.
Table 13: Mining Area C LOA Inert waste classification balance

<table>
<thead>
<tr>
<th>Waste stratigraphy</th>
<th>NORTH FLANK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Million m³)</td>
<td>Major Formation Type</td>
<td>Marra Mamba and Brockman Iron Formation</td>
</tr>
<tr>
<td></td>
<td>Inert Material Class 1 (competent)</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>Inert Material Class 2.3</td>
<td>1,088</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,318</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waste stratigraphy</th>
<th>SOUTH FLANK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Million m³)</td>
<td>Major Formation Type</td>
<td>Marra Mamba Iron Formation</td>
</tr>
<tr>
<td></td>
<td>Inert Material Class 1 (competent)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Inert Material Class 2.3</td>
<td>720</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>720</td>
</tr>
</tbody>
</table>

*All volumes in loose cubic metres

Table 14: Mining Area C LOA inert waste balance summary

<table>
<thead>
<tr>
<th>Description</th>
<th>NORTH FLANK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Million m³)</td>
<td>Overburden (waste) to be mined</td>
<td>1,318</td>
</tr>
<tr>
<td></td>
<td>BWT (+5 m) pit void</td>
<td>237</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>SOUTH FLANK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Million m³)</td>
<td>Overburden (waste) to be mined</td>
<td>720</td>
</tr>
<tr>
<td></td>
<td>BWT (+5 m) pit void</td>
<td>105</td>
</tr>
</tbody>
</table>

*All volumes in loose cubic metres

Management of overburden surplus is addressed in Section 8.4.4.

7.2.3. Acid and Metalliferous Drainage Geochemistry

AMD is a consideration for mine closure if concentrated levels of acidic, metalliferous or saline drainage enter waterways. Drainage that contains elevated concentrations of sulphuric acid, salts or toxic metals can present a risk to aquatic life, riparian vegetation, ground and surface water or users of these e.g. stock and humans. If the AMD risk is not managed during the life of the mine it may arise post closure. In WAIO operations potential sources of AMD include overburden storage areas, exposed pit walls and other disturbances.

BHP Billiton Iron Ore is committed to managing and mitigating AMD risk using a structured approach, consistent with global leading practice guidelines including INAP (2012) and DTIR (2007). Management for AMD materials across BHP Billiton Iron Ore's Pilbara sites is outlined at a high-level in the WAIO AMD Management Standard (BHPBIO 2015c; Appendix E). The overall strategy for AMD management is illustrated in Plate 2 with considerations across the full mine life cycle.
The approach as shown in Plate 2 is risk based approach, refined with increasing geochemical knowledge of the mine waste material, and this knowledge is integrated into the closure plan. Specifically, the characterisation stage (Stage 1) as shown in Plate 2 informs Stages 2 through 5 inclusive of OSA design as shown in Plate 2. The information also informs the decision making process for pit closure and mine void management.

Plate 2: The AMD Management Process

Specifically BHP Billiton utilises the following tools to model and assess AMD risk.

- Waste sampling during exploration and mine development
- Static and kinetic geochemical waste characterisation
- Coding AMD risk in mining block models
- AMD risk assessment
- Hydro-geochemical predictive modelling

BHP Billiton Iron Ore has developed procedures for classification of PAF material that can be a contributing source of AMD. During 2016, BHP Billiton Iron Ore made changes to methods of classifying all material within resource and mining models with respect to AMD (PAF to NAF end-members). This resulted in two different, but valid and conservative methods being used to conduct preliminary AMD risk assessment across Northern Flank and Southern Flank. The Northern Flank assessment undertaken during 2014 and reported here remains the same as in the previous Mining Area C Mine Closure Plan (BHP Billiton Iron Ore, 2015d). Southern Flank AMD risk was assessed during 2016 for
this Mine Closure Plan update. The methods used to evaluate AMD risk in each area are described in the respective sub-sections below.

**Northern Flank Preliminary AMD Risk Assessment**

In 2014 when the Northern Flank AMD risk assessment was undertaken BHP Billiton Iron Ore classified material according to the sulphur (S) content, stratigraphy, degree of oxidation, and other geochemical testing to characterise potential acid generation or metals release.

Specifically, at Northern Flank, materials with total sulphur concentration >0.2 wt% and located below the base of complete oxidation (BOCO) were classified as PAF. Exceptions to this classification method are some stratigraphies that have been identified as high-risk for AMD (Mt McRae Shale –Rx), Mount Sylvia Formation – Sx and Fault Zone), which are always classified as PAF material regardless of sulphur concentration and location with respect to the BOCO.

In accordance with the WAIO AMD Management Standard (BHP Billiton Iron Ore, 2015c) a Preliminary AMD Risk Assessment was undertaken in 2013/14 by Klohn Crippen Berger for Mining Area C, which addressed both current and proposed future mining operations (KCB, 2014). The assessment considered the source, pathways and receptors which may be impacted by any AMD from the Mining Area C operations. The assessment incorporated information supplied by BHP Billiton Iron Ore, including: geochemical characterisation of geological materials, geological and mine planning data, and findings of surface water, groundwater and ecological studies.

A conservative approach was taken to the classification of AMD for the purposes of the Preliminary AMD Assessment. The classification system, referred to as the NAPP (net acid production potential) classification, is based on sulphur concentration and NAPP values. Material with total sulphur concentration <=0.1 wt%, but with NAPP <=0 was classified as NAF, and material with total sulphur concentration >0.1 wt% and NAPP >0 were classified as PAF (KCB, 2014). The location with respect to the BOCO and stratigraphies were not used as part of the classification. Further work will be undertaken to test the assumptions in both the current BHP Billiton classification and the NAPP classification to refine management of AMD risk.

**Northern Flank Potential AMD Source**

The following material domains were identified in the assessment:

- In-pit mine waste – assessment of in-pit mine waste (not ore and low grade) was conducted to gain an appreciation of the AMD risk associated OSAs.
- Wall rock – assessment of the wall rock was conducted to gain an appreciation of the AMD risk associated with the pit wall and cone of depression.
- Outside pit mine waste – assessment of the material outside the pit shell was conducted to gain an appreciation of the AMD risk associated potential future modification of the pit shells.

Northern Flank as a whole is a low sulphur system, with material classified as PAF characterised by a low net acid production capacity (NAPP) of <5-6kg H₂SO₄/t on average, and thus not likely to generate elevated acidity (KCB, 2014).

When, and if, deposits R, P2, P5, P6 and Brockman Detrital are developed, PAF volumes are predicted to increase. Extensions beyond the current pit shells may intercept lithologies more sulphur-rich than those encountered so far, which may increase the acid generating capacity of mine waste, depending of the proportion of high sulphur lithologies comprising mine waste.

Initial interpretation of the exposure of PAF blocks on the pit wall using MicroMine software suggested that there might be locations where PAF materials are exposed on the pit walls. However, these exposures are situated above the water table, and most often located in the upper portions of the pit wall. These exposures could represent a small source of AMD, most likely associated with leaching of sparingly soluble acid sulphates (i.e. jarosite and alunite) and could contribute to solute loads in runoff.
Key stratigraphic units contributing to the PAF budget are:

- Joffre Member (Jx), Dales Gorge Member (Dx) and Mt Whaleback Shale (Wx) from the Packsaddle Range deposits.
- West Angela Member (Wax), Mt Newman Member (Nx and MN) and MacLeod Member from the Marra Mamba deposits.
- In addition, drillhole intervals analysis indicates that Tertiary Detritals (TD2) contain intervals with elevated sulphur, the tonnage of PAF waste produced from this unit is small compared to that associated with bedrock formations.

The majority of mine waste from current and future mining operations has been classified as NAF. However, a portion of this NAF waste may be at risk of releasing neutral and metalliferous drainage (NMD) or saline drainage depending on the leachability of metals within each lithology.

Indications from available leachate data suggest that samples from most stratigraphies had near-neutral to acidic leachates with generally low to moderate (17 – 400 mg/L) sulphate concentrations depending on lithology. These data indicate that there may be potential for the leachate or runoff from the material to be somewhat saline. It is possible that soluble salts are present in NAF materials, and PAF mined from near-surface locations. Such salts could readily leach resulting in short-term pulses of salinity in contact waters.

Depending on the availability of the ANC and the rate of acidity generation, there is potential for some buffering to occur within the OSAs. At this point, however, the total and effective ANC budget, the distribution of the ANC with respect to the mining blocks, and the final placement of this material in the OSAs are not well understood.

While the overall percentage of PAF mine waste predicted for Northern Flank is low and the net acid production potential is low, the size of the mining operation will dictate the final tonnage of PAF material. The cumulative impact of PAF mine waste may be environmentally significant if appropriate AMD management strategies during operation and closure are not implemented at site.

In assessing the potential risk of AMD generation a conservative approach was taken where by it was assumed BHP Billiton Iron Ore’s routine controls were not in place along with the conservative approach to AMD source classification (NAPP classification).

Outcomes of the assessment are summarised in Table 15 and Table 16 (refer to Appendix B for likelihood metrics). The likelihood of AMD generation has been ranked as a possible event for deposits B, C, E, F, P1 West, P1 East and P4. No PAF waste has been predicted at deposits A and D, while only an insignificant amount of PAF has been associated with the P3 Deposit. The likelihood of AMD generation from PAF mine waste at P3 has been ranked as an unlikely event. Also, the potential for AMD generation associated with pit walls has been ranked as an unlikely / rare event due to the limited exposure of PAF areas on the pit shell. It is important to note that uncertainty in assessments of the potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units. This could reduce estimated quantities of material identified as PAF.
Table 15: Likelihood for AMD generation from mine waste

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Likelihood</th>
<th>Mine Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Rare</td>
<td>0.1% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for all mine waste drill-hole intervals is negative. The NAPP block model for in-pit mine waste did not identity in-pit PAF material.</td>
</tr>
<tr>
<td>B</td>
<td>Possible</td>
<td>13% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~5 kg H₂SO₄/t). The NAPP block model predicts that 3% of mine waste is likely to be PAF. All PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>C</td>
<td>Possible</td>
<td>3% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~2 kg H₂SO₄/t). The NAPP block model predicts that 2% of mine waste is likely to be PAF. All PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>D</td>
<td>Rare</td>
<td>0.2% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for all mine waste drill-hole intervals is negative. The NAPP block model for in-pit mine waste did not identity in-pit PAF material.</td>
</tr>
<tr>
<td>E</td>
<td>Possible</td>
<td>0.7% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~4 kg H₂SO₄/t). The NAPP block model predicts that 0.4% of mine waste is likely to be PAF. All, but a negligible percentage of PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>F</td>
<td>Possible</td>
<td>10% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~4 kg H₂SO₄/t). The NAPP block model predicts that 6% of mine waste is likely to be PAF. All PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>P1E</td>
<td>Possible</td>
<td>7% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. The NAPP block model predicts that 1% of mine waste is likely to be PAF. All PAF material is located above the water table. Average NAPP value for PAF material is low (~4 kg H₂SO₄/t). Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
</tbody>
</table>

---

5 % of mine waste is based on the conservative NAPP classification (KCB 2014)
### Mine Waste

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Likelihood</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1W</td>
<td>Possible</td>
<td>6% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~5 kg H_2SO_4/t). The NAPP block model predicts that 2% of mine waste is likely to be PAF. All PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>P3</td>
<td>Unlikely</td>
<td>3% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~3 kg H_2SO_4/t). The NAPP block model predicts that 0.03% of mine waste is likely to be PAF. All PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>P4</td>
<td>Possible</td>
<td>7% of mine waste drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF material is low (~3 kg H_2SO_4/t). The NAPP block model predicts that 2% of mine waste is likely to be PAF. All PAF material is located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>Brockman Detrital</td>
<td>Possible</td>
<td>Lithologies likely to comprise the waste material at Brockman detrital, Scree and Tertiary Deposits may have the potential to develop AMD. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
</tbody>
</table>

### Table 16: Likelihood for AMD generation from wall rock

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Likelihood</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Rare</td>
<td>0.1% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for drill-hole intervals in the wall rock zone is negative. No PAF exposures have been identified on the pit wall.</td>
</tr>
<tr>
<td>B</td>
<td>Unlikely</td>
<td>6% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~3 kg H_2SO_4/t). The NAPP block model identifies a small surface exposure of PAF blocks on the pit wall (~15,000 m²). All PAF blocks intercepting the pit shell are located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
</tbody>
</table>

^6 % of mine waste is based on the conservative NAPP classification (KCB 2014)
### Wall Rock

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Likelihood</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Unlikely</td>
<td>0.8% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~1 kg H₂SO₄/t). The NAPP block model identifies a small surface exposure of PAF blocks on the pit wall (~8,000 m²). All PAF blocks intercepting the pit shell are located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>D</td>
<td>Rare</td>
<td>0.1% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for drill-hole intervals in the wall rock zone is negative. No PAF exposure have been identified on the pit wall.</td>
</tr>
<tr>
<td>E</td>
<td>Unlikely</td>
<td>0.6% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~5 kg H₂SO₄/t). The NAPP block model identifies a small surface exposure of PAF blocks on the pit wall (~30,000 m²). All PAF blocks intercepting the pit shell are located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>F</td>
<td>Unlikely</td>
<td>7% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~4 kg H₂SO₄/t). The NAPP block model identifies a small surface exposure of PAF blocks on the pit wall (~30,000 m²). All PAF blocks intercepting the pit shell are located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>P1E</td>
<td>Unlikely</td>
<td>4% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~4 kg H₂SO₄/t). No PAF exposures have been identified on the pit wall. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>P1W</td>
<td>Unlikely</td>
<td>4% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~10 kg H₂SO₄/t). The NAPP block model identifies a small surface exposure of PAF blocks on the pit wall (~24,000 m²). All PAF blocks intercepting the pit shell are located above the water table. Potential for AMD generation can be reduced if detailed geochemical testwork is conducted on key lithological units.</td>
</tr>
<tr>
<td>P3</td>
<td>Rare</td>
<td>1% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~3 kg H₂SO₄/t). No PAF exposures have been identified on the pit wall.</td>
</tr>
</tbody>
</table>
BHP Billiton Iron Ore
Mining Area C Mine Closure Plan

Wall Rock

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Likelihood</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4</td>
<td>Unlikely</td>
<td>2% of wall rock drillhole intervals have sulphur concentration &gt; 0.1 wt%. Average NAPP value for PAF drillhole intervals located in the wall rock zone is low (~3 kg H₂SO₄/t). The net acid production potential block model identifies a small surface exposure of PAF blocks on the pit wall (~3,000 m²). All PAF blocks intercepting the pit shell are located above the water table. Potential for AMD generation can’t be reduced if detailed geochemical test work is conducted on key lithological units.</td>
</tr>
<tr>
<td>Brockman Detrital</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Southern Flank Preliminary AMD Risk Assessment**

In 2016 an AMD risk assessment was undertaken by BHP Billiton Iron Ore for Southern Flank (Appendix G). Geochemical assay data from over 80,000 drillhole samples were incorporated into the resource model to assess net acid production potential (NAPP) and subsequently assign an AMD code/classification within the resource/mining model. The assessment considered the source, pathways and receptors for any potential AMD generated from the Southern Flank operations. In addition to the geochemical data the assessment incorporated geological and mine planning data, findings on surface water, groundwater and ecological studies.

Table 17 summarizes the purpose and modelling algorithms for assigning AMD classifications in resource and mining block models.

**Table 17: AMD Risk Classification**

<table>
<thead>
<tr>
<th>AMD Class Number</th>
<th>AMD Class Name</th>
<th>Possible Stratigraphy</th>
<th>Location Relative to Pre-Mining Water Table</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NAF</td>
<td>All</td>
<td>AWT or BWT</td>
<td>Low NAPP, inert, not an AMD risk</td>
</tr>
<tr>
<td>1</td>
<td>PAF</td>
<td>All except for Detritals and Surface Scree</td>
<td>BWT</td>
<td>Moderate or high NAPP, potentially acid forming, high AMD risk</td>
</tr>
<tr>
<td>2</td>
<td>Uncertain AMD risk weathered material</td>
<td>All except for Detritals and Surface Scree</td>
<td>AWT</td>
<td>Moderate or high NAPP, low to moderate acid forming or other AMD risk</td>
</tr>
<tr>
<td>3</td>
<td>Uncertain AMD risk detrital material</td>
<td>Detritals and Surface Scree</td>
<td>AWT or BWT</td>
<td>Moderate or high NAPP, low to moderate acid forming or other AMD risk</td>
</tr>
</tbody>
</table>

Data for conducting the AMD source risk assessment was sourced from the Geological Database (GBIS) and the Resource Models. Two types of assessments were completed.

A scoping level assessment was completed utilising drill core assay and geological data, and the 3D preferred pit shell and was extended to waste and low-grade ore located within the pit shell, and waste, low-grade and high-grade ore located within the wallrock. The wallrock was defined as that volume of rock located outside the pit shell but within ~20 meters from it. This assessment was qualitative in nature for material quantities. Geochemical properties were assessed based on exploration data and include total S, magnesium, calcium and Loss on Ignition. Total sulphur was used to estimate MPA, while
calcium, magnesium and loss of ignition are used to infer ANC. MPA and ANC combined are used to infer the NAPP value for each interval (AMD model classification). The NAPP value was then used to assign an AMD class to each drillhole interval.

A preliminary AMD source assessment was completed using outputs from the 3D Resource Models. This assessment provided a quantitative assessment of the AMD risk posed by the deposit by estimating material tonnages as a function of the AMD classification (AMD model) coded in the block model. Geochemical properties were assessed based on block model attributes (i.e. total sulphur, magnesium, calcium and loss on ignition values).

The following material domains were identified in the assessment:

- **Mine waste** – ex-pit (OSAs/waste dumps) or dumped in-pit mine waste, excluding high grade ore.
- **Wall rock** – assessment of the wall rock was conducted to gain an appreciation of the AMD risk associated with the pit wall and cone of depression.

Southern Flank can be characterised as a low sulphur system, the resource/mine models have no class AMD 1 (PAF) material and the majority (~97%) of waste classed as AMD 0 (NAF). Minor amounts of weathered and detrital material (~3%) are present, designated AMD 2 and 3 respectively, locally this percentage increases in some mining pits/pushback (Figure 7). Most sulphur in AMD 2 and 3 material has been oxidised and unlikely to be acid-generating as is common in weathered zones (INAP, 2014). Oxidised sulphur is likely to be in insoluble sulphate forms or minerals (i.e. gypsum) with any potential trace PAF amounts present as soluble acid sulphates (i.e. jarosite and alunite) which could contribute to solute loads in runoff. Additionally, trace lignite within the TD2 unit intersected in drilling contains ultra-fine pyrite, however, the lignite is generally discontinuous between drillholes and has an interpreted patchy distribution.

Key stratigraphic units with class AMD2 and 3 material are:

- West Angela Member (Wax), Mt Newman Member (Nx and MN) and MacLeod Member from the Marra Mamba deposits; and
- Tertiary Detritals (TD2)

Depending on the availability of ANC and rate of acidity generation, potential exists for some buffering to occur within OSAs and for pit wall run-off. At this point, however, the total and effective ANC budget, the distribution of the ANC with respect to the mining blocks, and the final placement of this material in the OSAs are not well understood. All AMD 0 (NAF), AMD 2 and AMD3 waste may be at risk of releasing neutral and metalliferous drainage (NMD) or saline drainage depending on the leachability of metals within each lithology.
Figure 7: Preliminary South Flank mine plan with indicative total mined waste and waste by AMD class (excluding AMD 0 NAF material) per pushback
Indications from available leachate data suggest that samples from most stratigraphies had near-neutral to acidic leachates with generally low to moderate (17 – 400 mg/L) sulphur concentrations depending on lithology. These data indicate that there may be potential for the leachate or runoff from the material to be somewhat saline. It is possible that soluble salts are present in NAF materials, and PAF mined from near-surface locations. Such salts could readily leach resulting in short-term pulses of salinity in contact waters.

In assessing the potential risk of AMD generation a conservative approach was taken where by it was assumed BHP Billiton Iron Ore’s routine controls were not in place along with the conservative approach to AMD source classification (NAPP classification).

Outcomes of the assessment are summarised in Table 18 and Table 19 (refer to Appendix D for risk matrix). The environmental impact without any controls and likelihood of AMD generation was assessed and all outcomes from mine waste and pit wall exposure come out as low risk due to no AMD 1 (PAF) material across Southern Flank. It is important to note even with a low risk that a cautious approach will still be taken to placement of AMD 2 and 3 material during mining and further detailed geochemical test work on key lithological units will be undertaken.

**Table 18: Likelihood for AMD generation from mine waste**

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Dumping Location</th>
<th>Impact</th>
<th>Likelihood</th>
<th>Mined Waste incl low grade*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex-pit</td>
<td>3</td>
<td>Very Rare</td>
<td>BWT: AMD 0=29Mt; AMD 1=0Mt</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AWT AMD 0=244Mt; AMD 2=3Mt; AMD 3=0.3Mt</td>
<td></td>
</tr>
<tr>
<td>In-pit</td>
<td>2</td>
<td>Rare</td>
<td>BWT: AMD 0=1Mt; AMD 1=0Mt</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AWT AMD 0=392Mt; AMD 2=10Mt; AMD 3=4Mt</td>
<td></td>
</tr>
<tr>
<td>Grand Central</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex-pit</td>
<td>2</td>
<td>Very Rare</td>
<td>BWT: AMD 0=2Mt; AMD 1=0Mt</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AWT AMD 0=246Mt; AMD 2=2Mt; AMD 3=1Mt</td>
<td></td>
</tr>
<tr>
<td>In-pit</td>
<td>1</td>
<td>Very Rare</td>
<td>BWT: AMD 0=29Mt; AMD 1=0Mt</td>
<td></td>
</tr>
</tbody>
</table>

* Approximate waste tonnages based on resource model outputs
### Table 19: Likelihood for AMD generation from wall rock

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Impact</th>
<th>Likelihood</th>
<th>AMD class as % total wallrock*</th>
</tr>
</thead>
</table>
| Highway       | 2      | Very Rare  | BWT Pit Wall  
AMD 0=15%; AMD 1=0%  
AWT Pit wall  
AMD 0=81.2%; AMD 2=3.6%; AMD 3=0.2% |
| Grand Central | 2      | Very Rare  | BWT Pit Wall  
AMD 0=11.2%; AMD 1=0%  
AWT Pit wall  
AMD 0=86.6%; AMD 2=1.9%; AMD 3=0.2% |
| Vista         | 2      | Very Rare  | BWT Pit Wall  
AMD 0=18.5%; AMD 1=0%  
AWT Pit wall  
AMD 0=79.1%; AMD 2=2.1%; AMD 3=0.4% |

*Based on outputs from drillhole assays

### Mining Area C Pathways

Potential transport pathways for AMD were identified as:
- Groundwater.
- Surface water.

A preliminary assessment of the likelihood of AMD entering transport pathways has been conducted, under the assumption that BHP Billiton Iron Ore’s controls and mitigation strategies are not employed. This assessment suggests that it would be possible for AMD to report to groundwater and surface water from overburden storage areas and backfilled pits, if any PAF material was left unmanaged.

### Mining Area C Receptors

The potential receptor areas include:
- Weeli Wolli Springs
- Coondewanna Flats (including Lake Robinson)
- Ben’s Oasis

At this stage of the project, impacts on receptors are difficult to quantify, even from only a qualitative aspect. Current information is limited, especially about pathways from sources and the impact of waste management/mitigation plans.

Table 20 summarises the source, pathway receptor analysis at post-closure associated with the likelihood (Appendix B for likelihood metrics) of AMD to enter transport pathways. Of note is the difference in likelihood of receptor impact between the pit lake and backfill scenarios.
Table 20: Source Pathway Receptor assessment post closure

<table>
<thead>
<tr>
<th>AMD Source</th>
<th>Transport Pathways</th>
<th>Hydraulic Regime</th>
<th>Receptor</th>
<th>Comments</th>
<th>Likelihood for AMD to enter transport pathways</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backfilled pit</td>
<td>Groundwater</td>
<td>In transition</td>
<td>Weeli Wolli Spring</td>
<td>During the time lag for the system to move from a sink to a flow through, leachable material that has accumulated within the backfill will be progressively remobilised. These leachable materials include soluble sulphide salts produced from sulphide oxidation, native sulphide salts, as well as leachable metals and salts from NAF material. In addition, readily soluble and sparingly soluble acid sulphide salts formed form sulphide oxidation in the cone of depression will be remobilised. Run off from the pit wall and seepage from the cone of depression may evaporate or infiltrate into the backfill.</td>
<td>Northern Flank: Possible Southern Flank: Unlikely</td>
</tr>
<tr>
<td>Flow through</td>
<td>Groundwater</td>
<td>Sink</td>
<td>Weeli Wolli Spring</td>
<td>Pore water in backfilled material may continually be leached as groundwater flows through it; however, loadings to the groundwater are likely to be lower compared to those released during transition to flow through. The loads to groundwater are likely to be sustained by the dissolution of sparingly soluble acid sulphide salts (i.e. jarosite / alunite) and from leaching of NAF materials. Once sulphide PAF is flooded its contribution to the acidity load leaving the pit is likely to be negligible. Run off from the pit wall may evaporate or infiltrate into the backfill.</td>
<td>Northern Flank: Possible Southern Flank: Unlikely</td>
</tr>
</tbody>
</table>

Management for AMD materials across BHP Billiton Iron Ore’s Pilbara sites is outlined at a high-level in the WAIO AMD Management Standard (See Section 8.4.1 for further detail).

7.2.4. Physical characteristics

As discussed in Section 7.2.1, the deposits located at Mining Area C can be differentiated into two different geological formations, named the Brockman and Marra Mamba formations after their dominant geologies. Within these formations materials are broadly defined in terms of geological stratigraphic
units. The proportion of the waste component associated with the different formations for Northern Flank is illustrated in Figure 8. **At Southern Flank waste is 100% from the Marra Mamba Iron Formation.**

Management of overburden physical characteristics is addressed in Section 8.4.1.

![Marra Mamba vs Brockman waste proportions for Northern Flank](image)

**Figure 8: Marra Mamba vs Brockman waste proportions for Northern Flank**

Material characterisation and field trials have been undertaken on waste types from both the Marra Mamba and Brockman formations and the associated stratigraphic units to further understand the erosion characteristics (Landloch 2012, 2013a, 2013b).

Analysis has included physical modelling including rainfall simulation and overland flow undertaken within laboratory conditions using predicted rainfall events based on local rainfall data. Laboratory methods including rainfall simulation and overland flow over a range of gradients have been undertaken resulting in quantification of:

- Interrill erodibility (Ki).
- Rill erodibility (KR)
- Critical Shear (tc)
- Effective Hydraulic conductivity (Ke)

The data has then been used in numerical modelling to assess how well a specific waste rock type (or blends of waste types) behaves under surface flow conditions. Numerical modelling tools of Water Erosion Prediction Project (WEPP) model and SIBERIA landform evolution model and the Revised Universal Soil Loss Equation (RUSLE) have been used.

Outcomes of the tests show variability in the parameters derived as illustrated in Figure 9.
In addition, field erosion trials located at other BHP Billiton Iron Ore sites are being used to collect data and calibrate the WEPP model predictions. The field trials will run for a number of years. Preliminary assessment of the existing data shows that WEPP is predicting runoff satisfactorily and reasonable agreement exists between measured and predicted cumulative erosion rates (Landloch, 2014).

SIBERIA modelling has analysed the performance of alternative landform design options including:

- Design profiles (linear slopes, concave slopes and bench and berm designs);
- Landform heights and angles; and
- Waste types including mixes (i.e. rockier material, growth media).

Outcomes of modelling corroborate that erosion is a function of the rock size distribution (well graded), slope grade and height. The application of concave slopes and augmentation of addition rock percentage to poorer performing waste material both successfully increased performance.

**Marra Mamba Deposits**

The major stratigraphic units that present the vast majority of the Marra Mamba style deposits can be broadly classified as Detrital, Mount Newman and West Angela waste materials.

Work to date has identified that the majority of the wastes associated with the Marra Mamba deposits, need to be considered highly erodible, therefore particular attention to the OSA design and construction techniques used to provide a stable landform will need specific management.

However, there can be a high degree of material variability from similarly classified geological units between locations.

Detritals can contain high proportions of clay rich materials or high levels of coarse fragments, significantly altering their response to erosive forces.
Brockman Deposits

Brockman deposits contain high proportions of Dales Gorge and Joffre materials. The material characterisation work associated with the Brockman waste types has shown that the material is significantly less susceptible to surface erosion than the Marra Mamba materials. Opportunities exist to stabilise the exterior surfaces of the Marra Mamba OSA’s to through combination with more competent waste types.

Management of overburden physical characteristics is addressed in Section 8.4.4.

7.2.5. Knowledge Gaps

The following knowledge gaps which have impacts on closure outcomes have been identified:

- Volume and availability of waste will be refined on an ongoing basis.
- Given the lower abundance of Inert Material Class 1 (Competent) rock suitable for the outer final landform rock armouring surfaces (particularly for South flank), maintain waste characterisation and erosion performance modelling focus as required to confirm final landform geometry and waste scheduling.
- Additional static and kinetic geochemical testing of the potential AMD generation is ongoing and required to refine assessments of the short and long term risks.

7.3. Slope stability and seismicity

A probabilistic seismic hazard assessment was conducted on selected BHP Billiton Iron Ore operations in the Pilbara in early 2012 (Meynink Engineering Consultants, 2012). The assessment was based on area seismic sources as no evidence of recent fault activity was recognised close to the BHP Billiton Iron Ore operations in the Pilbara during the preliminary neotectonic observations. The observations show that an inferred segmented fault system appears to run across the site; however, there is no indication of recent fault activity. In the Australian context, the Peak Ground Acceleration values estimated from this study correspond to a low to moderate seismic hazard.

7.3.1. Knowledge gaps

No knowledge gaps have been identified.

7.4. Landforms and land systems

Land systems across much of the grazing and pastoral lands of WA were surveyed, described and categorised during a series of surveys conducted by the Department of Agriculture. The Project lies within the Pilbara Region, which was surveyed in the period between 1995 and 1999, by Van Vreeswyk et al. (2004), with the results published in Technical Bulletin No. 92. The descriptions of the land systems below are consistent with those described in Technical Bulletin No. 92 (Table 21 and Figure 10).

A Soil and Landform Assessment was been carried out across the majority of the Southern Flank area (Outback, 2012) 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.
Table 21: Land systems underlying Mining Area C

<table>
<thead>
<tr>
<th>Land System</th>
<th>Description</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newman</td>
<td>Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.</td>
<td>Lower Proterozoic jaspilite, chert, siltstone, shale, dolomite and minor acid volcanics</td>
</tr>
<tr>
<td>Boolgeeda</td>
<td>Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.</td>
<td>Quaternary colluvium</td>
</tr>
<tr>
<td>Platform</td>
<td>Dissected slopes and raised plains supporting hard spinifex grasslands.</td>
<td>Stony plains with spinifex grasslands</td>
</tr>
<tr>
<td>Wunnamunna</td>
<td>Hardpan plains and internal drainage tracts supporting mulga shrublands and woodland (and occasionally eucalypt woodlands).</td>
<td>Quaternary alluvium and colluvium</td>
</tr>
</tbody>
</table>
Figure 10: Land systems of Mining Area C
7.4.1. Knowledge gaps
No knowledge gaps have been identified.

7.5. Soil characteristics
A review of the soil profiles at Mining Area C (MWH, 2015) found that most soil profiles consist of shallow clayey sand to sandy loam A horizon over a sandy loam B horizon with high coarse fraction. Soils within drainage lines of valley floors were slightly finer in texture (sandy clay loam) with less coarse material. Soils on upper ridge slopes and ridge crests were shallow and skeletal. The predominant difference between soil profiles across the site tends to be depth to solid or fractured rock, or coarse material. Root penetration depth, indicating depth of soil available for root exploration, ranged from 0.2 m to 0.8 m throughout the area. Soil pH ranged from slightly to moderately acidic with no consistent relationship to landscape position, while soil electrical conductivity (EC) was mostly found to be low. EC generally decreased with depth and some surface soils in drainage lines had slightly higher EC than surrounding, more-elevated areas.

As for the soil materials recorded at Southern Flank Envelope, the physical and chemical properties of the soil materials are relatively similar with the major difference between the soils present being the amount of coarse material present (Outback, 2012).

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. 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 are a valuable rehabilitation resource, suitable for rehabilitation placement on the upper, middle and lower slopes of waste landforms. 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.

In December 2013, BHP Billiton Iron Ore conducted a review of the soil requirements for mine closure against existing stockpiles at Northern Flank. The review concluded that the Northern Flank mine site requires approximately 2,654,000 m³ of soil for closure. In December 2014, a reconciliation of the quantity of stockpiled topsoil available recognised a deficit of approximately 1,120,000 m³ (excluding all transport areas (i.e. haul roads, tracks)). A high-level topsoil balance based on the current Northern Flank life of mine plan is provided in Table 22.

Table 22: Northern Flank topsoil balance

<table>
<thead>
<tr>
<th>Topsoil component</th>
<th>Volume (m³) x 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current topsoil stockpiles¹</td>
<td>1534</td>
</tr>
<tr>
<td>Topsoil requirements for current open footprint²</td>
<td>2654</td>
</tr>
<tr>
<td>Deficit based on current stockpiles</td>
<td>1120</td>
</tr>
</tbody>
</table>

¹ measured December 2014
² measured December 2013

Operations at Southern Flank are not expected to commence until early in the 2020s, mine planning is in preliminary stages and as yet no topsoil balances are available.

The suitability of soils at Mining Area C and other BHP Billiton Iron Ore sites as growth media during rehabilitation has been assessed as part of the WAIO Growth Media Atlas. This involved testing potential growth media material along with analogue material for chemical, fertility and physical analytes. The collation of this data forms the basis for the WAIO Growth Media Atlas.

The WAIO Growth Media Atlas will inform rehabilitation planning. As new areas are identified for rehabilitation and more soil samples are collected the Growth Media Atlas will continue to develop and...
expand. Reviewing the plant nutrition potential and structural attributes of specific growth media material compared to nearby analogue systems is used to inform rehabilitation planning and identify occasions where soil ameliorants or fertilisers may be required.

Management of Soils is addressed in Section 8.4.5.

7.5.1. Knowledge Gaps

Suitability of various waste types as growth media to be used during the rehabilitation process, is the focus on ongoing analysis for Mining Area C and other BHP Billiton Iron Ore mines.

7.6. Biodiversity

7.6.1. Threatened or Priority Ecological Communities

No Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) occur within the Mining Area C Development Envelope. Two sub-types of the Coolibah-lignum Flats PEC, which are associated with the Coondewanna Flats area (including Lake Robinson), occur immediately west of the Mining Area C Development Envelope. This area is separated from the development envelope by the Great Northern Highway. The Coondewanna Flats PEC is not considered to be groundwater dependent; although further work is required to determine whether the vegetation assemblages become partly dependent upon groundwater or even the overlying capillary fringe during significant drought periods where below average rainfall extends for > 9 years (AQ2, 2015).

Four other PECs occur between 10 km and 30 km of the Mining Area C Development Envelope; the Weeli Wolli Spring community (10 km to the east and south-east), the Fortescue Marsh (Marsh Land System, 30 km to the north-east), the West Anogals Cracking Clays community (15 km to the south), and the Brockman Iron Cracking Clay communities of the Hamersley Range (25 km to the south-west) (Figure 11).

The Weeli Wolli Springs PEC occurs within the cumulative groundwater footprint for Area C and Hope Downs Joint Ventures. Weeli Wolli Springs is discussed in detail in Section 7.7.

In the Biodiversity Audit of Western Australia’s 53 Biogeographical Subregions in 2002 (Kendrick, 2001), Mulga (Acacia aneura) is recognised as an ecosystem at risk within the Hamersley Interim Biogeographical Regionalisation of Australia (IBRA) subregion. Mulga in the Hamersley IBRA subregion is not listed as a TEC or PEC.
Figure 11: Location of Priority Ecological Communities in the vicinity of Mining Area C
7.6.2. Flora and vegetation

Mining Area C is located within the Hamersley IBRA Subregion in the Pilbara IBRA Bioregion (Thackway and Cresswell, 1995; DoE, 2014). The Hamersley Sub-region forms the southern section of the Pilbara Craton, and is dominated by Mulga low woodland over bunch grasses on fine textured soils in valley floors, with *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001).

Mining Area C is situated in the Fortescue Botanical District of the Eremaean Botanical Province (Beard, 1980; Van Vreeswyk *et al.*, 2004). Thirty four vegetation associations have been described and from within the Mining Area C Development Envelope (Onshore, 2016); see Figure 12.

No Declared Rare Flora (DRF) occur within the Mining Area C Development Envelope. Ten flora species listed as priority flora by the DPaW occur within the Mining Area C Development Envelope (Figure 13):

- *Acacia bromilowiana* (Priority 4);
- *Aristida jerichoensis* supsp. *spinulifera* (Priority 3);
- *Aristida lazaridis* (Priority 2);
- *Eremophila magnifica* subsp. *magnifica* (Priority 4);
- *Grevillea saxicola* (Priority 3);
- *Nicotiana umbratica* (Priority 3);
- *Rhamdia sp. Hamersley* (M. Trudgen 17794) (Priority 3);
- *Rostellularia adscendens* var. *latifolia* (Priority 3);
- *Sida* sp. Barlee Range (S. van Leeuwen 1642) (Priority 3);
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (Priority 3);

Twenty three introduced flora species have been recorded within the Mining Area C Development Envelope (Onshore, 2016); Table 23). None of these taxa are listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act).
Figure 12: Vegetation associations with the Proposed Mining Area C Development Envelope (see legend overleaf)
Figure 13: Conservation significant flora populations within the Proposed Mining Area C Development Envelope
Table 23: Introduced Flora Species recorded at Mining Area C

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Bidens bipinnata</td>
<td>Bipinnate Beggartick</td>
</tr>
<tr>
<td>*Cenchrus ciliaris</td>
<td>Buffel Grass</td>
</tr>
<tr>
<td>*Cenchrus setiger</td>
<td>Birdwood Grass</td>
</tr>
<tr>
<td>*Chloris barbata</td>
<td>Purpletop Chloris</td>
</tr>
<tr>
<td>*Chloris virgata</td>
<td>Feathertop Rhodes Grass</td>
</tr>
<tr>
<td>*Citrullus colocynthis</td>
<td>Colocynth</td>
</tr>
<tr>
<td>*Conyza bonariensis</td>
<td>Flaxleaf Fleabane</td>
</tr>
<tr>
<td>*Conyza sumatrensis</td>
<td>Tall Fleabane</td>
</tr>
<tr>
<td>*Cucumis melo subsp. agrestis</td>
<td>Ulcardo Melon</td>
</tr>
<tr>
<td>*Cynodon dactylon</td>
<td>Couch Grass</td>
</tr>
<tr>
<td>*Datura leichhardtii</td>
<td>Native Thornapple</td>
</tr>
<tr>
<td>*Digitaria ciliaris</td>
<td>Summer Grass</td>
</tr>
<tr>
<td>*Echinochloa colona</td>
<td>Awnless Barnyard Grass</td>
</tr>
<tr>
<td>*Euphorbia hirta</td>
<td>Asthma Weed</td>
</tr>
<tr>
<td>*Lactuca serriola</td>
<td>Prickly Lettuce</td>
</tr>
<tr>
<td>*Malvastrum americanum</td>
<td>Spiked Malvastrum</td>
</tr>
<tr>
<td>*Rumex vesicarius</td>
<td>Ruby Dock</td>
</tr>
<tr>
<td>*Setaria verticillata</td>
<td>Whorled Pigeon Grass</td>
</tr>
<tr>
<td>*Sigesbeckia orientalis</td>
<td>Indian Weed</td>
</tr>
<tr>
<td>*Solanum nigrum</td>
<td>Blackberry Nightshade</td>
</tr>
<tr>
<td>*Sonchrus oleraceus</td>
<td>Common Sowthistle</td>
</tr>
<tr>
<td>*Tridax procumbens</td>
<td>Tridax</td>
</tr>
<tr>
<td>*Vachellia farnesiana</td>
<td>Mimosa Bush</td>
</tr>
</tbody>
</table>

7.6.3. Terrestrial Fauna

The habitats and fauna identified within the Mining Area C Development Envelope and surrounding region are consistent with those identified for the Hamersley Subregion of the Pilbara IBRA (Biota Environmental Services, 2015).

Numerous surveys have been conducted at Mining Area C and surrounds, during which 11 vertebrate fauna species of conservation significance have been recorded within the Mining Area C Development Envelope. Twelve confirmed short-range endemic (SRE) invertebrate fauna species have been recorded within the Mining Area C Development Envelope, plus there are a number of potential SRE that occur. Four of the confirmed SRE species have not to date been recorded outside the development envelope.
The following species are considered to be important for management at Mining Area C:

- Ghost bat *Macroderma gigas* (listed as Vulnerable under the Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the Wildlife Conservation Act 1950 (WC Act)); and

- The short-range endemic millipede *Antichiropus* ‘DIP007’.

Within the Mining Area C Development Envelope the ghost bat relies on natural caves for roosting. (Figure 14). Sixty three caves have been identified within the development envelope, of which 25 are considered suitable for use as daytime roosts by the ghost bat. Fourteen of these caves occur within areas identified for mining. Ghost bats generally forage within 2 km of their roost, and utilise trees such as the snappy gum, *Eucalyptus leucophloia*, for feeding and resting. *Antichiropus* ‘DIP007’ occurs on hill crests across the Jirrpulpar Range, where it utilises vegetation at the base of the mallee eucalypt *Corymbia hamersleyana*.

Nine fauna habitats have been mapped within the Mining Area C Development Envelope (Table 24). Two of these habitats to have high value to vertebrate fauna (Gorge/Gully and Major Drainage Line), as they provide core habitat for conservation significant species. A number of roosts for the ghost bats have been recorded within the Mining Area C Development Envelope (Figure 14).

The habitats within the Proposed Mining Area C Development Envelope have been classified into six SRE habitat zones based on landform features, drainage features and vegetation features that influence SRE occurrence. Each zone contains one or several SRE habitat types. These habitat zones are:

- Major gorge/gully systems;
- River gorges;
- Shallow open gullies/ ridges;
- Hill slopes/ crests;
- Drainage areas;
- Mulga woodland; and
- Open plains.

The river gorges and major gorge/ gully systems are considered to have the most value to SRE species. In addition, area on the hill slopes/ crests that contain the mallee Eucalypt, *Corymbia hamersleyana*, is considered core habitat for the millipede *Antichiropus* ‘DIP007’. 
Table 24: **Fauna habitat descriptions of Mining Area C**

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Distinguishing habitat characteristics</th>
<th>Habitat value</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<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 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 the Development Envelope.</td>
<td>Medium – provides habitat for the Western pebble-mound mouse, which is largely restricted to this habitat type.</td>
<td><img src="image1.jpg" alt="Photo" /></td>
</tr>
<tr>
<td>Drainage Area/ Floodplain</td>
<td>Characterised by low and sparse vegetation compared to Major Drainage Lines. Consisted of <em>Acacia</em> low woodland sometimes with scattered <em>Eucalyptus xerothermica</em> and <em>Corymbia hamersleyana</em>. The understorey generally lack 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 Area C Rev 6 EMP.</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>
<td><img src="image2.jpg" alt="Photo" /></td>
</tr>
<tr>
<td>Habitat type</td>
<td>Distinguishing habitat characteristics</td>
<td>Habitat value</td>
<td>Photo</td>
</tr>
<tr>
<td>-------------</td>
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</tr>
<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>High - Gorge/ Gully habitats provide habitat for Pilbara olive python, northern quoll, Pilbara flat-headed blindsnake and the 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>
<td><img src="image" alt="Gorge/ Gully Habitat" /></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>Low – may provide habitat for water birds when inundated. No significant species are expected to be reliant on this habitat.</td>
<td><img src="image" alt="Hardpan Plain Habitat" /></td>
</tr>
<tr>
<td>Habitat type</td>
<td>Distinguishing habitat characteristics</td>
<td>Habitat value</td>
<td>Photo</td>
</tr>
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<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<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 <em>Acacia</em> species. Rocky outcropping is common throughout these valleys and crumbling breakaways form boulder piles in some locations. Previously mapped as Valley in the Area C Rev 6 EMP.</td>
<td>Low – no conservation significant species restricted to or largely reliant on this habitat type.</td>
<td><img src="image1.jpg" alt="Minor Drainage Line" /></td>
</tr>
<tr>
<td>Major Drainage Line</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. victrix</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 reedbeds around pools.</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/or 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>
<td><img src="image2.jpg" alt="Major Drainage Line" /></td>
</tr>
<tr>
<td>Habitat type</td>
<td>Distinguishing habitat characteristics</td>
<td>Habitat value</td>
<td>Photo</td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Mulga Woodland</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><strong>Medium</strong> - 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><img src="image1.jpg" alt="Mulga Woodland" /></td>
</tr>
<tr>
<td>Stony Plain</td>
<td>These are erosional surfaces of gently undulating plains, ridges and associated footslopes. 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 the Area C Rev 6 EMP.</td>
<td><strong>Low</strong> - Habitat is widespread within the Pilbara region and does not exclusively support any conservation significant species within the Development Envelope.</td>
<td><img src="image2.jpg" alt="Stony Plain" /></td>
</tr>
<tr>
<td>Habitat type</td>
<td>Distinguishing habitat characteristics</td>
<td>Habitat value</td>
<td>Photo</td>
</tr>
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</tr>
<tr>
<td>Sandplain</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>Medium - supports a diverse fauna community, particularly fossorial species, which are usually restricted to this habitat type. (Note, at a regional scale this habitat is considered to have high conservation value due to potential presence of the Greater Bilby).</td>
<td><img src="image" alt="Photo" /></td>
</tr>
</tbody>
</table>
Figure 14: Vertebrate fauna habitats and ghost bat roosts at Mining Area C
7.6.4. Subterranean fauna

**Troglafauna**

Troglafauna surveys at Mining Area C and its surrounds have been undertaken in accordance with BHP Billiton Iron Ore’s *Regional Subterranean Fauna Study* methodology which has been endorsed by DPaW. The sampling effort exceeded the minimum sampling effort prescribed in the *Guidance for the Assessment of Environmental Factors Statement No. 54a* (EPA, 2007) and the Environmental Assessment Guideline for Consideration of subterranean fauna in environmental impact assessment in Western Australia (EAG 12) (EPA, 2013).

A total of 3,073 specimens of troglafauna have been collected in the Proposed Mining Area C Development Envelope. These specimens represent at least 126 species from 19 orders (Bennelongia, 2016). Eighty-six of these species have only been recorded from within the Proposed Mining Area C Development Envelope to date.

The primary impact to troglafauna species at Mining Area C is the direct loss of habitat resulting from mine pit excavation during operations (Bennelongia, 2016). It is considered there will be no additional impacts to threaten troglafauna conservation following mine closure.

**Stygofauna**

Stygofauna surveys at Mining Area C and its surrounds have been undertaken in accordance with BHP Billiton Iron Ore’s *Regional Subterranean Fauna Study* methodology which has been endorsed by DPaW. The sampling effort exceeded the minimum sampling effort prescribed in the *Guidance for the Assessment of Environmental Factors Statement No. 54a* (EPA, 2007) and the Environmental Assessment Guideline for Consideration of subterranean fauna in environmental impact assessment in Western Australia (EAG 12) (EPA, 2013).

Mining Area C lies in the Hamersley Range and within the catchment of Weeli Wolli Creek, which is a tributary of the Fortescue River. The Weeli Wolli Creek Catchment is divided into three sub-catchments:

1) Upper Weeli Wolli Creek Catchment (1,877 km²);
2) Marillana Creek Catchment (2,050 km²); and
3) Lower Weeli Wolli Creek Catchment (210 km²) (into which 1 and 2 flow).

The Weeli Wolli Creek Catchment is flanked by the Coondewanna Catchment (862 km²), which is part of the Ashburton River. Groundwater sometimes flows across the catchment divide between the Upper Weeli Wolli Creek Catchment and Coondewanna Catchment (URS 2014).

A total of 5,963 specimens of stygofauna have been collected within the Upper Weeli Wolli and Coondewanna catchments, comprising at least 78 species from ten higher level groups. Seventeen stygofauna species have been recorded within the Groundwater Assessment Area (the area of modelled groundwater drawdown) of which six are only known from this area.

After mine closure, there will be a slow recovery of groundwater levels in the Mining Area C area to pre-mining conditions.

7.6.5. Knowledge Gaps

The following knowledge gaps which have impacts on closure outcomes have been identified:

- Two man-made ghost bat roosts have been built on BHP Billiton Iron Ore tenure during 2015/2016. Monitoring is underway to determine the success of these roosts and if they can be used to mitigate the impacts of loss of natural roosts;
- Ecology of the ghost bat in the Hamersley Ranges and the vicinity of Area C, including use of roosts and core feeding areas;
- The ability to recreate habitats for conservation significant species, including the SRE millipede and Priority flora;
An assessment on the potential impacts, including recovery, to the stygofauna community resulting from the recovery of groundwater levels post-closure;  
Assessment of rehabilitation areas as providing suitable habitat for fauna; and  
Recovery of the Weeli Wolli Springs PEC following closure of Hope Downs and subsequent management undertaken by Hope Downs Joint Venture to recover water levels at the springs

7.7. Hydrology

7.7.1. Surface Water

The conceptual understanding of Northern Flank and South Flank surface water regime was undertaken by RPS (2014) and MWH (2016). A summary of these findings are provided below.

Regional hydrology

The pre-mining surface water regime is illustrated in Figure 15.

Weeli Wolli Spring Catchment

The majority of the Northern Flank and South Flank orebodies are located within the Weeli Wolli Creek Catchment upstream from Weeli Wolli Spring. Weeli Wolli Creek is an ephemeral flowpath flowing in direct response to rainfall and Weeli Wolli Spring is a natural surface expression of groundwater flow resulting from hydrogeological features in the Weeli Wolli Creek bed. The surface water catchment upstream from Weeli Wolli Spring has an approximate area of 1,450 km².

Weeli Wolli Creek is one of several large watercourses discharging into the Fortescue Marsh, and Weeli Wolli Spring is located around 60 km upstream from the marsh. Other large watercourses discharging to the marsh include Marillana/Yandicoogina Creek (via Weeli Wolli Creek) and the Fortescue River. Several tributary creeks enter into Weeli Wolli Creek upstream from the spring, including Pebble Mouse Creek which passes adjacent to the South Flank development.

Ben's Oasis is a perennial pool on Weeli Wolli Creek located around 20 km upstream from Weeli Wolli Spring. The pool is a natural expression of the water table which has mounded upstream of a dolerite dyke. Womunna Waterhole (Wanna Munna Pool) occurs in a setting similar to Ben’s Oasis, but around 8 km further upstream on a tributary to Weeli Wolli Creek.

The natural Weeli Wolli Creek channel and main tributaries are expansive and well defined. The bed slopes are moderately steep which, in conjunction with the flow regime, has resulted in the creek beds dominated by coarse gravels and pebbles. Although the Weeli Wolli Creek main channels are relatively wide and deep, large flood flows tend to overtop the banks.

The gravel bed along Weeli Wolli Creek and its main tributaries is generally clear of vegetation with the exception of occasional eucalypt trees, whereas the creek banks (and some floodplain zones) typically support a continuous ribbon of riparian eucalypts. Melaleuca trees are also present around Weeli Wolli Spring. Away from the creek channel, the vegetation typically changes to spinifex and shrubs. Riparian eucalypts along the creek channels tend to be less dense with distance upstream from Weeli Wolli Spring.

Weeli Wolli Creek typically has 0 to 2 flow events a year. These events are generally short duration, with little post rainfall flow persistence, although peak discharges are typically generated by longer duration storms which saturate the catchment and streamed, resulting in streamflow. However, following above average wet seasons, the creek can flow for a period of several months. Under natural conditions, Weeli Wolli Spring discharges are continuous through the spring zone and dissipate into the river gravels a few kilometres downstream.

With the development of the Rio Tinto Iron Ore Hope Downs 1 deposit, mining operations have extended across Pebble Mouse Creek necessitating the creek to be diverted approximately 2 km eastwards from its natural course into the adjacent main Weeli Wolli Creek channel. This diversion is located around 3 to 4 km upstream from the natural confluence of the two creeks and about 16 km downstream of South Flank.
Excess dewatering water from mining operations at the Hope Downs 1 deposit is discharged into the main Weeli Wolli Creek channel just downstream from Weeli Wolli Spring (HDMS, 2000). Small dewatering volumes are also discharged upstream from the spring, to maintain the natural pools and spring flows. The main dewatering discharges have created a surface expression of the water table in the creek bed downstream from Weeli Wolli Spring to around its junction with Marillana Creek approximately 15 km downstream.

**Coondewanna Catchment**

The western parts of the Northern Flank and South Flank developments are located within the Coondewanna Catchment, which is an internally draining catchment of about 860 km² located to the east of the Weeli Wolli Spring Catchment as shown in Figure 15. Although internally draining, the catchment is located within the Ashburton River Basin. Catchment runoff is discharged into an internal depression known as Lake Robinson where water dissipates by seepage and evapotranspiration.

Although the runoff characteristics from ridgelines in the Coondewanna Catchment would be typical of Pilbara catchments, topographical mapping shows that the catchment contains numerous large relatively flat areas where runoff would tend to pool and slowly drain downstream. These areas represent the Clay-Pan and Hard-Pan landscape units and runoff over many of these flatish areas would discharge as sheetflow. These characteristics indicate that relative runoff volumes from the catchment as a whole would be low compared with a more freely draining catchment, such as the Weeli Wolli Spring Catchment.

Lake Robinson is located in the south-eastern sector of Coondewanna Catchment and is the lowest area at around 687 m AHD. The main flowpath discharging to Lake Robinson is Homestead Creek which drains the northern half of the catchment. Where Homestead Creek passes adjacent to Pack saddle Hill, around 8 km north from Lake Robinson, the creek has a well-defined single channel. The creek bed at this location is described as comprising coarse gravels and sands, around 15 m wide with 1 – 2 m high banks. Scattered eucalypt trees are located along the creek bed.

During a high rainfall event, runoff could potentially discharge to Lake Robinson from all sides, with proportionally higher runoff from ridgelines which are in close proximity. However it is estimated that as runoff from over 50% of the catchment would need to pass through flatish slowly draining areas prior to reaching Lake Robinson, relative runoff volumes to the lake would typically be low for small to medium rainfall events. Significant runoff to Lake Robinson would likely only occur after a large rainfall event. It is estimated that runoff and inundation at the lake has a return period of ~1 in 4 or 5 years.

**Local hydrology – Northern Flank**

The existing and proposed mine infrastructure (i.e. railway, stockpiles, waste dumps, facilities) is located in the base of a broad valley, aligned east-west, with a base width around 1000 to 1500 m, through the eastern portion of which a tributary of Weeli Wolli Creek flowed. This drainage path is now heavily modified by mining activities.

Although the majority of the mine development area catchment drains eastwards to the Weeli Wolli Creek, the western portion drains westwards to the Coondewanna Flats area. On the valley floor, the natural divide between the two catchments is on the western side of OHP2 (E Deposit plant). From this catchment divide, the valley floor slopes through the mine development area, both eastwards and westwards at a gradient of around 0.7%, though some local variations to this slope occur. Two main tributary creeks enter the valley floor from the north side ridge, both of which are significant sources of runoff. The western main tributary creek draining the Northwest Sub-Catchment (Figure 15) has a catchment area of around 9 km². The creek has a delta which formed the pre-mining catchment divide within the valley floor. Depending on the creek path exiting this catchment, runoff would either be directed to the east or west. Prior to mining the flow was generally directed to the east. Through mining operations, BHP Billiton Iron Ore has implemented earthworks which result in this catchment now flowing westwards into the Coondewanna Catchment.

The eastern main tributary creek draining the North Central Sub-Catchment has a catchment area of around 6 km² and naturally drains eastwards to the Weeli Wolli Creek system. Currently, the flows are being captured in an existing mine diversion drain installed along the north side of the C Deposit Pit,
and directed eastwards towards an existing sediment basin. North from the mine area catchments, drainage generally flows northwards in the Marillana Creek Catchment and to the northeast into the Yandicoogina Creek Catchment. A small portion of the planned P3 pit extends into the Yandicoogina Creek Catchment. The C, D and E deposit pits intercept catchments draining from the south. As these streams are well incised, diversion of these catchments is not practical and stormwater is managed in-pit (Figure 26).

Changes in natural surface water flow patterns resulting from development of pits, OSAs and other infrastructure were identified in the Mining Area C Hydrological Impact Assessment and Water Management Summary (BHP Billiton Iron Ore, 2015b). Impacts to the surface water flow volume and quality is not expected to be significant owing to the continued use of preventative controls such as creek diversion and sedimentation ponds. The volume of surface water intercepted by mining activities is estimated to be around 740 Megalitres per annum (ML/a) from the total catchment flow for the Upper Weeli Wolli catchment area. The interception and effective removal of surface water which would ultimately discharge or infiltrate into the Weeli Wolli Spring region is around 4.2% of pre-development volumes and is considered to be insignificant in comparison to the disruption which has occurred owing to mining in the lower catchment. For Coondewanna, the volume of surface water flow may increase slightly to 0.3% owing to changes in landform runoff in the vicinity of the surface water catchment divide, which effectively increases the capture area.

Management of surface water is addressed in Section 8.4.3.

**Local hydrology – Southern Flank**

The Southern Flank development is generally located along catchment divides straddling the Weeli Wolli Creek and Coondewanna catchments with Mount Robinson to the south (Figure 15). The north western and south western local sub-catchments drain westwards across the Great Northern Highway into Lake Robinson within the Coondewanna Catchment. The north eastern local sub-catchment drains to Weeli Wolli Creek, and the south eastern local sub-catchment drains to Pebble Mouse Creek.

Pebble Mouse Creek passes to the south of the Southern Flank development and flows in an easterly direction. The catchment is about 166 km² upstream of Southern Flank and about 340 km² to its junction with Weeli Wolli Creek. The creek is generally well defined with a 10m wide, 1 – 1.5 m deep low flow channel. The planned developments come within the Pebble Mouse Creek floodplain but the main channel flow path remains unaltered.

Changes in natural surface water flow patterns resulting from development of pits, OSAs and other infrastructure were identified in the Southern Flank Surface Water Environmental Impact Assessment (MWH, 2016).

The post-closure creek capture of Pebble Mouse Creek represents the largest potential loss of catchment area draining to downstream receptors. The location of the closest planned pit to the creek was compared against the modelled 10,000 year ARI flood extent. The assessment shows the pit perimeter is about 100m away from the estimated 10,000 year flood extent with at least 2m freeboard (Figure 26). Therefore, creek capture is currently not considered a closure risk.

Impacts to the surface water flow volume are not expected to be significant with the potential disturbance area being 3.5% of the Weeli Wolli Creek catchment and 4.7% of the Coondewanna catchment. Impacts to water quality are also not expected to be significant with standard management measures applied to mitigate against erosion, sedimentation and contamination.

Management of surface water is addressed in Section 8.4.3.
Figure 15: Mining Area C pre-mining surface water catchments
Figure 16: South Flank 10,000 year Pebble Mouse Creek capture risk
7.7.2. Groundwater

Groundwater abstraction at Mining Area C is approved under Groundwater Well Licence (GWL) No. 110044(10), which has an annual water entitlement of up to 15,330,000 kilolitres per annum (kL/a). In accordance with the GWL Operating Strategy for Mining Area C (BHP Billiton Iron Ore, 2014a) has been developed and implemented.

BHP Billiton Iron Ore undertakes conceptual and numerical modelling to understand the dewatering management needed for operations and closure. Further details are provided in the sections that follow.

Conceptual model

The conceptual understanding of Mining Area C groundwater was undertaken by RPS (2014) and summarised below.

The North Flank and Packsaddle deposits that constitutes Mining Area C are situated in a groundwater catchment that is approximately coincident with the surface water catchments of Weeli Wolli Spring (1,450 km²) and Coondewanna (860 km²) (Figure 17). The Mining Area C closure hydrogeological assessment is therefore focussed on these areas.

The regional groundwater flow system is hosted in valley aquifers (detritals) and underlying dolomite (where karstic). This system is surrounded by low permeability (aquitard) geology. Within the low permeability units however there are pods of high-permeability material associated with orebodies. The extent to which the orebodies are in hydraulic connection with the broader regional groundwater system varies. The hydrogeology can be influenced by structural features with an enhancement of permeability associated with faults and folds, and dykes potentially acting as flow barriers.

Groundwater generally flows across the catchment from west to east; from Coondewanna Flats and along the North and South Flank Valleys (Figure 17). Groundwater then flows to Weeli Wolli Spring that marks the surface and groundwater outflow from the groundwater catchment.

Groundwater levels are around 700 mAHD at the western catchment margins and fall to 550 mAHD at the spring outflow. In the area of Mining Area C, groundwater levels prior to mining were between 660 to 570 mAHD (west to east). In certain areas these have been reduced locally by up to 80 m due to dewatering activities. In the vicinity of Rio Tinto Iron Ore’s Hope Downs 1 mine, groundwater levels have been reduced by up to 55m since mining commenced in 2006.

The depth to water across the area varies between 0 mbgl and over 100 mbgl, but typically the range across much of the catchment is 15 – 60 mbgl. Generally, depth to water is lowest in the areas of Coondewanna Flats and Weeli Wolli Spring where surface water and groundwater flow concentrates. Depth to water is greatest in the upland areas (Figure 18).

The majority of the groundwater recharge occurs via seepage from the Lake Robinson – which forms in Coondewanna Flats after inundation events. Enhanced recharge also occurs in the area of Weeli Wolli Spring via surface exposures of calcrites. Recharge occurs seasonally or periodically in response to high magnitude low frequency rainfall events. On average, significant recharge to the groundwater system occurs annually at Weeli Wolli Spring and every four years at Coondewanna Flats. A limited amount of recharge also occurs from diffuse recharge over the entire catchment in response to seasonal rainfall events.

Natural groundwater discharge from the catchment occurred primarily at Weeli Wolli Spring as spring baseflow and as throughflow in the alluvium of the creek valley. Additional groundwater discharge occurs as evapotranspiration losses, likely to occur in particular in the area upstream of Weeli Wolli Spring, at Ben’s Oasis and possibly Coondewanna Flats, where vegetation access groundwater.

Induced discharge also occurs through pumping to support mining operations in the catchment. The main sources of abstraction within the area are from the Mining Area C and Rio Tinto Iron Ore’s Hope Downs mining operations.

Dewatering abstraction from C and E deposits started in 2010 at around 8000 kilolitres per day (kL/d) cumulatively and has increased since to 42,000 kL/d. Dewatering volumes are predicted to increase when new BWT pits become operational. Majority of the groundwater from dewatering activities is used
by mining operation and the excess volumes are currently managed through managed aquifer recharge scheme.

Dewatering from the Hope Downs mining operations commenced in January 2007 and is proposed to continue until the end of 2025. Rio Tinto Iron Ore have estimated that a dewatering abstraction rate of up to approximately 110,000 kL/d will be required (HDMS, 2000). This is predicted to have an impact on natural flows at Weeli Wolli Spring and Rio Tinto Iron Ore have committed to artificially support the spring until the natural flow returns to within 10% of pre-mining flow rates (HDMS, 2000).

All groundwater samples from the catchment are fresh with total dissolved solids (TDS) ranging between 200 mg/L and 700 mg/L. Higher TDS values are generally associated with areas of potential evapotranspiration.

**Numerical model**

A three dimensional numerical groundwater flow model has been constructed to assess the behaviour of the catchment under various closure scenarios. The model incorporates the majority of the Coondewanna and Weeli Wolli Spring catchments and the major recharge and discharge mechanisms within them (Figure 18). The model was calibrated to groundwater levels observed between 1998 and late 2012 and Weeli Wolli Spring flows observed between 1998 and 2006. The majority of the groundwater observations are in the vicinity of the Mining Area C mine, but several regional observations were also available.

Mine void closure configurations for Northern Flank are yet to be finalised. To understand the potential changes in groundwater regime as a result of alternative mine void closure configurations, a number of scenarios were tested. Initial modelling for Northern Flank considered two mine void closure alternatives:

- a) Base case: All BWT pits (excluding A and E) backfilled to above pre-mining water table. Current mine waste schedule without rehandling of waste to backfill pits
- b) Alternative case: All BWT pits backfilled to above pre-mining water table. Illustrates the 'no pit lake' case.

The groundwater model was updated to assess the groundwater change due to South Flank activities. This model was used to assess potential closure impacts due to South Flank. Modelling for South Flank considered two mine void closure scenarios:

- a) Case 1: All BWT pits backfilled to above pre-mining water table with the exception of Highway deposits.
- b) Case 2 All BWT pits backfilled to above pre-mining water table. Illustrates the 'no pit lake' case.

The models were used to assess recovery in groundwater levels and the change in groundwater quality from the point of closure onwards. To do this, the model will be run for the life of mine (2014 to 2073) and then from closure until the point when the groundwater system has reached equilibrium (full recovery).

For North Flank change in hydrological conditions at Coondewanna Flats is predicted to be between 6 and 9.5 m by the end of mining activities in 2054. The net change or rate of change in water levels is considered unlikely to result in an impact to the PEC (AQ2, 2015). Recovery time for water levels to pre-mining levels is expected to be in the order of 100 years. Impacts to Weeli Wolli Spring are considered unlikely.

For South Flank an additional change of between 4-14m is predicted at Coondewanna Flats by the end of mining activities. For Case 1 groundwater levels continue to drop post-mining as the aquifer equilibrates with evaporation from the pit void at Highway. This results in a permanent drawdown of 17-27m beneath Coondewanna, with a permanent drawdown of around 0.5-0.7m propagating to Weeli Wolli Spring. This drawdown would take in the order of hundreds of years to reach and stabilise at those levels. The extension of drawdown to Weeli Wolli is subject to uncertainty and is precautionary based on the assumption that these two areas are well connected via the regional aquifer. Should this connection prove to be less robust then residual impacts at Weeli Wolli from an open pit at Highway may not eventuate.
For Case 2, recovery times for water levels at Coondewanna to pre-mining levels are in the order of 200-300 years (BHP Billiton Iron Ore, 2016) and are driven by natural recharge processes. Impacts to Weeli Wolli Spring are considered unlikely as a result of South Flank activities, however, cumulative impacts from all operations in the catchment (including Hope Downs) has potential to result in a change at Weeli Wolli following Hope Downs closure activities in 2054.

The net change or rate of change in water levels is considered unlikely to result in an impact to the Coondewanna PEC. However, a longer monitoring data set (of the soil and groundwater hydrological conditions) would be required to determine whether the vegetation assemblages become partly dependent upon groundwater or even the overlying capillary fringe during significant drought periods where below average rainfall extends for > 9 years (AQ2, 2015).

Consultation with key stakeholders, (including the Department of Water) regarding model predictions and management strategies will be ongoing.

Management of groundwater is addressed in Section 8. Further work proposed to close knowledge gaps in regards to groundwater is outlined in Section 8.5.
Figure 17: Conceptual hydrology of the Central Pilbara
Figure 18: Groundwater contours and depth to water
7.7.3. Eco-Hydrological

Ecohydrology is a relatively new and rapidly advancing interdisciplinary field. It integrates a wide range of disciplines including meteorology, hydrology/hydrogeology, geomorphology, biogeochemistry, soil science, and the various branches of ecology.

Ecohydrological models have been developed for the Coondewanna Flats, Weeli Wooli Spring and Bens Oasis (RPS, 2014) which draw together the movement and storage of water in the environment and the relationship to vegetation. The conceptual models will continue to be developed and updated over the life of the Mining Area C operation, informed by new data and information as it becomes available.

Gaining an understanding of ecohydrology enables improved management, protection and/or restoration of landscape, water and ecological assets.

7.7.4. Coondewanna Flats model

The key features of the ecohydrological conceptualisation of the Coondewanna Flats are depicted in Figure 19.

Ecosystem components

- Vegetation of the Lake Robinson area includes Western Coolibah (*Eucalyptus victrix*) woodlands over open shrubland of Lignum (*Duma* (Muehlenbeckia) *florulenta*) and tussock grassland of *Eriachne benthamii*, *Eulalia aurea* and *Themeda triandra*; growing on orange brown loamy clay. This corresponds to the zone of most frequent and prolonged inundation following catchment runoff events.

- Vegetation of the slightly more elevated flats surrounding the Lake Robinson area includes open forest of Mulga (*Acacia aptaneura* and closely related taxa) with occasional Western Coolibah over sparse Lignum and tussock grasses growing on red brown clay loam.

- The Western Coolibah trees on Coondewanna Flats rely on stored soil moisture to meet their water use requirements. Studies indicate they are able to obtain water for prolonged periods from deeper layers in the unsaturated zone above the water table (pre-dawn leaf water potentials of at least 4,000 kPa have been measured after prolonged dry conditions). There is no evidence to suggest that they use groundwater. It is believed that the surface water regime of regular soil water replenishment (around 3 out of 4 years) maintains sufficient soil moisture to support these trees.

- The surface water dynamics of Coondewanna Flats are likely to influence Western Coolibah bud-set, flowering, seed production and seedling recruitment. However further investigations are necessary to understand the relationship between flooding regimes and the phenological cycle of the woodland trees.

- Mulga is a shallow rooted species with xerophytic adaptations to drought stress. It is likely that the water use requirements of the Mulga communities are met by soil water in surface layers (up to 5mbgl), which is replenished by rainfall and run on.

- The Lake Robinson waterbody is ephemeral but may persist for several months after large catchment runoff events. Little is known about the water quality or aquatic invertebrate assemblages in the lake when it holds water.
Figure 19: Coondewanna Flats (including Lake Robinson) ecohydrological model

7.7.5. Weeli Wolli Spring (and Ben’s Oasis)

The key features of the ecohydrological conceptualisation of the Weeli Wolli Spring area are depicted in Figure 20.

Ecosystem components

- The Weeli Wolli Spring area hosts a PEC including groundwater dependent vegetation, permanent pools supporting a range of fauna, a unique bat community for the Pilbara and a diverse stygofauna community.

- The riparian woodlands include the obligate phreatophyte Silver Cadjeput (Melaleuca argentea) and the facultative phreatophytes River Red Gum (Eucalyptus camaldulensis) and Western Coolibah. These access shallow groundwater and contribute to groundwater discharge via evapotranspiration. Woodland transpiration is likely to occur from areas where the water table is less than 20 mbgl (albeit at a declining rate as the water table depth increases). The proportion of groundwater used by the woodland vegetation (as a component of total water use) would be expected to be greatest where the depth to water table is shallow (i.e. where soil moisture storage in the unsaturated profile is limited by depth).

- The base of the calcrite is such that there is up to 30 m of saturated calcrite across a broad area. This provides the main stygofauna habitat, although data sources suggest that stygofauna do occur in other alluvial deposits over a wider area.

- A number of permanent pools occur in the calcrite formation up gradient from Weeli Wolli Spring, which are sustained by the shallow groundwater regime. These provide aquatic habitat and a permanent water source for terrestrial fauna and avifauna. The valley of Weeli Wolli Spring is known to support a very rich microbat assemblage.
Ben’s Oasis

No information is available regarding groundwater levels or seasonal variation at Ben's Oasis. No drilling has occurred in the area and the stratigraphy is poorly characterised. As such, there is insufficient information to formulate a conceptual ecohydrological model for Ben’s Oasis at the present time. Based on general knowledge of the area and extrapolation from elsewhere, it is postulated that the groundwater system may comprise either:

- A perched-alluvial aquifer confined to a shallow channel incised through low-permeability basement. Bank-storage and seepage from this perched aquifer would replenish local rockpools between surface runoff events. Perched groundwater in this shallow aquifer would also support riparian vegetation; or

- A currently undefined flow constraint in the regional groundwater system, which through subsurface impoundment brings water levels close to the surface. Surface flow at Ben's Oasis is likely to have a similar frequency to the Weeli Wolli Spring area (i.e. on average two surface water flow events each year) but the magnitude will be substantially less in proportion to the much smaller contributing catchment area. On the basis of the regional water balance, total discharge from Ben's Oasis attributable to evapotranspiration is estimated to be up to 1,000 kL/d.

Figure 20: Weeli Wolli Spring ecohydrological model

7.7.6. Knowledge Gaps

The following knowledge gaps which have impacts on closure outcomes have been identified:

- Reliable estimates of the surface runoff characteristics - peak flows, volumes and quality.
- Uncertainty in Hope Downs closure plans and range of groundwater outcomes.
- Likely groundwater recovery times across the catchment.
- Better definition of the mine development plans for the pit and OSA areas
- Improved understanding of regional connectivity between Coondewanna Flats and Weeli Wolli Spring
Coondewanna PEC dependence on groundwater: Longer monitoring data set (of the soil and groundwater hydrological conditions) would be required to determine whether the vegetation assemblages become partly dependent upon groundwater or even the overlying capillary fringe during significant drought periods where below average rainfall extends for > 9 years (AQ2, 2015).

7.8. Site Contamination

Mining Area C has 21 suspected contaminated sites which are managed in accordance with BHP Billiton Iron Ore Contaminated Sites Management (Work Instruction). Listed in the BHP Billiton Iron Ore Contaminated Sites Register, all 21 sites have been ranked as “Low” impact to groundwater, “Low” to “Moderate” impact to nearby receptors, and “Low” to “Moderate” impact to soil. The sites are listed in Table 25 below, and illustrated on Figure 21. An inspection schedule is maintained across site to ensure that these sites are inspected on a periodic base (the frequency determined by risk posed) and the contamination is controlled.

Table 25: Mining Area C suspected contaminated sites

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>Area C OSA – Fibrous Material</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C AN Facility</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Landfarm</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Landfill – inert</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Landfill – putrescible</td>
</tr>
<tr>
<td>Other</td>
<td>Area C Historical sewage irrigation areas admin</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Fuel Farm – C Deposit</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Fuel Farm – E Deposit</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Workshop – MEW</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Workshop – Rubber Workshop</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Heavy Vehicle washpad</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C Heavy Vehicle evaporation pond</td>
</tr>
<tr>
<td>Other</td>
<td>Area C Waste water treatment plant</td>
</tr>
<tr>
<td>Other</td>
<td>Area C Biomax evaporation ponds OHP</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Area C REG Coreshed</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Backup Power generators diesel</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>Airport refuelling area</td>
</tr>
<tr>
<td>Other</td>
<td>Area C Historical sewage irrigation areas Village</td>
</tr>
<tr>
<td>Other</td>
<td>Area C Biomax evaporation ponds Admin</td>
</tr>
<tr>
<td>Other</td>
<td>Area C Biomax evaporation ponds E Deposit</td>
</tr>
<tr>
<td>Other</td>
<td>Mulla Mulla</td>
</tr>
</tbody>
</table>

Further contaminated sites investigations are proposed at Mining Area C to determine the severity of contamination and define any remedial works. Prioritisation of investigations is based on risk as discussed with the DER.
Figure 21: Suspected contaminated sites at Mining Area C
7.8.1. Knowledge Gaps
The following knowledge gaps have been identified:

- As infrastructure is decommissioned and removed, detailed site investigations will be carried out to determine optimum management and remediation programs for these sites.

7.9. Visual Amenity
In 2015, BHP Billiton Iron Ore commissioned Urbis Pty Ltd to conduct a Landscape & Visual Impact Assessment for Northern Flank as part of the Area C EMP Revision 6 (Urbis, 2015).

The only surrounding viewpoint assessed to be impacted significantly by development of Northern Flank is the Great Northern Highway to the west of current operations at Mining Area C where the visual impact is assessed as high. The Hope Downs Mine Secondary Accommodation Village and the Packsaddle Village are assessed as low to moderate potential visual impact. All remaining viewpoints are assessed as potentially experiencing a very low to low visual impact.

360 Environmental Consultants (2013) were appointed to carry out a Landscape and Visual Impact Assessment for Southern Flank. Nine viewpoints, located within the local, sub-regional and regional settings, were chosen for detailed assessment based on their higher levels of viewer sensitivity. These are listed below:

- Mt Meharry Lookout – 25 km to the west.
- Mt Robinson - summit – 9.6 km to the south-west.
- Mt Robinson - car park – 9.8 km to the south-west.
- Packsaddle Village – 3.8 km to the north-west.
- Hope Downs Secondary Accommodation Village – 1.1 km to the east.
- Hope Downs Accommodation Village – 7.5 km to the east.
- Weeli Wolli Spring – 14 km to the east.
- Great Northern Highway (West) – running along the western boundary of the proposed development envelope.
- The Governor (6 km) from the south west corner of the proposed development envelope.

Of six potential high-value viewpoint sites identified and assessed for South Flank by 360 Environmental 2013 changes to the footprint and location of pits, overburden storage and infrastructure were made in 2016. This includes but is not limited to the location of ore handling infrastructure and rail and train loading facilities which are no longer planned to be located to the south of the mining area. As a result of the high potential for visual impact from the OSA being located adjacent to the Great Northern Highway, these OSA’s have been moved to the east to avoid and/or minimise these impacts.

7.9.1. Knowledge Gaps
No knowledge gaps have been identified.

7.10. Cultural heritage
Comprehensive archaeological and ethnographic surveys have been undertaken over Mining Area C. As a result of the surveys, heritage sites have been recorded at different locations within the Proposed Mining Area C Development Envelope. Out of respect for the wishes of traditional owners, the locations of the recorded Aboriginal heritage sites are not shown in this Closure Plan.

BHP Billiton Iron Ore is aware of the location and extent of all known Aboriginal heritage sites within the footprint covered by the Closure Plan. BHP Billiton Iron Ore manages and protects Aboriginal heritage in compliance with the Aboriginal Heritage Act with strict internal processes and procedures and avoids
all Aboriginal heritage sites with engineered solutions where practicable. If any heritage site cannot practically be avoided, BHPBIO seeks to consult with the relevant Native Title Group and apply for approval from the Minister for Aboriginal Affairs under Section 18 of the *Aboriginal Heritage Act 1972* before the site is disturbed. Requirements around the management and minimising impacts to significant heritage places and values are a performance requirement of BHP Billiton.

Closure and rehabilitation at Mining Area C has the following potential impacts on Aboriginal heritage sites:

- Damaging sites during mining operations and construction of Project infrastructure;
- Collecting or excavating artefacts from heritage sites;
- Damaging sites by off-road use of vehicles; and
- Trespassing on sites by unauthorised personnel and culturally inappropriate behaviour, such as defacing rock art.

**The primary mechanism for protection of cultural heritage sites identified as being significant at Mining Area C will be avoidance of identified sites.** Any post closure issues (including ongoing management) relevant to these sites will be discussed with the relevant Native Title Group through the stakeholder engagement process. Discussions could also include the opportunity to repatriate artefacts that have been collected and stored during the mining process. All work will be conducted in compliance with the *Aboriginal Heritage Act 1972*.

### 7.10.1. Knowledge Gaps

No knowledge gaps have been identified.

### 7.11. Local land use

On a regional setting, the primary land use is low intensity grazing with iron ore mining being the dominant industry. Also within this vicinity is the southern part of Karijini National Park (approximately 20 km to the west), the most significant feature of which is Mt Meharry (Urbis, 2012). Mt Meharry is Western Australia’s highest mountain (1250 mAH) with 4WD access to its summit (Urbis, 2012).

The current land use for areas not directly affected by mining in the vicinity of Mining Area C operations area is low intensity grazing and conservation reserves.

Third party mining operations are in close proximity to Mining Area C operations. The cumulative impact of these neighbouring operations, particularly those impacts to regional surface water and groundwater hydrology, have been incorporated into the development of the closure strategies in this closure plan. Post mining land use is further discussed in Section 0.

### 7.11.1. Knowledge Gaps

No knowledge gaps have been identified.
8. Identification and management of closure issues

The successful planning and execution of Sustainable closure and rehabilitation in the Pilbara requires a holistic, long term view of landscape scale outcomes coupled with progressive operational level activities that implement or preserve options toward meeting the outcomes.

A key driver for the holistic regional approach to closure and rehabilitation is the regional scale and long life span of BHP Billiton Iron Ore’s proposed future mining footprint within the Pilbara. This driver necessitates the use of a regional approach adaptable over time, as opposed to considering individual mines in isolation. The regional approach, by its very nature, provides an avenue to consider potential post closure cumulative impacts including visual amenity, water, land use, and biodiversity/ecosystem function.

BHP Billiton Iron Ore’s adaptive management approach includes updating specific mine closure plans to account for closure risk, liability and stakeholder requirements as informed by the outcomes of the Corporation Alignment Planning process.

BHP Billiton Iron Ore applies a suite of modelling and assessment tools (Figure 22) to guide the application of management approaches to address closure issues. Monitoring programs provide data and information to support and inform the progressive development of the mine closure strategy for a site.

![Figure 22: Closure planning over the Mining Area C life cycle](image)

**8.1. Adaptive Management**

The concept of adaptive management is a structured, procedural, iterative approach to decision making. By its very nature, adaptive management employs an inherent capacity to incrementally improve confidence through the re-integration of data into the forward planning process, thereby reducing risk. Therefore, in circumstances where potential impacts cannot be entirely avoided, the adaptive management approach allows for an evaluation of the preferred mitigation controls employed, such that they are progressively improved and refined, or entirely alternate solutions adopted.

BHP Billiton Iron Ore recognises that learning is at the heart of adaptive management. Models, research and development, and experience as they relate to closure and rehabilitation are the basis of learning.
Management approaches can be subsequently informed through the cause-and-effect feedback mechanism under the adaptive management framework.

It is recognised that observation of outcomes alone is insufficient as a feedback mechanism, as interactions in complex systems can be iterative, dynamic, and discontinuous as external circumstances change and internal behaviour crosses systemic thresholds. Continuous testing and refinement of models, research and plan implementation against new data and new hypotheses is therefore a core component of any effective adaptive management strategy.

BHP Billiton Iron Ores application of adaptive management to closure and rehabilitation involves regularly assessing performance and adjusting management practices to facilitate continuous improvement.

This adaptive management approach, shown Figure 23, will apply to the Operations and associated closure issues, and takes into consideration the results of rehabilitation and trials from BHP Billiton Iron Ore’s other Pilbara Operations and best practice rehabilitation techniques used elsewhere in the mining industry.

![Figure 23: Adaptive Management Cycle](image)

### 8.1.1. Rehabilitation trials and research

As part of BHP Billiton Iron Ore adaptive management approach rehabilitation trials and research across the Pilbara operations are utilized to inform closure and rehabilitation planning.

BHP Billiton Iron Ore has undertaken progressive rehabilitation at a number of its Pilbara Operations, which enable learnings from one project area to be applied to new areas through an adaptive management approach. Rehabilitation Development Monitoring is undertaken to assess initial rehabilitation, revegetation establishment, development over time, and determine whether completion criteria (see Section 6) have been met. Appendix C provides a summary of historical research findings and current research projects.

The outcomes of monitoring, research and trials are reported in further detail in the Annual Environmental Reports for the site. Additional ongoing external research programs, including the Pilbara Seed Atlas and Restoration Seed Bank Initiative through the Botanic Gardens and Parks Authority, continue to provide input to improving rehabilitation success across BHP Billiton Iron Ore’s Pilbara Operations.
Assessment of rehabilitation monitoring results assists with defining these successes, and provides input to the development of robust ecological completion criteria metrics. The rehabilitation monitoring program and ongoing assessment of results from this program enables the adaptive management approach which will continue to be used throughout the life of Mining Area C.

In addition to BHP Billiton Iron Ore’s rehabilitation research the adaptive management approach maintains rehabilitation planning flexibility to accommodate changes in method or technology which are developed more broadly in the mining, closure and rehabilitation industry.

8.2. Risk Management

Risk Management is an integral component of the BHP Billiton Iron Ores closure planning process. Risk management is undertaken to qualitatively and quantitatively guide the selection of closure options, assess specific risks and identify controls for the design and execution of closure projects.

In accordance with BHP Billiton Iron Ore’s Corporate Alignment Planning process (BHP Billiton 2016a) risk assessments are conducted for all of BHP Billiton’s operations in order to prioritise and manage risks consistent with Australian Risk Management Standard AS/NZS ISO 31000:2009 Risk Management – Principles and Guideline.

The primary objective of BHP Billiton Iron Ore’s risk assessment and management system is to minimise risk in all aspects of its operations; including closure planning. The risk assessment process and the development of a risk profile are undertaken in accordance with:

- BHP Billiton: Our Requirements - Risk Management; and
- The WAIO Health Safety and Environment risk management procedure.

In the Closure context risk management processes include three main types of risk assessment:

1. Closure Planning Risk Assessment (health, safety, environment, legal, community, financial): a predominantly qualitative assessment (including stakeholder consultation) to identify mine closure risks and opportunities associated with closure and management strategies to preserve, maintain or enhance values or beneficial uses. These assessments also include consideration of post closure event risks (i.e. failure).


3. Construction/Workplace Risk Assessments: As a closure project reaches execution, risk management is used to guide the effective management of risk in the execution phase.

Closure Planning Risk Assessments are undertaken against closure scenarios to optimise the outcome. Mitigating unacceptable risks to a tolerable level may involve the development of control options against each of the risk factors, including the commissioning of additional technical studies and/or research. Such a process is iterative and is aimed at providing, on balance, the most appropriate closure outcome given the key risk drivers. Closure risks are reviewed on a regular basis and are recorded and maintained in a closure risk register.

For example Initial Closure Planning Risk Assessments identify risk issues with controls often directed to further investigations/study programs which may include scientific risk assessments. Outcomes of the studies and investigations subsequently provide increased knowledge moving to controls directed to specific closure strategies and design features for the mine site. Subsequently as the Mine Closure Strategy is developed the risk assessments progressively mature with the increase in knowledge and information over the life of the mine.

Stakeholders and specialists may be called upon to provide advice on aspect areas of significance or where in-house expertise is unavailable or unsuitable.
8.2.1. Closure Planning Risk Assessments

BHP Billiton Iron Ore involve people with a cross section of relevant knowledge and experience, including employees, contractors and other stakeholders. Evaluation of identified risks is undertaken by the level of management that is consistent with the significance of the closure risk. Scientific Risks Assessments are undertaken by specialists in the relevant field.

8.3. Identification of closure issues

A Closure Planning Risk Assessment was undertaken separately for Northern Flank and Southern Flank Closure considering the current operations and the life of asset Mining Area C boundary. Cumulative risk of the combined areas were also considered. The assessment workshop assessed event risks which may impact on achieving the guiding closure principles. Participants included stakeholders within BHP Billiton Iron Ore with expertise in technical closure disciplines Table 26 and Table 27 outlines the aspects identified as requiring specific attention in the Closure Planning process for Mining Area C. This is based on the collection and analysis of closure data (Section 7) and the Closure Risk Assessment workshop. The risk matrix and detailed assessments are provided in Appendix D.

The sections that follow provide an overview of proposed closure management of issues identified as having an uncontrolled risk rating of high / medium. Management measures will be refined progressively (in line with the adaptive management approach). The Closure Risk Assessment will be reviewed and updated prior to the next revision of this Mine Closure Plan.
Table 26: Northern Flank closure and rehabilitation issues identified

<table>
<thead>
<tr>
<th>Factor</th>
<th>Residual Risk rating</th>
<th>Description of Risk</th>
<th>Causes</th>
</tr>
</thead>
</table>
| Safety                  | Low                  | Injury to public caused by the nature of the closed landforms                       | • Public access (attractiveness and proximity to people impacts on risk)  
• High faces  
• Unstable faces (poor wall control or inadequate geotechnical understanding)  
• Hydrostatic gradients during water table rebound  
• Unstable ground on OSAs                                                                 |
| Landforms               | High                 | Final landform causing negative impact on surroundings post closure                 | • Surface instability (erosion) as result of waste characteristics and final landform design  
• Surface water not adequately managed  
• Design is visually intrusive (scale/shape/location)                                                                                          |
| Sustainability          | Moderate             | Revegetation does not support native flora and fauna species and is not self-sustaining | • Inadequate growth media  
• Poor seed supply and selection  
• Poor vegetation reestablishment (including climate change)  
• Landform failure  
• Contaminated soils/water (e.g. AMD)  
• Inadequate habitat (structural and vegetation)  
• Weeds  
• Incorrect provenance  
• Topsoil/growth media loss (e.g. erosion)  
• Lack of fauna habitats/ micro-habitats                                                                                                           |
| Hydrology               | Moderate             | Surface water regime has a negative impact on key receptors (flow and quality)     | • Drainage re-alignments/diversions changes downstream flows.  
• Drainage re-alignments/diversions fail  
• Closure Structures (OSAs) interrupt drainage lines                                                                                                 |
| Terrestrial Environmental Quality | Moderate         | Contamination from the site causes adverse impact on receptors.                   | • Potential AMD from OSAs and pit walls  
• Fibrous material  
• Industrial spills (e.g. hydrocarbon) not managed                                                                                                   |
### Table 27: Southern Flank closure and rehabilitation issues identified

<table>
<thead>
<tr>
<th>Factor</th>
<th>Residual Risk rating</th>
<th>Description of Risk</th>
<th>Causes</th>
</tr>
</thead>
</table>
| Safety         | Moderate             | Injury to public caused by the nature of the closed landforms                      | • Public access (attractiveness and proximity to people impacts on risk)  
• High faces  
• Unstable faces (poor final wall control or inadequate geotechnical understanding)  
• Hydrostatic gradients during water table rebound  
• Unstable ground on OSAs |
| Landforms      | High                 | Final landform causing negative impact on surroundings post closure                | • Surface instability (erosion) as result of waste characteristics and final landform design  
• Surface water not adequately managed  
• Design is visually intrusive (scale/shape/location) |
| Sustainability | Moderate             | Revegetation does not support native flora and fauna species and is not self-sustaining | • Inadequate Growth media  
• Poor seed supply and selection  
• Poor vegetation reestablishment (including climate change)  
• Landform failure  
• Contaminated soils/water (e.g. AMD)  
• Inadequate habitat (structural and vegetation)  
• Weeds  
• Incorrect provenance  
• Topsoil/growth media loss (e.g. erosion)  
• Lack of fauna habitats/micro-habitats |
| Hydrology      | Low                  | Surface water regime has a negative impact on key receptors (flow and quality)    | • Drainage re-alignments/diversions changes downstream flows.  
• Drainage re-alignments/diversions fail  
• Closure Structures (OSAs) interrupt drainage lines  
• Site contamination (AMD/Hydrocarbon spills/Fibrous materials) |
|                | Low                  | Groundwater quality and quantity has negative impact on key receptors             | • BWT pit void (including any backfill) changes hydro-geological regime (quality, quantity and through flow). Post dewatering recovery may take centuries  
• AMD (pit wall & in-pit OSAs)  
• Site contamination (Hydrocarbon spills/Fibrous materials) |
8.4. Management of identified issues

8.4.1. Acid and metalliferous drainage

There are a variety of mine waste management and mitigation options available for higher risk stratigraphies that have AMD generation potential. Material can be encapsulated, co-disposed with inert or acid neutralising material, disposed subaquously or a combination of options can be applied. These are evaluated on a site specific basis following the completion of appropriate material characterisation, risk assessment and modelling. Figure 24 illustrates various available PAF and other AMD waste management strategies.

![PAF waste management strategies](image)

**Figure 24: PAF waste management strategies (following DITR, 2007)**

In the event that overburden or wall rock exposure presents an AMD risk following future mine plan iterations or operational overburden material testing, the following management measures will be applied consistent with BHPBIO guidance.

Designated locations for PAF encapsulation are identified as part of the mine planning process, and should PAF be confirmed through Mine Geology drilling, the short term mine plan will direct the PAF to the designated location.
PAF material is placed in containment cells constructed of paddock dumped material (Figure 25) designed in accordance with leading practice guidance to limit oxygen and water ingress. PAF material management should focus on designing PAF material storage within the minimum number of locations and contained toward the centroid of waste dumps as the primary focus. This will ensure that sufficient clean inert waste is located above any PAF material until the slopes of the OSA have been regraded.

**Figure 25: Conceptual waste dump with PAF storage**

AMD Class 2 and 3 material, although presenting a lower AMD risk compared to PAF material, is also identified and managed but with less stringent design requirements. AMD Class 2 and 3 material generally requires further site by site risk assessment, however material placement is generally not within 10m of final rehabilitation surface.

Mining of material with AMD potential can leave exposed PAF (AMD Class 1) or lower AMD risk (AMD Classes 2 and 3) material on pit walls and require managing potential AMD during operations pushback development and post mining on final pit walls. High level guidance for controls to consider in managing potential AMD are outlined as follows:

**During operations pushback development**

- Avoid pit wall PAF exposure, considering the economic impact and mine planning options;
- Remove pit wall PAF exposure, considering the economic impact and mine planning options;
- Minimise the duration of exposures before they are removed, backfill is placed against the exposures or the exposure under a water cover or saturation; and
- Contain drainage into sump and assess water quality with water sampling and analysis.

Where water quality sampling results indicate that further action should be considered

- Passively neutralise within sump if suitable material (e.g. calcrete) is available;
- Pump and treat drainage from sump; and
- Intercept, pump and treat groundwater (least preferable option).
Post mining

Where water sampling during operations requires further action and material is expected to remain above a water cover (i.e. AWT), additional management post-mining may be required.

If the AMD risk to receptors is assessed as moderate or high:

- Consider placing backfill against the exposure or implement an alternative pit wall treatment technology.
- Further assess risk, monitor and control drainage with long term treatment if warranted.

If the AMD risk to receptors is assessed as low:

- Monitor to confirm that no further action is required

Mining Area C considerations

As outlined in Section 7.2.3, the potential sources of AMD at Mining Area C post-closure are:

- Mine waste and by association OSAs;
- Pit wall surfaces;
- Wall rock within the cone of depression while the water table recovers to pre-mining levels, or if the water table does not fully recover to pre-mining water levels;
- Pits, and depending on the closure scenario:
  - Backfilled pits;
  - Pit lakes (if they are to occur); and
  - Pit voids.

Based on the findings of the Northern Flank Preliminary AMD Risk Assessment (KCB, 2014) and the potential for AMD generation in unmanaged PAF mine waste has been ranked between rare and possible depending on the deposit (Table 15 in Section 7.2.3). The potential for AMD generation associated with pit walls has been ranked as unlikely/rare event due to limited exposure of PAF areas on the pit shells.

The Southern Flank Preliminary AMD Risk Assessment (Appendix G) assessed impact without controls and likelihood of AMD generation and resulted in a low risk from mined material and material exposed in the pit wall (Table 15 and Table 16).

A preliminary assessment of the likelihood of AMD entering transport pathways (if PAF material is left unmanaged) was assessed as unlikely to possible (Table 20 Section 7.2.3) depending on the AMD source (e.g. backfilled pits, pit lakes and OSAs) and the hydraulic regime.

Mining Area C management

The current preferred option for PAF (AMD 1 material) management at Mining Area C is encapsulation. Designated locations for PAF encapsulation are identified as part of the mine planning process, and should PAF be confirmed through the Mine Geology blast hole drilling, the short term mine plan will direct the PAF to the designated location. Note, based on the BHP Billiton Iron Ore classification, no PAF has been confirmed through the Mine Geology blast hole drilling to date. Mines Closure Design Guidance Procedures (BHP Billiton, 2016e) direct AMD 2 and AMD 3 material to be treated with caution and ensure it is not dumped within 10m of any final landform surface.

Based on the current state of knowledge AMD risk for Mining Area C closure and rehabilitation will be managed according to the details in Table 28.
Table 28: AMD risk management for closure and rehabilitation

<table>
<thead>
<tr>
<th>Risk management and control</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Management Actions** (physical actions undertaken during operational and during closure phase to enable closure outcomes) | • Avoiding exposure (mine plan optimization dependent) of PAF (AMD class 1) in final pit walls  
• If avoidance is not possible, backfilling exposed PAF (AMD class 1) with NAF or ANC material (dependent of groundwater recovery)  
• Contain mined PAF (AMD class 1) material within OSAs to minimise oxidation  
• AMD 2 and AMD 3 material to be treated with caution and ensure it is not generally dumped within 10m of any final landform surface.  
• Verification of OSA compliance to ‘as dumped’ design. |
| **Tools** (processes, procedures, plans used to guide and inform the planning of management actions) | • Ongoing monitoring in accordance with BHPBIO AMD Management Standard (2014)  
• Process and guidance for placement of materials within OSAs and OSA design guidance provided by the BHPBIO Mines Closure Design Guidance Procedure 2016 |
| **Improvement Activities** (further studies based on knowledge gaps) | • Further studies will be completed to determine the mine void closure strategy (including consideration of backfill) to manage AMD risks  
• Targeted analysis of key lithologies to increase geochemical characterisation testing  
• Update AMD Risk Assessment with additional analytical data and updated in-pit block model for PAF waste by 2019.  
• On the basis of ongoing AMD studies assess the need to update the existing Mining Area C PAF waste and other AMD risk classification, resource model coding and management systems. |

8.4.2. Groundwater

Should pits be left as open voids at the completion of BWT mining, they will result in the development of pit lakes that reach equilibrium on a balance of pit inflows and evaporation, which have the potential to impact local and regional groundwater and surface water resources. Public safety also requires consideration.

BHP Billiton Iron Ore uses Hydrogeological Conceptual and Predictive Modelling to inform closure planning. Groundwater flow modelling is undertaken to predict the range of possible outcomes for pit voids post closure, which guides further technical studies and site-specific closure plans to focus on key uncertainties. Groundwater flow models provide predictions for water level recovery rates and equilibrium levels for the pit void options available at closure.

The initial conceptual model is updated and validated throughout the life of mine as more data becomes available. As with hydrological modelling, such updates and validations would inform closure strategies landform design from conceptual through to detailed, thereby reducing risk and increasing confidence.

The outputs from this work would guide closures strategies, provide input to hydrogeochemical assessments (section 7.7) and inform environmental impact assessments using and source, pathway, receptor approach.

Hydrogeological assessments are currently based on the conceptual model as outlined in Section 7.7.2.
Northern Flank considerations

For the Packsaddle pits (P1-P6) recharge and groundwater throughflow will be very low compared with potential evaporative losses from those pits that mine BWT. These pits will likely become groundwater sinks if left as open voids. Pit lakes may eventually become saline due to evaporative concentration.

The North Flank valley pits, where hydraulic connection to the regional aquifer system exists, there will be the potential for throughflow to the pits. However, it is still expected that evaporative losses would exceed total inflows and the pits will likely also become groundwater sinks if the pits are not backfilled. Even if the pits are backfilled with overburden (to above the pre-mining water table level), the water level recovery within the pits is likely to be very slow and it may take many decades for water levels to recover unless some form of enhanced final void recharge is adopted (e.g. diversion of surface water flows into the pits). However the impacts at Weeli Wolli Spring or Coondewanna Flats, if any, are expected to be manageable.

The potential impacts associated with the presence of PAF material within the Mining Area C was further explored in the Preliminary AMD Risk Assessment conducted by Klohn Crippen Berger in 2013/14 (KCB, 2014) and is discussed further in Section 8.4.1.

Southern Flank considerations

Post-closure groundwater recovery modelling at nearby receptors around South Flank show potential permanent drawdown effects when BWT pit voids remain. However, uncertainties within the conceptual groundwater model, such as the extent of regional connectivity, make a range of aquifer recovery outcomes plausible. Backfilling these pits will be a mitigation option if future studies and groundwater modelling outcomes validate longer-term drawdown at the key receptors. Additionally, impacts from saline pits to Weeli Wolli Springs or Coondewanna Flats, if any, are expected to be manageable.

Preliminary iterations of the mine plan has shown potential to dump approximately 30-50% of waste in-pit as part of operational waste movement, scheduling scenarios could be focussed on BWT pit voids. Part of the closure strategy will be to drive mine plan optimisation to dump waste in-pit, where practicable, and potentially achieve backfill of BWT pit voids to AWT through normal mining operations.

Unmitigated there is likely to be a lag in post-mining aquifer rebound, though this may be reduced by operational groundwater management strategies. If warranted a number of options are available post-mining to augment recovery, these include water injection and enhanced recharge using pit voids or dedicated infiltration basins.

Mining Area C management

At this stage of Mining Area C mine life management is focussed on developing an understanding of closure outcomes based on alternative closure management measures.

Management measures are likely to focus on both active operational measures and passive closure management measures. Operational measures are addressed through the Central Pilbara Water Resource Management Plan (2016c) and currently include managed aquifer recharge. Adaptive and effective application of operational management measures may reduce the recovery time for the groundwater resource post closure.

Closure management measures primarily relate to mine void management options. Several options are available for mine void closure (as discussed Section 8.4.4) including; BWT pits, pit lakes and backfill. Critical to the strategic decision is consideration of potential long-term impacts following mining below groundwater into the unoxidised zone and the geotechnical stability of the pit walls.

BHP Billiton Iron Ore commits to infill the Northern Flank mine voids where practical depending on operating constraints. The current life of mine waste schedule sees all pits (excluding A and E) backfilled to above pre-mining water table without the need for waste material re-handling. The mine plan waste schedule will be progressively re-visited based on mine planning constraints and updated throughout the life of mine, informed by the outcomes of the closure studies.

Based on the current state of knowledge for Mining Area C groundwater closure and rehabilitation risk will be managed in accordance with the details in Table 29.
Table 29: **Groundwater risk management for closure and rehabilitation**

<table>
<thead>
<tr>
<th>Risk management and control</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Management Actions**      | • Implementation of Central Pilbara Water Resource Management Plan;  
                              • Pit voids management: At Northern Flank pits BWT will be backfilled during operations as part of a waste management program and also post operations to a level which prevents impacts to water quality & allows for aquifer recovery at the key receptors. Backfilling of BWT pit voids at South Flank to above pre-mining water is an option available and will be considered where unacceptable impacts to water quality or quantity are likely as a result of pit lakes.  
                              • Impacts at Coondewanna Flats: Review of the hydrology and potential impacts and the finding discussed with the Regulators in the event that modelling and monitoring of water levels indicates they are likely to fall below the investigation thresholds at time of closure.  
                              • If following the review impact is considered likely, mitigation controls, such as include the infiltration and injection into the aquifer, will be implemented.  
                              • Impacts at Weeli Wolli Spring: Once Hope Downs groundwater affecting activities have ceased and closure has commenced, the cumulative impacts resulting from Mining Area C operations will be reconsidered. |
| **Tools**                   | • Ongoing modelling and monitoring of water levels for Coondewanna Flats  
                              • Implement requirements of the Central Pilbara Water Resource Management Plan (or its equivalent) if water levels fall below the investigation thresholds  
                              • No implementation measures have been considered for Weeli Wolli Spring as impacts are unlikely. Once Hope Downs groundwater affecting activities have ceased and closure has commenced, the cumulative impacts resulting from Mining Area C operations will be reconsidered |
| **Improvement Activities** | • Further studies will be completed to determine the mine void closure strategy (including consideration of backfill) to manage groundwater risks  
                              • Review and update the Mining Area C conceptual model (as more data becomes available) including further field investigations  
                              • Finalisation of the numerical model and then continuous update and calibration as required to refine and validate the predictions.  
                              • Modelling mitigation measures (using the numerical model) to offset any identified groundwater changes at the receptors. |

### 8.4.3. Surface Water

The surface water system at closure will be designed to meet the closure principle of no significant impact on baseline surface water quality and flow regimes in nearby waterways. Key considerations will include an assessment of the likelihood that mine voids will ‘capture’ creek lines, or that major climatic events will result in damage to surface water controls (including those on constructed landforms) that may in turn impact future groundwater/surface water interactions and hence, long term water balances.

The design of surface water management works to meet operational needs will include consideration of closure requirements. These designs will then be revisited 5 years prior to the closure of the site where closure design will be developed. The development of this design near to the end of the pit life

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will permit closure design to benefit from the data captured through the operational period as well as the increased certainty around final landforms.

The surface water management post closure will focus on ensuring long term stability of OSAs. The closure design will consider:

- Surface Water Runoff from OSAs;
- Natural creek sections adjacent to Pits; and
- Diversion/realignment Sections.

The drainage from the OSAs and any upstream catchments will be managed to ensure landforms are stable in the long term. The final shaping of OSAs is further discussed in Section 8.4.4.

**Northern Flank considerations and management**

The conceptual surface water management regime for Northern Flank post-closure is illustrated in Figure 26. The approach focuses on ensuring long term stability of OSAs as well as managing the interrupted creeks and drainage lines in the vicinity of the mined pits including:

- Interruption of drainage from catchments south of E, D and C deposits and north of OSA 7 and P3. These may be managed by permanent capture into the adjacent mine pits.
- Interruption of drainage through P1 East, this may be managed through either establishing the drainage line across backfilled P1 East pit or capture to the adjacent pit.
- Interruption of drainage through P2, these may be managed through establishment of the drainage line across backfilled P2.

As noted in Section 7.8.1 the changes in the pre-mining surface water regime are not considered significant. However further detailed studies will be undertaken to confirm the closure designs and options selection, in particular for the P1 East re-alignment.

**Southern Flank considerations and management**

As noted in Section 7.7.1 creek capture and the changes to surface waste regime is not considered a significant risk for South Flank.

Specific post-closure management measures for South Flank will be determined as operational plans are developed.

**Mining Area C considerations and management**

The drainage from the OSAs and any upstream catchments will be managed to ensure landforms are stable in the long term. The final shaping of OSAs is further discussed in Section 9.2.

The natural creek areas next to the pits will include flood protection bunds for protection during operation. The flood protection works required for closure will be designed and constructed to achieve stable, maintenance free draining landforms and may be different to the operational flood bunds. The options which would be considered include additional rock armouring, changes to the elevation and slope of protection bunds and stream management to locally reduce velocities at critical locations.

In waterway sections which are diverted for mining operations, the initial diversion design will consider closure requirements. The systems will be designed to achieve comparable hydraulic and geomorphological characteristics to the original creek systems. Seepage from the creek base and interaction with groundwater will be studied and measures incorporated to reduce seepage where appropriate. The design ARI for the diverted creek sections will be selected on a case by case basis. Consideration will be made to the fate of flood events in excess of the design ARI to ensure that the system is stable in the long term. This consideration may include the use of spill out structures to divert an increasing proportion of the flow above the design ARI event into mine voids. Design features of spill out structures may include heavy rock armouring and include features such as launching aprons, baffles and weirs to improve stability.
Based on the current state of knowledge surface water for Mining Area C closure and rehabilitation will be managed in accordance with Table 30.

Table 30: Surface water risk management for closure and rehabilitation

<table>
<thead>
<tr>
<th>Risk management and controls</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Actions</strong>&lt;br&gt;(physical actions undertaken during operational and during closure phase to enable closure outcomes)</td>
<td>• Specific management strategies that could be used by BHP Billiton Iron Ore to meet the management objectives&lt;br&gt;• include:&lt;br&gt;  ◦ Avoiding drainage line intersection.&lt;br&gt;  ◦ Permanent realignment&lt;br&gt;  ◦ Reinstall over backfilled pits&lt;br&gt;  ◦ Intercept (discharge to pit or local capture)&lt;br&gt;• Implementation of surface water diversions in line with operational requirements and closure plan locations.</td>
</tr>
<tr>
<td><strong>Tools</strong>&lt;br&gt;(processes, procedures, plans used to guide and inform the planning of management actions)</td>
<td>• Design of integrated landforms across all domains taking account of the post closure surface water regime as detailed in Section 7.8.&lt;br&gt;• Surface water diversion required for mine closure to be designed and constructed to closure standard requirements.</td>
</tr>
<tr>
<td><strong>Improvement Activities</strong>&lt;br&gt;(further studies based on knowledge gaps)</td>
<td>• Investigation of the suitability of operational surface water controls and the required modifications to meet closure requirements&lt;br&gt;• Further studies will be completed to address identified knowledge gaps&lt;br&gt;• Develop design principles and details for structures remaining post mining that will be exposed to surface drainage including P3 and P1 east drainage re-alignments, 2 years prior to realignment.&lt;br&gt;• Where overburden storage areas encroach in the flood zones, additional studies will be completed to determine the 100 year Average Recurrence Interval (ARI) flood event.&lt;br&gt;• Further develop the parameters and design objectives to ensure that surface water drainage requirements are included at the various stages of planning and execution.</td>
</tr>
</tbody>
</table>
Figure 26: Surface Water Management conceptual arrangement post closure.
8.4.4. Landforms

The development of the post mining landform design is an iterative process, integrating all the closure domains. Critical to the transfer of the operational domains, particularly OSAs, to a successful and sustainable landform design is a fundamental understanding of the chemical and physical properties of the soil and/or waste material used to construct the final landform. In particular, the surface materials must be appropriate to withstand erosive forces and sustain vegetation growth in the long term. Inherent in this consideration is the water and nutrient holding capability of the growing media. Similarly, its chemical properties must have low AMD and dispersivity / sodicity risk.

BHP Billiton follows the adaptive management framework, with the mine plan and closure landform designs evolving over the life of mine as constraints information and knowledge becomes available as a function of time. Current knowledge and guidance for landform design is captured in the Mines Closure Design Guidance Procedure (BHP Billiton, 2016e).

Management of erosion is the primary tool for achieving a sustainable landform. The design objective applied is to create slopes on which rilling will be minimal or absent. Such slopes will have little potential to become heavily gullied, and any interill erosion that occurs will be relatively insignificant to potential rates of erosion by rilling that could develop on long steep, slopes. If rilling and gullying is avoided, the slope should be sustainable.

BHP Billiton Iron Ore undertakes a suite of work to inform and guide the landform design process including:

- **Resource Sterilisation Assessment:** Is an assessment of resource or potential mineralisation beneath an area typically selected for proposed OSA construction. Drilling, surface mapping, geological modelling and/or resource modelling data are typically used to identify and quantify any mineral resources within the area that may become ‘sterilised’ or economically unviable to mine if the proposed closure strategy proceeds. This assessment also applies to pit voids where backfill is proposed as part of the operations and/or closure strategy. It would add to the spatial dataset to assist with OSA positioning at the conceptual stage.

- **The Resource Block Model:** Contains geological resource information for planned and operational mines. The model contains amongst other things the relevant stratigraphies and geochemical properties of the rock mass allowing for the identification of ore and waste material. Examination of the resource model and associated drilling would be undertaken prior to closure being considered to ensure that a high level of certainty is held on sterilisation of the orebody.

- **Waste Characterisation:** A critical component of a sustainable landform is the physical and geochemical nature of the waste material used in landform construction. To this end, waste characterisation would inform a suitable material for use on final slopes, with any inappropriate material being buried within the OSA or mine void as appropriate.

- **Mine Plan Optimiser:** Mine planning software would be used to assist in generating an optimal pit design based on financial and geotechnical parameters, assuming an appropriate risk level. The mine planning software is also used to schedule multiple deposits based on optimal maximised net present value (in considerations of operational and environmental constraints). Schedules provide the necessary information to develop optimal waste strategies and are an iterative process. This informs waste production rates which would subsequently inform waste volumes and therefore, OSA design.

- **Numerical Erosion Potential Modelling:** Environmental surface erosion modelling can be undertaken as part of the detailed OSA design stage to evaluate the predicted rates and locations of erosion on a final landform. This process is supported by numerical inputs obtained from the material characterisation programs. This activity supports planning considerations around final landform design and waste scheduling objectives.

- **Physical Erosion Potential Modelling:** The physical hydraulic examination of mine waste that forms the outer surfaces of OSA landforms is undertaken to determine the key erosion characteristics of the waste material. This is undertaken within laboratory conditions using predicted...
rainfall events using local rainfall data. It provides validated data for the numerical modelling on how well a specific waste rock type behaves in surface flow conditions, and would inform detailed OSA design considerations regarding stable slope angles and material use. In addition field trials are utilised where appropriate to validate laboratory findings.

For mine void closure several landform options are available as shown in Figure 27.

![Mine void closure landform options](image)

**Figure 27: Mine void closure landform options**

Landforms created from OSAs can be located within a mine void (in-pit OSAs as shown in Figure 28) or outside the mine void footprint (ex-pit OSAs). At closure, OSAs are re-profiled into a final landform through rehabilitation earthworks. To maximise the longevity of OSA final landform, the technical studies, modelling and analysis tools discussed above inform the detailed design. Figure 28 shows a selection of alternatives that may be adopted, including:

- In-pit OSA: Utilising the mine void to permanently store waste material;
- Buttress OSA: Creating an extension to an existing landform; and
- Free-standing OSA: Creating new landforms.

Options for surface profiles, which vary based on the surface waste material characteristics and hydraulic condition, include:

- Bench and Berm Profiles: Using a stepped profile to manage the slope length and associated surface water flow path. Store and release drainage designs may be used to manage surface water; and
- Concave Profiles: Creating hydraulic conditions on the landform surface that reduce the slope gradient in stages from the crest to toe of the slope to manage the surface water flow velocity as it drains down the batter.

- Linear Profiles: continuous slope with uniform angle from crest to toe.

For each option, the key dimensions of height (H) of the OSA, slope length (L), slope angle, and berm width are determined by the waste characteristics of the external face and surface water catchment.

Figure 28: Waste landform conceptual options

The management of physically unstable waste is addressed through the waste landform design process with available management measures including:

- Encapsulation: Place unstable material on the inside of OSAs where exposure to erosive forces will be avoided (Figure 29);

- Armour with suitable material: Utilise erosion-resistant waste material on the outer face of the OSA as part of the closure landform earthworks (Figure 29); and

- Slope length and gradient control: Design the OSA slopes and height to ensure the erosive forces do not exceed the material characteristics’ ability to resist erosion. A key consideration in this option is the surface water management from the top of the OSA (see Figure 28).

Design decisions regarding the application of these measures include material characteristics, surface water management, outcomes of erosion potential modelling, disturbance footprint, visual impact and integration with the adjacent landforms (natural and closure features).
Figure 29: Integrated waste landform concept

The management of surface water on OSAs may be addressed with:

- Store and release cover systems: To maintain water on or within the closure landform (see Figure 28);
- Water shedding profiles: Such as concave slopes to drain surface water to surrounding drainage networks (see Figure 28); or
- Defined drainage chutes: Providing a defined drainage line transferring surface drainage off the closure landform to surrounding drainage networks.

In regards to pit voids current blasting practices used to reduce the potential for pit wall failure post-closure include the use of trim shots. Geotechnical and hydrological assessments will be used to inform the pit design and reduce stability issues, with surveys being undertaken to check final pit walls against designs. Mining Area C Closure Final Landform Design will require integration of all the domains as listed in Table 4 and summarised below:

- Overburden Storage Areas;
- Infrastructure;
- Mine voids (above and below watertable); and
- Roads and rail.

Mining Area C considerations

The current optimised mine plan as shown in Figure 2 will result in OSAs located within the mine void (in-pit OSAs) and outside the mine void footprint (ex-pit OSAs) along with run-of mine voids. The focus of the Mining Area C closure final landform design will be to integrate these landforms across the site (including infrastructure domains, road and rail footprints).
The opportunities to minimise the size of the overburden storage areas by increasing the amount of overburden material used to infill final voids (as void areas become available and/or as resources are mined out) is explored as part of ongoing operational planning. In regards to pit voids current blasting practices used to reduce the potential for pit wall failure post-closure include the use of trim shots. Geotechnical and hydrological assessments will be used to inform the pit design and reduce stability issues, with surveys being undertaken to check final pit walls against designs.

As outlined in Section 7.2.4 the Mining Area C waste comprises Marra Mamba and Brockman formation waste with Brockman waste less susceptible to erosion than the Marra Mamba wastes. Design solutions have been developed to manage the characteristics of the surface material on OSAs and are communicated through the Mines Closure Design Guidance Procedure (BHP Billiton, 2016e). Ongoing work and testing of final landform designs will be ongoing and provide an avenue to improve guidance in that procedure and continue adaptive management practices. Further work will need to be carried out to identify alternative growth media to assist with deficit at Northern Flank.

A waste characterisation and erosion modelling study of OSA landform stability with Marra Mamba Iron Formation rock, including material from Northern Flank, provides information on Marra Mamba waste characteristics across Mining Area C. This study along with operational experience from progressive OSA rehabilitation at Northern Flank 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 conservative ≤ 10° slope angles with an outer layer of competent rock armour with to achieve a stable landform. At South Flank this will be considered the base case with adaptive management over the life of mine (based on further waste characterisation and detailed design) to develop stable landforms. The Mines Design Closure Procedure (BHP Billiton 2016e) will be used to inform final landform design at Mining Area C.

The decision making process to determine how these domains will be integrated into a closure final landform design will take into consideration the full suite of potential closure impacts utilising tools discussed above. The final landform design for Mining Area C will develop over the life of mine based upon multi-disciplinary inputs including for example:

- Exploration data;
- Mine waste characterisation;
- Hydrology, hydrogeology, and hydrogeochemistry information;
- End land use and tenure considerations;
- The physical footprint;
- Cumulative impacts;
- Visual impact considerations;
- Mine planning, scheduling, and waste volumes;
- Flora, fauna and heritage issues; and
- Stakeholder inputs.

All of these factors interact over the life of mine in an iterative process such that the evolving mine closure strategy may progress from conceptual to detailed and include the specifics on landform design.

Based on the current state of knowledge the final landform design for Mining Area C closure and rehabilitation will be managed in accordance with the details in Table 31.

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### Table 31: Final landform risk management for closure and rehabilitation

<table>
<thead>
<tr>
<th>Risk management and controls</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Actions</strong></td>
<td>Design of an integrated landforms across all domains taking account final landform design as developed</td>
</tr>
<tr>
<td>(physical actions undertaken during operational and during closure phase to enable closure outcomes)</td>
<td>In pit dumping of waste material, where practicable, to reduce OSA footprint</td>
</tr>
<tr>
<td></td>
<td>At Northern Flank all BWT pits to be backfilled to 5m AWT at closure</td>
</tr>
<tr>
<td></td>
<td>Implement OSA design principles from Mines Closure Design Guidance Procedure. Particular attention to the OSA design (including conservative slope angles) and construction techniques used to provide a stable landform for Marra Mamba wastes</td>
</tr>
<tr>
<td></td>
<td>Execute progressive rehabilitation in accordance with 5 year mine plan (annually refreshed)</td>
</tr>
<tr>
<td></td>
<td>Abandonment bunds controls at Highway Deposit</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>WAIO Mines Closure Design Guidance Procedure</td>
</tr>
<tr>
<td>(processes, procedures, plans used to guide and inform the planning of management actions)</td>
<td>Ongoing detailed OSA rehabilitation planning within annual 5 year mine planning cycle and detailed closure landform designs (integrating all domains) to be developed based on outcomes of technical studies and assessments when there is less than 2 years to closure</td>
</tr>
<tr>
<td></td>
<td>Rehabilitation earthworks in accordance with the BHP Billiton Iron Ore’s Earthworks for Rehabilitation Procedure (SPR-IEN-LAND-010)</td>
</tr>
<tr>
<td></td>
<td>Waste characterisation and erosion potential modelling</td>
</tr>
<tr>
<td></td>
<td>Geological model informs pit design</td>
</tr>
<tr>
<td></td>
<td>Mine waste balance and put design updates</td>
</tr>
<tr>
<td><strong>Improvement Activities</strong></td>
<td>Mine Planning analysis to determine ultimate pit void extents and waste balance for final landform detailed designs</td>
</tr>
<tr>
<td>(further studies based on knowledge gaps)</td>
<td>Further studies will be completed to address the knowledge gaps</td>
</tr>
<tr>
<td></td>
<td>Develop the conceptual and detailed closure management and design tools (including application timing) to identify the optimal closure overburden storage area design and mine void outcomes</td>
</tr>
<tr>
<td></td>
<td>Undertake further waste characterisation, modelling and analysis to refine the Waste Class classification on an ongoing basis</td>
</tr>
</tbody>
</table>

### 8.4.5. Sustainability

The revegetation program will be designed to establish native vegetation that blends with the surrounding areas and will provide habitat and foraging areas for native fauna, while taking into consideration any constructed landform and the waste material characteristics within the potential root zone.

The establishment of a robust soil profile (based on waste characterisation as outlined in Section 7.2) is critical for the successful establishment of vegetation and compliance with the relevant completion criteria (see Section 6). Prior to use in rehabilitation, topsoil is stripped and stored (if required) in accordance with the procedures outlined BHP Billiton Iron Ore’s Growth Media Management Procedure (SPR-IEN-LAND-009).

The use of topsoil and alternative growth media for rehabilitation is being investigated as part ongoing rehabilitation works across Western Australia Iron Ore with the resulting data being collated in the
Growth Media Atlas. This ongoing study seeks to not only establish the quantity and quality of current stockpiled material but also identify alternative growth media materials within waste rock stockpiles that can be utilised for rehabilitation activities.

The Rehabilitation Standard requires that revegetation be conducted so as to establish plant species that will support the approved post-mining land use. The selection of plant species used in revegetation is to be selected from the revegetation species lists generated for each site as part of planning works, and must include a range of typical vegetation assemblages suited to the post-mined landform. The diversity of vegetation types used in rehabilitation must be maximised in order to improve habitat value and encourage colonisation by a wide range of fauna.

Based on the available climate change predictions, BHP Billiton Iron Ore considers that the most appropriate rehabilitation revegetation approach is to design landforms and select native species based on the current climatic conditions. If there were to be an effect on rehabilitated landforms and revegetation from climate change, those changes would reasonably be expected to be gradual and would be experienced across the entire region, including adjoining unmined areas. By revegetating based on the current climatic conditions the mine will blend in with the surrounding vegetation, regardless of the effect of climate change (i.e. any future changes would affect unmined and rehabilitated areas equally). Major differences between regional and post-mined vegetation will be managed by ensuring sufficient diversity of species within rehabilitated sites, so that the natural adjustments to a changing climate will be accommodated within the local species pool.

**Mining Area C considerations and management**

Dependent on the provisional final land use (Section 5.3) revegetation at Mining Area C operations will use local provenance native seed (from the local area, but as a minimum from within 100 km of site within the Pilbara Biogeographic Region) consistent with vegetation associations and native species recorded in the mine area prior to mining (BHP Billiton Iron Ore, 2008).

Development of specialised habitats for conservation significant fauna identified in the Mining Area C area will be considered during rehabilitation works. Conservation significant fauna often have specific habitat requirements that limit where they can forage, shelter and reproduce. Specific habitats will be established where appropriate materials (e.g. rocks, logs) are available onsite. The following broad habitat types may be considered, in line with species identified to date in the Mining Area C area:

- The western pebble-mound mouse (*Pseudomys chapmani*), Pilbara fat-headed blind snake (*Ramphotylops ganei*) and SRE millipede *Antichiropus ‘DIP007’* are known to occur on rocky crests and slopes featuring *Eucalyptus* woodlands, *Acacia* and *Grevillea* shrublands and *Triodia* spp. low hummock grasslands.

- Gorge/gully habitat represents a small proportion of the available habitat in the area. The Pilbara olive python (*Liasis olivaceus barroni*), ghost bat (*Macrodemura gigas*), Pilbara barking gecko (*Underwoodisaurus seorsus*), Pilbara flat-headed blind snake and northern quoll (*Dasyurus hallucatus*) are all known to utilise Gorge/Gully habitats which often feature caves, overhangs and rock pools. These areas may represent a source of fauna that may recolonise rehabilitated areas where suitable habitat occurs.

- Minor and major drainage lines and surrounding floodplains may be frequented by the Pilbara barking gecko, rainbow bee-eater (*Merops ornatus*) and peregrine falcon (*Falco peregrinus*). The Pilbara olive python can also occur along drainage lines which feature more complex and well developed vegetation communities than surrounding areas.

- Mulga woodlands are provide habitat for a number of species largely restricted to this habitat, and support a seasonal avian community when trees are in flower.

Ecological barriers may exist for particular species in rehabilitated landforms. Examples of ecological barriers for certain Pilbara species include the absence of; old growth spinifex vegetation, suitable sized gravel/stones, caves and rock crevices or alluvial soils (Outback Ecology 2012). Many fauna species, including migratory species, depend on temporary and permanent water sources and associated habitat that occurs along drainage lines.
Based on the provisional final land use (Section 5.3) revegetation at the Mining Area C mining operations will use local provenance native seed (from the local area, but as a minimum from within 100 km of site within the Pilbara Biogeographic Region) consistent with vegetation associations and native species recorded in the mine area prior to mining (BHP Billiton Iron Ore, 2008).

During rehabilitation works suitable material will be identified for use in the creation of landforms that mimic those of surrounding areas, with natural drainage lines being restored where practicable. Specialised fauna habitats will be established if available resources can be identified, however there are currently no plans to disturb new areas to source these materials.

Revegetated landforms (as part of progressive rehabilitation) will be monitored to determine adequacy of habitat structure, recolonisation of landforms and success of revegetation batter.

Based on the current state of knowledge, the rehabilitation of disturbed areas of the Mining Area C operations will be undertaken consistent with the Rehabilitation Standard and the details in Table 32.

**Table 32: Sustainability risk management during rehabilitation and closure**

<table>
<thead>
<tr>
<th>Risk Management and Controls</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Management Actions** (physical actions undertaken during operational and during closure phase to enable closure outcomes) | • Growth media (topsoil) management in accordance with the BHP Billiton Iron Ore’s Growth Media Management Procedure (SPR-IEN-LAND-009).  
  • Local provenance native seed (from the local area, but as a minimum from within 100 km of site within the Pilbara Biogeographic Region).  
  • WAIO approach: Implementation of the WAIO Rehabilitation Standard and undertake progressive rehabilitation as per CAP cycle – business as usual |
| **Tools** (processes, procedures, plans used to guide and inform the planning of management actions) | • WAIO Rehabilitation Standard.  
  • Growth Media Management Procedure (SPR-IEN-LAND-009).  
  • Progressive Rehabilitation  
  • Topsoil stockpiling  
  • Seed collection and storage (supported by studies in to propagation) |
| **Improvement Activities** (further studies based on knowledge gaps) | • Further studies will be completed to address the knowledge gaps  
  • Ghost bat habitat – continued study of the ecology of the ghost bat within the Pilbara, including the efficacy of artificial habitats.  
  • Progressive Rehabilitation Locations which may be available for a minimum of five years for rehabilitation/landform trials will be planned as they become available in the annual planning cycle on an ongoing basis.  
  • WAIO Growth Media Atlas to identify suitable growth media for use in rehabilitation.  
  • Assessment of rehabilitation areas as providing suitable habitat for fauna.  
  • **BHP commits to research on how to re-create habitat on rehabilitated OSAs and pits for terrestrial fauna, including Antichiropus ‘DIP007’ and ghost bat.** |

**8.5. Closure improvement**

Section 8.4 provides an overview of closure issues, modelling and assessment and management initiatives which BHP Billiton Iron Ore will undertake to progress Closure Planning during the life of Mining Area C. Section 7 discusses the baseline knowledge that BHP Billiton Iron Ore currently has regarding Mining Area C and also discusses the knowledge gaps which have been identified. Table 33 summaries these activities to fill gaps in the existing knowledge base and further define the closure methodology.
<table>
<thead>
<tr>
<th>Technical Area</th>
<th>Knowledge gap</th>
<th>Proposed Improvement activity</th>
<th>Indicative timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government and stakeholder consultation</td>
<td>Closure strategy endorsement by all stakeholders (section 4.2)</td>
<td>Consultation will continue to be undertaken with identified stakeholders in line with the broader Stakeholder Consultation Programme.</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Completion Criteria</td>
<td>Under development</td>
<td>Ecological Criteria: Review and refine completion criteria taking into consideration improved knowledge to develop more measurable metrics</td>
<td>2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other criteria: Review and refine completion criteria taking into consideration improved knowledge to develop more measurable metrics</td>
<td>Ongoing</td>
</tr>
<tr>
<td>SUSTAINABILITY</td>
<td>Topsoil deficit relative to volume required (section 7.5)</td>
<td>Continue to develop the growth media atlas for identification of suitable growth media</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Progressive Rehabilitation</td>
<td>Areas available for rehabilitation</td>
<td>Locations which may be available for a minimum of five years for rehabilitation/landform trials will be planned as they become available in the annual planning cycle on an ongoing basis.</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Ecology of the ghost bat in the Pilbara, including use of roosts and core feeding areas, and ability to colonise artificial adits</td>
<td>Two man-made ghost bat roosts have been built on BHP Billiton Iron Ore tenure during 2016. Monitoring is underway to determine the success of these roosts and if they can be used to mitigate the impacts of loss of natural roosts. Studies are also ongoing on ecology of the species in the Pilbara, including genetic and hormone studies and radio-tracking.</td>
<td>2016-ongoing</td>
</tr>
<tr>
<td>Habitat re-creation</td>
<td>The ability to recreate habitats for conservation significant species, including the SRE millipede and Priority flora</td>
<td>Conservation significant species – continue to undertake research and surveys for conservation significant species within the vicinity of Mining Area C, with the intent to further ecological knowledge of these species</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Assessment of rehabilitation areas as providing suitable habitat for fauna</td>
<td>Develop and execute monitoring of rehabilitated areas for fauna habitation</td>
<td>2017</td>
</tr>
<tr>
<td>LANDFORMS</td>
<td>HYDROLOGY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Waste characterisation</strong></td>
<td><strong>Determining if the vegetation assemblages at the Coondewanna PEC become partially dependent on groundwater in significant periods of drought (annual average rainfall extends &gt;9 years) (Section 7.7)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste rock availability suitable for the outer final landform rock armouring surfaces (particularly for South flank), (Section 7.2 and Section 8.4.4).</td>
<td>Continued monitoring of the soil and groundwater hydrological conditions, to establish a longer dataset.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ongoing characterisation of waste is required to refine the mine model and inform final landform designs</td>
<td>Ongoing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume and availability of waste will be refined on an ongoing basis</td>
<td>Ongoing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Landform design</th>
<th>Hydrogeology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Develop the conceptual and detail closure management and design tools (including application timing) to identify the optimal closure overburden storage area design and mine void outcomes</strong></td>
<td><strong>Further studies will be completed to determine the mine void closure strategy (including consideration of backfill) to manage groundwater risks</strong></td>
</tr>
<tr>
<td>Detailed closure landform designs (integrating all domains) to be developed based on outcomes of technical studies and assessments.</td>
<td>Review and update the Mining Area C conceptual model (as more data becomes available) including further field investigations</td>
</tr>
<tr>
<td>Less than 5 years to closure</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Less than 2 years to closure</td>
<td>As more data becomes available</td>
</tr>
</tbody>
</table>

**Stygofauna recovery post mine void backfill**

An assessment on the potential impacts, including recovery, to the stygofauna community resulting from the recovery of groundwater levels post-closure at adjacent operations (e.g Yandi) to inform Mining Area C outcomes. +2025

Reducing uncertainty in hydrogeological predictions to inform mine void closure strategies

Review and update the Mining Area C conceptual model (as more data becomes available) including further field investigations

As more data becomes available

Improved understanding of regional connectivity between Coondewanna Flats and Weeli Wolli Spring (Section 7.7)

Review and update the Mining Area C conceptual model (as more data becomes available) including further field investigations

As more data becomes available
### Surface Water Hydrology

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable estimates of the surface runoff characteristics - peak flows, volumes and quality (Section 7.7)</td>
<td>Develop design principles for structures remaining post mining that will be exposed to surface drainage (weirs, diversion channels, flood protection structures, etc.).</td>
<td>2018</td>
</tr>
<tr>
<td>Better definition of the mine development plans for the pit and OSA areas (Section 7.7 and 8.4.4)</td>
<td>Where overburden storage areas encroach in the flood zones, additional studies will be completed to determine the 100 year Average Recurrence Interval (ARI) flood event.</td>
<td>When triggered</td>
</tr>
<tr>
<td>Suitability of operational surface water controls and the required modifications to meet closure requirements</td>
<td>Further develop the parameters and design objectives to ensure that surface water drainage requirements are included at the various stages of planning and execution.</td>
<td>2016</td>
</tr>
</tbody>
</table>

### INLAND ENVIRONMENTAL QUALITY

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional static and kinetic geochemical testing of the potential AMD generation is ongoing and required to refine assessments of the short and long term risks (Section 7.2)</td>
<td>Further studies will be completed to determine the mine void closure strategy (including consideration of backfill) to manage AMD risks</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Targeted analysis of key lithologies to increase geochemical characterisation testing</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>Update the AMD Risk Assessment with additional analytical data and updated in-pit block model for PAF waste by 2019</td>
<td>2019</td>
</tr>
<tr>
<td></td>
<td>On the basis of ongoing AMD studies assess the need to update the existing Mining Area C PAF waste and other AMD risk classification, resource model coding and management systems.</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>

### Potentially Contaminated sites

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum management and remediation programs for the contaminated sites (Section 7.8).</td>
<td>Contamination assessments will be undertaken for any potential contaminated site, in accordance with the requirements of the Department of Environmental Regulation and relevant technical guidelines. Prepare and implement remediation plan, as appropriate.</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>

### FINAL LAND USE AND DECOMMISSIONING.

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final land use default assumption as low intensity grazing (Section 5.3)</td>
<td>Final land use planning study to be undertaken. Stakeholders to agree and endorse the final land use for Mining Area C operations</td>
<td>Within 2 years of closure</td>
</tr>
</tbody>
</table>
9. Closure implementation

Taking into account the identified closure issues and acknowledging the further studies, investigations and design work that will occur during the life of the mine this section describes how Mining Area C operations will be rehabilitated and closed in a manner that satisfies the objectives and guiding principles, completion criteria and in accordance with the DMP/EPA guidelines. Closure implementation strategies defined below are based on experience across BHP Billiton Iron Ore’s Pilbara Operations and on the BHP Billiton Iron Ore Closure and Rehabilitation Standard (Appendix F).

Rehabilitation of disturbed areas will be conducted progressively during the mine life with complete closure of the mine not expected to occur until 2073.

9.1. Standard closure and rehabilitation strategies

BHP Billiton Iron Ore has developed and will implement the Rehabilitation Standard 0001074 (Appendix F) which covers all procedures relevant to rehabilitation works including rehabilitation planning, growth media, earthworks for rehabilitation, audit and inspect, seed management, rehabilitation data management and rehabilitation monitoring. This rehabilitation standard is used across BHP Billiton Iron Ore’s Pilbara mine sites and other areas where appropriate. Rehabilitation and revegetation of the final mine landforms and infrastructure and support facilities will be conducted in accordance with the Rehabilitation Standard. A description of each is provided in the subsections below.

The approach to closure implementation for rehabilitation and decommissioning of the key components of the operations are discussed in the following paragraphs.

9.1.1. Earthworks

The BHP Billiton Iron Ore Earthworks for Rehabilitation Procedure describes the rehabilitation earthworks required across BHP Billiton Iron Ore Pilbara mining operations to meet closure objectives stated in Section 5. It has been prepared to provide a consistent methodology based on previous rehabilitation success and identified issues. The results of rehabilitation monitoring are assessed for performance and are used to adjust and refine this methodology in accordance with BHP Billiton Iron Ore adaptive management approach (Section 8.1).

Rehabilitation earthworks aim to re-profile the land surface to create landforms that are consistent with the surrounding landscape, within the constraints imposed by the physical nature of the materials, in accordance with the stated closure objectives.

Earthworks consist of reshaping the slope to a profile suited to the nature of the material used (determined by waste characterisation studies and modelling of erosion potential (see Section 8.4.4).

Surface water management may include the construction of compacted bund approximately 2 m high and 12 m wide along the crest of the overburden storage area to prevent surface water runoff down the slopes of the overburden storage area. The faces of the slopes are designed and constructed as weathering structures and generally contain appropriate internal gullies and alluvial fans at the base to promote water shedding. Concave faces may be used to facilitate water-shedding.

9.1.2. Surface treatment

A number of surface treatments may be used, depending on the size and nature of the rehabilitated area. The proposed surface treatments for rehabilitation areas at Mining Area C have been developed to satisfy the stated closure objectives and may consist of one or more of the following:

- deep ripping of compacted surfaces;
- selective application of topsoil material (or alternative growth media) to provide a medium to support plant growth;
surveyed contour ripping or scarifying of surfaces following the application of soils to maximise water infiltration and enhance revegetation success; and

- selective placement of logs or smaller woody debris and/or boulders (if available) across the re-profiled surface and/or constructing rocky cliff features (where potential exists) to provide additional habitat areas for fauna species recorded prior to mining.

The Growth Media Management Procedure (BHP Billiton Iron Ore, 2014b) provides general information on soils of the Pilbara region and methods for soil stripping, stockpiling and use in rehabilitation.

Direct placement of topsoil onto rehabilitation areas is preferable. If direct placement is not possible, soil should be stockpiled in low mounds, ideally no more than 2 m high to maintain biological activity. Compaction of the topsoil stockpiles should be minimised by building from the edge (rather than the top of the stockpile), deep ripping and spreading stripped plant material to encourage revegetation. Revegetating the stockpiles will also minimise dust, erosion and weed establishment.

9.1.3. Revegetation

The Rehabilitation Standard requires that revegetation be conducted so as to establish plant species that will support the approved post-mining land use. The selection of plant species used in revegetation is linked to the appropriate landforms and species lists as identified in the baseline flora and vegetation surveys. Species lists for the relevant domains are generated for each site as part of planning works, and typically include a range of typical vegetation assemblages suited to the post-mined landform. The diversity of vegetation types used in rehabilitation must be maximised in order to improve habitat value and encourage colonisation by a wide range of fauna.

Based on the provisional post mining land use (Section 5.3) revegetation at the Mining Area C mining operations will use local provenance native seed (from the local area, but as a minimum from within 100 km of site within the Pilbara Biogeographic Region) consistent with vegetation associations and native species recorded in the mine area prior to mining.

The BHP Billiton Iron Ore Seed Management Procedure (BHP Billiton Iron Ore, 2015g) describes the types of seed species mixes and seeding rates that BHP Billiton Iron Ore uses at its Pilbara mining operations. This mix can be adapted to suit the particular characteristics of the site through BHP Billiton Iron Ore adaptive management approach (refer Section 8.1 and 8.4.5). The procedure also lists appropriate seed vendors which collect seed which meets the standards set by the Seed Management Procedure.

To promote vegetation density, species diversity and plant age heterogeneity, additional seeding (in subsequent years) will be conducted if required.

Two rainfall periods occur at Mining Area C area – one from January to March and the other from May to August. The most reliable rainfall period occurs from January to March. Accordingly, revegetation activities will be completed during November and December where practicable.

9.1.4. Cultural heritage

There is the potential for closure works to impact on sites of cultural significance via direct or indirect disturbance (e.g. erosion). All activities that require land disturbance, including during decommissioning and rehabilitation, will be authorised by BHP Billiton Iron Ore via the Project Environmental Aboriginal Heritage Review (PEAHR) procedure. For each planned disturbance area, the following details are addressed in the PEAHR form:

- A summary of the proposed disturbance activities;
- A plan showing the location of the proposed works;
- The anticipated environmental, land access and Aboriginal heritage impacts; and
- Specific management measures where necessary (BHP Billiton Iron Ore 2008b).

The primary mechanism for protection of cultural heritage sites identified as being significant at Mining Area C will be avoidance of identified sites. Any post closure issues (including ongoing management)
relevant to these sites will be discussed with the relevant Banjima people through the stakeholder engagement process (Section 4).

9.1.5. Site contamination
Site contamination as a result of activities during mining operations has the potential to compromise environmental values and result in non-compliance against relevant completion criteria. In areas where the potential for soil contamination is identified assessment will be managed in accordance with Department of Environment and Conservation requirements including sampling/analysis and remediation/management.

Remaining surfaces will be reshaped to conform to surrounding landforms, with surface treatment and revegetation implemented as outlined in Section 9.1.2 and 9.1.3.

9.1.6. Dust emissions
Dust has the potential to be emitted during decommissioning and bulk earthworks activities during closure. Dust control measures will be implemented during closure e.g. regular watering of unsealed roads, exposed surfaces and active earthwork areas. Upon closure dust generation from the rehabilitated surfaces is expected to be similar to other nearby natural landforms.

9.2. Closure strategies for specific domains
In line with the DMP/EPA Guidelines, BHP Billiton Iron Ore has adopted a domain model for closure implementation; identified domains are defined as those areas of similar operational land uses and subject to similar closure strategies. Implementation strategies have been informed by the standard rehabilitation strategies outlined in the previous section and the management measures outlined in Section 8.4, to mitigate the key closure risks/issues.

Closure domains identified at the Operations are:
- Mine Voids;
- OSAs;
- Infrastructure; and
- Roads and Rail.

An indicative view of areas for rehabilitation and decommissioning can be seen in Figure 2. Integrated closure landform design will be developed as discussed in Section 8.4.4.

9.2.1. Mine voids
As outlined in Section 8.4.4 mine void closure alternatives are shown in Figure 27.

BHP Billiton Iron Ore commits to infill the Northern Flank mine voids, where practical depending on operating constraints. Based on the current mine waste schedule all mine voids excluding A and E backfilled to above pre-mining water table without the need for waste material re-handling. At Southern Flank backfilling BWT pits will be considered where unacceptable impacts to water quality or quantity are likely as a result of pit lakes. Using this outcome based management strategy will mitigate the risk of pit lakes as a water effecting activity. Operational placement of mine waste in-pit, as backfill, is considered an effective strategy to assist closure outcomes, Mining Area C waste schedules will be progressively re-visited based on mine planning constraints and updated throughout the life of mine with consideration of closure.

Safety bunds will be established around the final pit walls. The bunds will be constructed as per the DMP recommended practice. The bunds will be a minimum 2 m high with a base width of minimum 5 m and constructed at least 10 m away from the edge of the area known to contain potentially unstable rock mass as per recommended practice (DoLR, 1997). At Southern Flank a number of western mine pits are adjacent the Great Northern Highway. Pit abandonment bunds there will meet regulatory
requirements and also consider whether additional measures are required to control unauthorised public access risks.

9.2.2. Overburden storage areas

Final landform designs of the out-of-pit overburden storage areas will be informed by waste characterisation and modelling of erosion potential as outlined in Section 8.4.4. The final shape of the overburden storage areas will be designed to maintain surface stability and minimise erosion by managing surface water runoff. The final landform design will be guided by the Mines Closure Design Guidance Procedure and executed in accordance with the earthworks strategies under the Rehabilitation Standard. BHP Billiton Iron Ore will monitor the stability and revegetation success of the rehabilitated overburden storage areas during the mine life. Monitoring of rehabilitation is discussed in Section 10.

Any low grade ore that is encountered will be placed adjacent to the overburden storage areas, as it is likely that low-grade ore will be both added and removed depending on ore blending requirements. Market demand will determine how much, and when it is viable to process the low grade material. No separate stockpile for low grade will be established. In the event that this material is not blended with the high grade ore, BHP Billiton Iron Ore will re-profile these areas into the overburden storage areas.

9.2.3. Infrastructure, road and rail

In accordance with the Iron Ore (Mount Goldsworthy) Agreement Act 1964, prior to removing the rail rolling stock, equipment and removable buildings, BHP Billiton will notify the State in writing giving the option for the State to purchase the infrastructure subject to valuation. Other stakeholders including adjacent landholders will also be consulted regarding infrastructure decommissioning as part of the post mining land use consultations. In the event the State or other stakeholders do not take up the infrastructure ownership, decommissioning plans will be prepared to guide the decommissioning, demolition and removal of all fixed site assets.

BHP Billiton Iron Ore’s office buildings (including Packsaddle and Mulla Mulla Village) and minor equipment will be removed from site.

At closure the infrastructure associated with dewatering the Mining Area C pits ahead of mining will be removed; the water bores will be capped in accordance with the requirements of the relevant government administering authority.

Following the removal of infrastructure, road and rail facilities re-profiling of the land surface, additional surface treatments and revegetation works will be implemented in accordance with the standard rehabilitation procedures described in the Rehabilitation Standard (Appendix F).

9.2.4. Waste Facilities

BHP Billiton Iron Ore’s office buildings (including Packsaddle and Mulla Mulla Village) and minor equipment will be removed from site.

At closure the infrastructure associated with dewatering the Mining Area C pits ahead of mining will be removed; the water bores will be capped in accordance with the requirements of the relevant government administering authority.

Following the removal of infrastructure, road and rail facilities re-profiling of the land surface, additional surface treatments and revegetation works will be implemented in accordance with the standard rehabilitation procedures described in the Rehabilitation Standard (Appendix F).

9.3. Progressive rehabilitation

Progressive rehabilitation and ongoing performance assessment will be carried out in areas where mining operations have been completed and further disturbance is unlikely.

Five Year Rehabilitation plans are developed annually as part of the CAP process, outlined in Section 1.4. It is developed to align with the Five Year Mining plans and identifies areas available for final
landform earthworks and rehabilitation within the five year period, see Figure 30 for Northern Flank Plan.

The main components of the progressive rehabilitation programme are described in the Rehabilitation Standard (Appendix F) and reported annually within the Annual Environmental Report.
Figure 30: Northern Flank Five year Rehabilitation Plan
9.4. Implementation schedule

Figures 31, Figure 32, Figure 33, Figure 34 provide an overview of the progressive mining at Northern Flank in 2020, 2030 and indicative mine completion showing mine void backfill and OSA development. Closure dates for specific OSAs and domains have not been determined beyond the next five years (Figure 30) and will depend on the completion of the Long Term Plan for the operations.

Table 34: Indicative Southern Flank Rehabilitation Schedule shows the indicative mine closure schedule for Southern Flank, based on an assumed mine commencement date of 2021.

Note that uncertainty exists in rehabilitation timing and sequence as mine plans are subject to change due to various factors including market conditions, additional resource/geological/geotechnical/hydrological data etc.

Infrastructure for Northern Flank and Southern Flank will likely continue to be utilised beyond the mining of deposits outlined herein. Subsequently it is not anticipated that any major infrastructure decommissioning will occur for a number of decades. Typically, BHP will decommission unnecessary infrastructure as it becomes available.
Figure 31: Mining Area C current status
Figure 32: Mining Area C indicative progress 2020
Figure 33: Northern Flank indicative progress 2030
Figure 34: Northern Flank indicative mine completion
Table 34: **Indicative Southern Flank Rehabilitation Schedule**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Feature</th>
<th>Approximate Completion timing¹</th>
<th>Closure execution timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSA (ex-pit)</td>
<td>Grand Central²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OSA39</td>
<td>2034</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OSA33</td>
<td>2034</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vista²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OSA Central Vista</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OSA37</td>
<td>2028</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OSA36</td>
<td>2030</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2040</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Highway</td>
<td>TBC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TBC</td>
<td>TBC</td>
<td></td>
</tr>
<tr>
<td>Mine Voids</td>
<td>Highway, Grand Central and Vista</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Highway, Grand Central and Vista</td>
<td>TBC</td>
<td>Options for using Southern Flank infrastructure beyond ~2052 are likely. However, removal of unnecessary infrastructure, as it becomes available, is the base case assumption.</td>
</tr>
</tbody>
</table>

¹ Timing reviewed annually with directional mine plans

² Indicative OSA areas available for rehabilitation based on preliminary mine planning. Note waste volumes within as dumped OSAs may not use the entire OSA capacity/footprint shown in Figure 2.

Progressive rehabilitation will take place on ex-pit waste OSAs as they become available for regrade and revegetation.

Current mine planning has mining of Highway deposits commencing >10 years from mine start up, therefore mine plan and rehabilitation schedule have a high level of uncertainty regarding timing.

Progressive backfill within selected mine voids through to mining completion ~2052 (Grand Central, Vista and Highway). Closure options for Highway below water table mine voids, including backfill, remain under investigation to validate local/regional eco-hydrological impacts.
9.5. Unplanned or unexpected closure

BHP Billiton Iron Ore is required to review a range of risks associated with the closure of its facilities annually as assessed using the risk processes described in Risk Management – Our Requirements (BHP Billiton, 2016b). One of these risks is unexpected or unplanned closure.

In the event that unplanned or unexpected closure occurs, the site will be decommissioned and rehabilitated in line with the objectives and strategies outlined in this document. In the absence of more detailed information (as planned in Section 8), the overall objective under this scenario will be to make landforms such as overburden storage areas secure and non-polluting following decommissioning and decontamination activities, with application of topsoil prioritised for these areas.

Annual cost provisioning for closure in line with the closure cost estimating methodology outlined in Section 11 provides an understanding of the current closure liability, with present closure obligation costs representing an unplanned or unexpected closure scenario.
10. Closure monitoring and maintenance

10.1. Monitoring programme overview

Across its Pilbara mining operations, BHP Billiton Iron Ore has implemented monitoring programmes to evaluate the performance of rehabilitated mine landforms and to assess whether they have either met the site completion criteria or are showing satisfactory progress towards meeting these criteria. These programmes will be expanded as new areas of the mine are rehabilitated, and will be refined based on monitoring results and rehabilitation success.

Ecological monitoring post closure will be in accordance with the Rehabilitation Standard (Appendix F) and the Rehabilitation Monitoring Procedure (SPR-IEN-LAND-012). An important component of leading practice rehabilitation is the use of monitoring and research to track the progress of rehabilitation, and ensure continuous improvement through adaptive management:

- monitoring procedures shall be used to assess whether initial establishment has been successful, rehabilitation is developing satisfactorily against established criteria and is ready for signoff; and
- research activities shall be undertaken where knowledge gaps or deficiencies in rehabilitation progress occur.

Monitoring events will be undertaken in line with the process outlined in within this section, with the outcomes informing rehabilitation strategies, facilitating refinement in completion criteria and directing maintenance and remedial action plans consistent with the adaptive management plans approach (Section 8.1).

10.1.1. Rehabilitation monitoring methodology

Progressive rehabilitation and ongoing performance assessment will be carried out in areas where mining and related operations have been completed and further disturbance is unlikely. Monitoring procedures will be used to assess whether initial establishment has been successful, rehabilitation is developing satisfactorily, and is ready for signoff. Previous rehabilitation monitoring used Ecosystem Function Analysis. A review of the BHP Billiton Iron Ore Pilbara rehabilitation monitoring system was undertaken during 2011. This resulted in the establishment of a three stage monitoring process:

1. Rehabilitation Establishment Assessment, 3 to 24 months of age. Rehabilitation Establishment Assessment provides feedback on the stability and erosion of rehabilitation areas and an assessment of vegetation establishment.

2. Rehabilitation Development Monitoring, Years 3, 5, 7, 9, 12, 15. Rehabilitation Development Monitoring is an in-depth assessment of rehabilitation involving Landscape Function Analysis, erosion monitoring and quadrat vegetation monitoring using existing monitoring transects. It is applied to maturing rehabilitated areas. Rehabilitation Development Monitoring methodology was followed for the first time in 2011, with positive results in quantifiable vegetation measures that will assist in the development of completion criteria.

3. Rehabilitation Landform Appraisal, Years 3, 7, 12 and thereafter if required. Rehabilitation Landform Appraisal provides a summary of the status of large scale rehabilitated landforms and areas not covered by Rehabilitation Development Monitoring.

Assessing whether a particular area has met all criteria will require compilation of all relevant site records of rehabilitation operations, monitoring data, photographic records and summarising these in a short report. Assessment procedures used against particular criteria will generally fall into one of three categories:

1. Using ‘operational criteria’ to confirm that operations have been carried out according to agreed Ministerial Statements, and any other commitments and procedures;

2. Determining whether agreed criteria milestones and standards have been met as measured using monitoring procedures, visual inspection and other methods as appropriate; and
3. Using more detailed trials and research investigations in typical rehabilitated areas to determine whether more in-depth criteria, such as those relating to sustainability following burning, have been met.

Should ongoing monitoring indicate potential non-compliance with established closure criteria the appropriate maintenance and/or remedial work will be undertaken. Further monitoring will be subsequently undertaken on repaired areas to demonstrate compliance with relevant criteria.

To ensure quality control is maintained at all stages of the rehabilitation processes (e.g. execution of rehabilitation works, maintenance and monitoring), activities will be completed in line with BHP Billiton Iron Ore’s suite of procedures which provide guidance on aspects such as:

- rehabilitation audit and inspection;
- rehabilitation data capture; and
- rehabilitation monitoring.

10.1.2. Weed Monitoring

BHP Billiton Iron Ore weed management procedures describe the weed monitoring to be conducted, in addition to measures used to prevent the introduction and spread of weeds and the ongoing effectiveness of weed control measures.

Post-mining control measures and monitoring programmes (and completion criteria) will be developed and/ or refined during the mine life in consultation with the relevant authorities. Approved changes to the monitoring programmes and completion criteria will be documented in the Annual Environmental Report and revisions of the BHP Billiton Iron Ore weed management procedures.

10.1.3. Fauna monitoring of rehabilitation areas

BHP is currently assessing the use of terrestrial invertebrate fauna monitoring to track successional changes within BHP’s rehabilitation areas over time, using the composition of the terrestrial invertebrate assemblages as a biological indicator (bioindicator).

The aim of the fauna monitoring programme is to use appropriate invertebrate groups as bioindicators (taxa that may be used as surrogates for monitoring the full terrestrial invertebrate ecosystem) to determine the success of the rehabilitation by the re-establishment of biological diversity and ecosystem processes (within the boundaries of natural variability).

There is a strong precedent within the published literature for the use of ants as bioindicators; particularly as indicators of environmental change or the progression of rehabilitation. A pilot study is currently being undertaken across a subset of BHP’s Pilbara sites. Using results of this pilot study, BHP will develop a detailed approach to fauna monitoring across its sites, including time post-rehabilitation to commence monitoring, survey methods, survey frequency, and survey end-point (i.e. criteria to cease monitoring).

Vegetation monitoring will be undertaken annually across Mining Area C within two years of completion of rehabilitation. In order to determine if habitats suitable to support Antichiroopus ‘DIP007’ and ghost bats (Macrotelena gigas) are re-establishing, monitoring protocols will be updated to target the regrowth and progress of Corymbia hamersleyana mallee, Eucalyptus leucophloia and other large tree species. Corymbia hamersleyana mallee has been identified as a key habitat component for Antichiroopus ‘DIP007’ with the majority of species records obtained from leaf litter at the base of the mallee (Biologic REF). Studies of the ghost bat in the Northern Territory have shown that foraging bats spent most of their time hanging from small branches or the main trunk in the mid-to-upper canopy of eucalypts at heights up to 3 m from the ground (Tidemann et al., 1985). Field observations suggest that ghost bats in the Pilbara adopt a similar strategy (M. O’Connell, Biologic per comm).

Upon the establishment of suitable habitat within rehabilitated areas, BHP will commence fauna monitoring within rehabilitation to determine if Antichiroopus ‘DIP007’ (Southern Flank only) and ghost bats are re-colonising these areas. Management actions, targets, monitoring and reporting for ghost bats and short-range endemics at Mining Area C are detailed in the Biodiversity EMP.
### 10.1.4. Regional water monitoring network

The Regional Monitoring Network has been installed as an operational and catchment scale monitoring programme that collects important information for compliance reporting and to improve the capacity to estimate receptor response to changing hydrological conditions and natural climatic variations and stresses.

The Regional Monitoring Network (Figure 35) is used to develop the understanding of the Baseline Conditions (prior to BHP Billiton Iron Ore operations) and Current Conditions (with BHP Billiton Iron Ore operations), to define the natural variance in hydrological conditions, to underpin the adaptive management and modelling process and to be consistent with the threshold variables being used to assess significance of impacts to receiving receptors. The Regional Monitoring network and mine monitoring for the Mining Area C mining operations will continue to be used to support and inform closure assessments, enabling progressive improvement in understanding and confidence in the achievement of the stated closure objectives related to the hydrological regime.

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#### Figure 35: Regional Monitoring Network overview

The data used in the modelling includes not only the Regional Monitoring Network surface and groundwater data, but also hydrology, hydrogeological and environmental technical studies of baseline conditions.

The Regional Monitoring Network is currently functioning across each of BHP Billiton Iron Ore’s hub areas, and it will be strategically expanded and tele-remoted to build on BHP Billiton Iron Ore’s ability to:

- Enable an improved understanding of hydrogeological, hydrological and ecological baseline characterisation, conceptualisation and flow controls.
- Determine impact: positive, negative or no effect from BHP Billiton Iron Ore operations.
- Establish effects of long term water abstraction and flow modification.
- Predict groundwater footprint based on drawdown via modelling, conductivity, specified yield, pump tests and operational dewatering.
- Record natural conditions, climate variability and characterise control or reference sites.
- Evaluate the interdependency between water and environment systems.
- Collect long term trending and monitoring data.
- Assess the likelihood of impact from BHP Billiton Iron Ore and third-party operations.
- Identify, define and monitor receptors and values.
• Enable environmental impact early warning triggers and thresholds to be developed for receptors.

The Regional Monitoring Network – Hydrological will enable time-variant data collection from various hydrological systems, including:

• Groundwater aquifers water levels and quality.
• Surface water drainage features and creeks flow volumes.
• Soil moisture content.
• Spring discharges, seepages, waterholes and marsh zones.
• Weather and climatic conditions.

The data from the Regional Monitoring Network - Ecological will be supplemented by data collected on:

• Vegetation assemblages.
• Significant flora and fauna values.
• Tree health monitoring, which may include leaf moisture, sap flow and trunk/stem growth gauges or satellite / aerial photography based vegetation condition.
• Hydrological dependence of receiving receptors on surface water, groundwater or soil moisture.

10.1.5. AMD monitoring

AMD monitoring will be integrated with the regional monitoring network (Section 11.1.4) as required based on progressive refinement of the assessment of AMD risk following mine closure.

The risk of AMD generation and release is directly related to the concern that the chemical quality of local and regional water resources could be degraded. Surface water and groundwater monitoring are the primary methods for assessing water quality impacts from AMD. In addition, the following activities can be conducted to monitor AMD potential:

• The integrity of landforms that are constructed to prevent AMD generation and release will be inspected.
• Inspections for AMD discharge to surface water.
• Chemical monitors can be installed in landforms containing potential AMD generating material to assess changing conditions over time.
• Long duration kinetic testing can be conducted in laboratories to verify assumptions about the chemical behaviour of the geological materials.

The application of these methods to Mining Area C will be determined as the understanding of AMD risk is refined.

10.1.6. Surface water monitoring

In addition to the Regional Monitoring Network (Section 11.1.4), inspections of drainage surfaces and erosion control measures will be carried out as soon as possible after periods of heavy rainfall to assess structural integrity of surface hydrological features such as rehabilitated overburden storage areas. Follow up monitoring will occur progressively throughout the closure monitoring period.

If failures are identified appropriate maintenance/remedial actions will be determined and implemented.

10.1.7. Groundwater monitoring

In addition to the Regional Monitoring Network (Section 0), additional monitoring deemed necessary to support the closure and rehabilitation assessment will be determined over the life of the Mining Area C operations with any changes to the programme reported in the Annual Environmental Report.
10.1.8. Off-site Impacts and landform stability monitoring

As part of the general monitoring of the site visual inspections will be conducted to identify obvious off-site impacts. Visual inspections will be undertaken in conjunction with the public safety inspections. Rehabilitated landforms will be inspected after significant rainfall to assess stability and to monitor for areas where unacceptable erosion has occurred. Where necessary, maintenance works will be undertaken to improve performance.

10.1.9. Public safety monitoring

During operations and after mine closure, periodic inspections will be conducted to determine the condition of the safety bunds (and any other safety measures) erected around the open pits and a record kept of those inspections. Where the integrity of the bunds has been compromised to the extent that inadvertent public access could occur, maintenance will be conducted.

10.2. Reporting

The progress and performance of the following at the Mining Area C mining operations will continue to be reported through the Annual Environmental Report:

- rehabilitation monitoring sites,
- any new rehabilitation activities conducted,
- research and development activities; and
- progress towards developing completion criteria.

Rehabilitation details reported in the Annual Environmental Report will include a summary of the rehabilitation monitoring results for the reporting period, maintenance/remedial actions completed or planned and the area and nature of any new rehabilitation that has been undertaken on-site. Any rehabilitation activities planned for the future reporting period will continue to be reported as environmental initiatives on an annual basis. Reporting results will also be made available to the relevant authorities on request.
11. Financial provisioning for closure

BHP Billiton Iron Ore will ensure that financial provisions for the expected closure and rehabilitation cost of environmental disturbance (representing a present obligation) are recognised at the annual reporting date. As the extent of disturbance increases over the life of an operation, the provision is increased accordingly. Costs included in the provision encompass all closure and rehabilitation activities expected to occur progressively over the life of the operation, at the time of closure and during the post closure period (e.g. monitoring). This includes all expected indirect costs, such as project management costs, statutory reporting fees and technical support costs.

The financial provision preparation is undertaken in accordance with BHP Billiton’s Group Level Documents: Corporate Alignment Planning (GLD 018) and Finance - Accounting Interpretations (GLD.004.01).

In some cases, substantial judgements and estimates are involved in forming expectations of future activities and the amount and timing of the associated cash flows. These expectations are formed based on existing environmental and regulatory requirements or, if more stringent, Company standards or policies giving rise to a constructive obligation.

Adjustments to the estimated amount and timing of future closure and rehabilitation cash flows are a normal occurrence in light of the substantial judgements and estimates involved. Factors influencing those changes include:

- Revisions to estimated mine life;
- Developments in technology;
- Regulatory requirements and environmental management strategies;
- Changes in the estimated extent and costs of anticipated activities; and
- Movement in economic input assumptions (interest rates, inflation).

BHP Billiton Iron Ore maintains sufficient closure input assumption documentation to support the closure model financial provision outcomes. The provision process and outcomes are subject to internal and external audit on an annual basis.

For Northern Flank the provision is made up of:

- OSAs, stockpile and general land disturbance rehabilitation;
- Pit void closure (abandonment bund etc.);
- Infrastructure removal;
- Post closure monitoring costs; and
- Human Resource allowances.

Since no ground disturbance has yet taken place at Southern Flank no closure provision yet exists.
12. Data management

BHP Billiton Iron Ore will collect, store and manage closure data in line with its existing data management procedures, including the WAIO-wide Rehabilitation Data Capture Work Instruction (001006).

The Mine Closure Plan and related information will be managed by BHP Billiton Iron Ore. All data will be stored in a central and readily accessible location in accordance with existing BHP Billiton Iron Ore standards and procedures. After lease relinquishment BHP Billiton Iron Ore will transfer the Mine Closure Plan and all associated information to the DMP for its files.

BHP Billiton Iron Ore will progressively update this Mine Closure Plan over time to capture and summarise current closure planning information associated with:

- closure planning prior to cessation of operations;
- implementation of the closure program of works; and
- post-closure monitoring and reporting period.

BHP Billiton Iron Ore will communicate closure planning progress to the regulators via existing Annual Environmental Reporting channels. BHP Billiton Iron Ore will update the Mine Closure Plan as knowledge gaps are filled and closure plans are refined.
13. References


BHP Billiton (2016a) Our Requirements: Corporate Alignment Planning (GLD 018).

BHP Billiton (2016b) Our Requirements: Environment and Climate Change (GLD 009).

BHP Billiton (2016c) Our Requirements: Risk Management (GLD 017)


BHP Billiton Iron Ore Pty Ltd (1997) Mining Area C to Yandi Rail Environmental Management Plan


BHP Billiton Iron Ore Pty Ltd (2012) Environmental Monitoring, Data Management and reporting Procedures 0045364 Version 1

BHP Billiton Iron Ore Pty Ltd (2013) WAIO Closure and Rehabilitation Management Strategy Version 001

BHP Billiton Iron Ore Pty Ltd (2014a) GWL Operating Strategy for Mining Area C (ref: 0019544 version 2)

BHP Billiton Iron Ore Pty Ltd (2014b) Growth Media Management (ref: SPR-IEN-LAND-009 version 3.0)

BHP Billiton Iron Ore Pty Ltd (2014c) Earthworks for Rehabilitation (ref: SPR-IEN-LAND-010 version 4.0)

BHP Billiton Iron Ore Pty Ltd (2015a) Mining Area C Life of Project Environmental Management Plan Revision 6

November 2016
BHP Billiton Iron Ore
Mining Area C Mine Closure Plan

BHP Billiton Iron Ore Pty Ltd (2015b) Mining Area C Hydrological Impact Assessment and Water Management Summary


BHP Billiton Iron Ore Pty Ltd (2015e) WAIO Environment Water Management Standard IO.BLD.P01 Version 4.0

BHP Billiton Iron Ore Pty Ltd (2015f) Mining Area C Mine Closure Plan Revision 2

BHP Billiton Iron Ore Pty Ltd (2015g) WAIO Sees Management Procedure (ref: SPR-IEN-LAND-011 version 2.0)


BHP Billiton Iron Ore Pty Ltd (2016b) Biodiversity Strategy 0120098 Version 1.0

BHP Billiton Iron Ore Pty Ltd (2016c) Central Pilbara Water Resource Management Plan

BHP Billiton Iron Ore Pty Ltd (2016d) Pilbara Public Environmental Review Strategic Proposal

BHP Billiton Iron Ore Pty Ltd (2016e) WAIO Mines Closure Design Guidance Procedure


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Environment Protection Authority (EPA) (2000) *Position Statement Number 2: Environmental Protection of Native Vegetation in Western Australia*. Published by Environmental Protection Authority, Western Australia.

Environment Protection Authority (EPA) (2004a) *Position Statement Number 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia*. Published by Environmental Protection Authority, Western Australia

Environment Protection Authority (EPA) (2004b) *Position Statement Number 7: Principles of Environmental Protection*. Published by Environmental Protection Authority, Western Australia

Environment Protection Authority (EPA) (2005) *Position Statement Number 8: Environmental Protection in Natural Resource Management*. Published by Environmental Protection Authority, Western Australia.

Environment Protection Authority (EPA) (2006) *Guidance Statement Number 6: Rehabilitation of Terrestrial Ecosystems*. Published by Environmental Protection Authority, Western Australia.

Environment Protection Authority (EPA) (2007) *Guidance Statement Number 54a: Sampling methods and survey considerations for subterranean fauna in Western Australia*. Published by Environmental Protection Authority, Western Australia.

Environment Protection Authority (EPA) (2008) *Guidance Statement Number 33: Environmental Guidance for Planning and Development*. Published by Environmental Protection Authority, Western Australia.

Environment Protection Authority (EPA) (2013) *Environmental Assessment Guideline for Consideration of subterranean fauna in environmental impact assessment in Western Australia (No. 12)*. Published by Environmental Protection Authority, Western Australia.

Environment Protection Authority (EPA) (2013a) *Environmental Protection Bulletin Number 19: EPA involvement in mine closure*. Published by Environmental Protection Authority, Western Australia.


HWE Mining (2010) *Area C Aboriginal Heritage Plan* BHP Billiton iron Ore HIMS reference number 406-10


Urbis (2012) Mining Area C - EMP Revision 5 (B, P4 and Extension to OSAs 5 and 8) - Visual Assessment Review. Report prepared for BHP Billiton Iron Ore Pty Ltd


Appendix A: Ministerial Statement 491
Appendix B: Preliminary AMD Risk Assessment likelihood metrics

Table B1: Likelihood metrics (Klohn Crippen Berger 2014)

<table>
<thead>
<tr>
<th>Uncertainty</th>
<th>Description</th>
<th>Frequency at Location</th>
<th>Likelihood Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>Almost certain</td>
<td>Could be incurred more than once a year</td>
<td>10</td>
</tr>
<tr>
<td>Likely</td>
<td>Likely</td>
<td>Could be incurred every 1-2 years</td>
<td>3</td>
</tr>
<tr>
<td>Possible</td>
<td>Possible</td>
<td>Could be incurred within a 5 year cycle</td>
<td>1</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Unlikely</td>
<td>Could be incurred a 5-20 year time frame</td>
<td>0.3</td>
</tr>
<tr>
<td>Rare</td>
<td>Rare</td>
<td>Could be incurred a 20-50 year time frame</td>
<td>0.1</td>
</tr>
<tr>
<td>Very rare</td>
<td>Rare</td>
<td>Occurs once every 100 years</td>
<td>0.03</td>
</tr>
</tbody>
</table>
### Appendix C: BHPBIO Closure and rehabilitation Research and Trials

#### Table C1: Summary of Findings - Rehabilitation Performance at BHP Billiton Iron Ore’s Pilbara Operations

<table>
<thead>
<tr>
<th>Site</th>
<th>Description of Findings from Rehabilitation Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Scalloping has been demonstrated to be effective on competent waste materials on slopes below 20°, at slopes higher than 20° or where materials are not competent, erosion tends to be more pronounced. When using scalloping as a rehabilitation technique, the scallops must be ‘interlocked’ to minimise erosion and optimise the success of revegetation. The construction of bunds on the top of overburden storage areas around the perimeter is essential as it prevents water from flowing down the slopes and minimises erosion potential. Material that has a higher sulphidic content can impact on the success of revegetation. It has been found that using inert waste material as a cover can minimise the impact of sulphidic material. When applying topsoil it is preferable that it be incorporated (keyed-in) into the subsurface material to minimise surface erosion. Contour ripping has been effective at slopes below 20°; however the contours must be surveyed accurately to minimise failure of rip lines. Backfilling pits with waste material minimises visual impacts of the operations and reduces the need to disturb land for new out-of-pit overburden storage area areas. Increased revegetation success has been observed when seeding has occurred prior to the main wet season (i.e. before January).</td>
</tr>
<tr>
<td>Mt Whaleback and Orebody 29/30/35</td>
<td>Previous trials have found that revegetation performance generally increases with greater depth of topsoil application (i.e. there would be an ideal topsoil depth which would be dependent on the species).</td>
</tr>
<tr>
<td>Jimblebar - Wheelarra Hill, OB18</td>
<td>Prior to 2004, qualitative rehabilitation monitoring at the Wheelarra Hill mine showed some areas encountered problems due to plants being of the same age. By adjusting the rehabilitation method used, BHP Billiton Iron Ore has demonstrated that this issue can be overcome by undertaking additional seeding (or planting) in subsequent years. Operational experience has indicated that due to the unpredictable rainfall in the Newman area, seed application should, where practicable, be timed to coincide with major rainfall events. Preliminary rehabilitation monitoring results indicate that rehabilitated stockpiled fines are capable of supporting local native species and are exhibiting growth on a trajectory that would suggest that a sustainable ecosystem will develop over time. The batters of the rehabilitated stockpiled fines have not performed well in terms of stability. These batters were generally profiled to a final slope of 20°, and were directly seeded and contour ripped. High litter development appears to be associated with higher densities of Triodia spp. on the rehabilitated stockpiled fines. Higher infiltration and nutrient cycling values recorded in the Landscape Function Analysis monitoring programme also appear to be correlated with the high litter content of topsoil.</td>
</tr>
<tr>
<td>Marillana Creek (Yandi)</td>
<td>Monitoring of overburden storage area surfaces confirmed significantly advanced rates of recovery in rehabilitated areas with topsoil (i.e. greater than 25% foliar cover) when compared with rehabilitated areas without topsoil (i.e. less than 10% foliar cover). It was also determined that topsoil should be spread at a depth of 50 mm to 60 mm to achieve optimum use of available topsoil resources. Promotion of soil harvesting and progressive rehabilitation has led to high success rates for rehabilitation. As a result of Yandi’s soil harvesting, it has been possible for all rehabilitation areas to date to have topsoil applied.</td>
</tr>
</tbody>
</table>
Table C2: Summary of active rehabilitation research

<table>
<thead>
<tr>
<th>Subject</th>
<th>Research Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Management</td>
<td>Pilbara Seed Atlas: a five year research project involved with the development of practical recommendations for the collection, processing, storage, germination, and efficient use of seeds in mine-site restoration in collaboration with researchers from the Botanic Gardens and Parks Authority. Restoration Seed Bank: initiative is a five-year partnership between BHP Billiton Iron Ore (WA), the University of Western Australia, and the Botanic Gardens and Parks Authority to improve the existing ‘restoration supply chain’ from seed collection, cleaning, drying, storage, treatment, distribution, germination, establishment and monitoring, verification and reporting.</td>
</tr>
<tr>
<td>Growth Media</td>
<td>Yarrie/Nimingarra: Topsoil deficit has been identified as an issue for future rehabilitation works. As a result, BHP Billiton Iron Ore is conducting a trial to use shallow lateritic material as future growth media on rehabilitated landforms. Yarrie/Nimingarra: Growth media trials utilising in-situ waste materials are being incorporated into progressive rehabilitation works Growth Media Atlas: to enable successful establishment of vegetation in rehabilitated areas by assessing existing topsoil stockpiles for the chemical, physical and plant growth properties; and identify suitable alternative growth media materials that could be made available for rehabilitation.</td>
</tr>
<tr>
<td>Fire Ecology</td>
<td>Jimblebar, Wheeler Hill, OB18, Marrillana Creek (Yandi): BHP Billiton Iron Ore is investigating fire ecology (i.e. response of ecosystems following fire) by monitoring areas which have been burnt. Findings from this investigation will be used to determine the possibility of using fire as a rehabilitation tool and to better manage fire affected areas.</td>
</tr>
<tr>
<td>Surface treatments</td>
<td>Yarrie/Nimingarra: Trial to assess the stability and revegetation success using alternative surface treatments to ‘moonscaping’, such as contour ripping, and the creation of contour banks. Yarrie/Nimingarra: Surface treatment trials are being undertaken to assess stability and revegetation success using no rip and minimal rip treatments, and are incorporated into progressive rehabilitation works. Area C: Rock armour trial undertaken to assess varying surface treatments and armour treatments on minimising surface erosion.</td>
</tr>
</tbody>
</table>
| Ghost Bats             | Studies have been undertaken by BHP Billiton Iron Ore since 2011 to understand ghost bat distribution and ecology within the Pilbara. These studies included visual inspection of
<table>
<thead>
<tr>
<th>Subject</th>
<th>Research Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>caves, nocturnal observations, acoustic and ultrasonic detectors, infrared video recorders and scat collection to evaluate the level of and relative importance of caves. Further studies of the ecology of the ghost bats in the Pilbara will continue and provide more information to assist in identifying key habitats (roosting and foraging) for the species. Several artificial roost sites are also being trialled.</td>
<td></td>
</tr>
</tbody>
</table>

Table C3: Summary of Findings – Waste Rock Management at BHP Billiton Iron Ore’s Pilbara Operations

<table>
<thead>
<tr>
<th>Subject</th>
<th>Research Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutralising Mineral Reactions for Control of Acid Completed 2004</td>
<td>Investigation of ARD control including mineral reaction control and hydrogeologic control through cover design, assessment and prediction of short and long-term mineral reactivity in waste deposits, measurement of the reactivity of minerals with long-term neutralising capacity. Included a case study of Mt Whaleback. Research partners: AMIRA International, University of South Australia, Env. Geochemistry International, Levay &amp; Co. Env. Services Findings: Identified ARD passivation mechanisms and methods for assessing the reactivity of minerals.</td>
</tr>
<tr>
<td>Evaluation of ARD Passivation Treatments Completed 2013</td>
<td>Confirmation and definition of ARD passivation mechanisms leading to a methodology for implementation at mining sites using readily available materials. Included a case study of Mt Whaleback. Research partners: AMIRA International, University of South Australia, Env. Geochemistry International, Levay &amp; Co. Env. Services Findings: Improved understanding of pyrite oxidation control and test methods. Identified alternative treatment options for long term ARD control. Extension of the project is planned for long-term acid rock and tailings drainage mitigation through source control.</td>
</tr>
<tr>
<td>Acid generating characterisation of stored waste rocks and current impact upon the surface environment, Mt Goldsworthy Iron Ore Mine Completed 2009</td>
<td>Masters research project investigated Overburden Storage Area (OSA) waste rock material and AMD release at Mt Goldsworthy. Research Partner: Environmental Inorganic Geochemistry Group (EIGG) at Curtin University Findings: Identified the occurrence and characteristics of acid generating waste rock on the surface of OSAs and their affects on vegetation. The work is being extended in a PhD research project.</td>
</tr>
<tr>
<td>Environmental impact of the storage of lignite waste rocks from the Jimbiebar iron ore mine, Newman, Western Australia 2013</td>
<td>Study of Tertiary lignites (young, immature, low grade coal deposits) that may pose risks of combustion and AMD formation if they contain pyrite or other metal sulphide minerals. Research partner: EIGG at Curtin University Findings: Identified the geochemical and mineralogical nature of the rock types, their sulphide contents, and capacity to release acidic, metal laden drainage. Informs proper management and storage of the waste rock material</td>
</tr>
<tr>
<td>Investigation into the Rapid Oxidation Potential for Pyrite Containing Mt McRae Shales from Mt Whaleback Completed 2013</td>
<td>Investigation and recommendation of options for treatment of PAF wastes to remove long term liabilities. Research Partners: Umwelt Australia, University of Western Australia, ChemCentre Findings: A desktop study has been completed that reviewed chemical, biological and physical treatment options. Identified possible laboratory and pilot scale trials that could be conducted.</td>
</tr>
</tbody>
</table>
Pit Lake Disposal of Pyritic Shale Completed 2013

Conducted a desktop study of potential subaqueous disposal of shale. Included review of several case studies and examples that have been described in the literature where pit lakes have been used for the pit lake storage of sulphidic waste material, including waste rock and mine tailings. Considered implications for pit lake waste rock disposal at Mt Whaleback.

Research Partners: Umwelt Australia, ChemCentre

Findings: A key finding from the literature review is that pit lakes are considered to be an effective location for the long term storage of acid generating materials. This information will inform long-term management of Mt Whaleback pyritic waste and other potentially problematic mine waste deposits.

Table C4: Summary of active Waste Rock research

<table>
<thead>
<tr>
<th>Subject</th>
<th>Research Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Rock Drainage Cover Research Programme at Mt. Whaleback and Yarrie mine sites</td>
<td>Cover system field trials have been monitored at the Mt Whaleback site and Yarrie site since 1997. The trials evaluate performance of cover systems of varying thickness that primarily utilise the moisture store-and-release concept. Research partners: O'Kane Consultants.</td>
</tr>
<tr>
<td>Mechanisms of acid release from waste rock piles containing pyritic carbonaceous shale, Mt Goldsworthy Mine</td>
<td>PhD research project. Detailed study with the overall goal of elucidating not only the full extent of acid-generating potential but also comprehending the kinetics of the geochemical alteration and AMD production. Comparisons will be drawn with other iron ore minesites across the Pilbara region where shale is encountered to assess implications for waste rock management and closure. Research partner: (EIGG) at Curtin University</td>
</tr>
<tr>
<td>Analysis for selenium content of iron mining waste rock in the Pilbara</td>
<td>Investigation of the difficulties in producing accurate and reliable analysis for Se in geological materials and application of the optimised procedures to environmental samples encountered in BHP’s iron ore operations. Research partner: EIGG at Curtin University</td>
</tr>
<tr>
<td>Investigation into PAF Waste and Shale Reactivity Iron Ore Mines in the Pilbara</td>
<td>Isothermal reactor and ARD testing of reactive pyritic shale samples to investigate spontaneous combustion reactivity and ARD potential. Evaluation of the associated management strategies. Research Partner: University of Western Australia</td>
</tr>
</tbody>
</table>
Appendix D: Mining Area C Closure Risk Assessment and Matrix
## Risk Rating Matrix

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Severity level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Almost Certain</td>
<td></td>
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<tr>
<td>Likely</td>
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<tr>
<td>Possible</td>
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<tr>
<td>Unlikely</td>
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<tr>
<td>Rare</td>
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<tr>
<td>Very Rare</td>
<td></td>
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</tbody>
</table>
## North Flank Risk Assessment

<table>
<thead>
<tr>
<th>Objective (Business, Project or Task Based)</th>
<th>Risk event</th>
<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
</table>
| Final landform (OSA) surface stability failure Northern Flank is managed to meet the Mining Area C Closure Objective | Erosion or weathering event exposes buried waste rock and releases waste rock and/or sediment onto downslope areas | * Poor waste characteristics knowledge (not defined/known and do not respond as anticipated)  
* Models do not contain current waste coding (characterisation known)  
* Waste schedule doesn’t consider waste destination based on model coding  
* Design does not incorporate known waste characterisation erosion parameters  
* Not constructed as designed (waste character, schedule, design in place)  
* Drive for progressive rehab constrained by operational infrastructure results in steeper slopes.  
* Pits not closed out to allow infill, resulting in more explit OSAs | Financial | Remedial cost, future approval conditions | 3 | * Inert waste classes derived based on geological knowledge, BRK and MM erosional stability assessments completed  
* Inert waste class coding included within Mining Model  
* Waste schedule based on waste characterisation to develop final landform.  
* OSA Design Manual  
* Master Area design review process to verify that closure design guidance has been incorporated.  
* Monthly flyover and iomaps waste compliance to design (visual assessment)  
* Verification of OSA compliance to “as dumped” design (See action)  
* Regrade execution to regrade design tolerance (i.e., Rehab WIN)  
* WAIO FMS (Mine Star) rollout has capability of tracking waste from source to destination (See action). | * Remediation of OSA failure |
### Final landform (pit wall) failure Northern Flank

**Objective:** Managed to meet the Mining Area C Closure Objective

<table>
<thead>
<tr>
<th>Risk event</th>
<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
</table>
| Final pit wall fails beyond the abandonmen t bund, or agreed abandonmen t structure | * Abandonment bund position incorrectly designed for pit wall slope (hard rock, unconsolidated material)  
* Pit slope design criteria had unknown risks not realised at the time  
* Constraints prevented abandonment bund from being located appropriately. | Financial     | Remedial cost, future approval conditions | 2                   | * Pit wall stability analysis FoS 1.2, then increase acceptance criteria (FoS 1.5) based on risk review with subject matter experts (eg. Tenure).  
* Master Area design review process to verify that geotech design guidance has been incorporated.  
* Backfill strategy operationally managed with good material availability | * Buttress slope to increase stability  
* Restablish abandonment bund | |
| Acid Metalliferous Drainage release Northern Flank is managed to meet the Mining Area C Closure Objective | Final OSA landforms are stable but AMD discharge occurs  
Poor PAF waste characteristics knowledge (not defined/ known and do not respond as anticipated)*  
Models do not contain current PAF waste coding (characterisation known)*  
Waste schedule doesn’t consider PAF waste destination based on model coding*  
Design is ineffective (encapsulation, store-and-release system does not perform as anticipated).*  
Design does not incorporate known PAF waste characterisation drainage control parameters.* Not constructed as designed (PAF waste, schedule, design in place). | Financial     | Remedial cost, future approval conditions | 3                   | * AMD Management Standard Proc 96370AMD Sample Selection, Collection and Data Management Procedure*  
PAF coding included within Resource Model carried through to Mining Model*  
Mining Area C AMD Risk Assessment*  
OSA Design Manual*  
Verification of OSA compliance to "as dumped" design (See action)*  
Regrade execution to regrade design tolerance (i.e., Rehab WIN)*  
WAIO FMS (Mine Star) rollout has capability of tracking waste from source to destination (See action). | AMD material recovered and moved to a dedicated PAF cell | |

### Notes
- * denotes information that is unknown or incorrect.
- Financial impacts include remedial costs and future approval conditions.
- Health and safety impacts include public access risk.
- Environment impacts include stakeholder confidence declines.
- Community impacts include poor waste characteristics.
- Legal impacts include compliance issues.
- Preventative controls address specific risks and failures.
- Mitigating controls focus on corrective actions and future prevention.
- Residual risk ratings indicate the level of remaining risk after mitigation.
### Groundwater level and quality Northern Flank

**Objective**
- Pit lake becomes a throughflow system and influences surrounding water level and quality beyond acceptable limits

**Risk event**
- Regional cumulative influence level of confidence is poor; assumptions (including third party and baseline of Weeli Wolli) incorrect
- Inadequate sensitivity testing within predictive assessments (eg hydro parameters)
- Geochemical dynamics poorly understood (eg dispersive or density driven flow) (AMD relevant to MAC)
- Increase in knowledge identifies AMD issues not currently controlled.
- Underestimate / lack of understanding the residual impact of RTIO on Weeli Wolli

**Causes**
- FINANCIAL: Remedial cost, future approval conditions
- ENVIRONMENT: Water dependent receptor value (Coondewanna, Weeli Wolli) declines, sub fauna impacts (Weeli Wolli)
- COMMUNITY: Cultural value of WeeliWooli spring declines
- REPUTATION: Stakeholder confidence declines
- LEGAL: Sub faunal impacts (Weeli Wolli)

**Impact type**
- Uncontrolled Impact

**Rating**
- 4

**Preventative controls**
- 3D numerical groundwater flow model under various closure scenarios - inform pit closure strategy.
- Significant receptors hydrological conceptual models (i.e., Coondewanna Flats and Weeli Wolli)
- Pit wall rock and mined waste characterisation
- Third party data sharing.
- Monitoring network
- Backfill strategy to AWT

**Mitigating controls**
- Post operations MAR
- Direct surface water into pit to manage salinity
- Demonstrate groundwater recovery trajectory (to manage lack of baseline knowledge)

**Residual Risk Rating**
### Objective (Business, Project or Task Based)
- **Mineral Area C Mine Closure Plan**

### Risk event
- Managed to meet the Mineral Area C Closure Objective
- Not meet acceptable limits

### Causes
- Design inadequate (diversion structure, pit wall, OSA). Land bridges (aquaduct) may not maintain flow upon closure: * Waste rock geochemistry poorly characterised and integrated into predictive assessments;* Inadequate flood protection (minor watercourse capture into the pit). Design for closure drainage conceptual only; * Inadequate sensitivity testing (e.g., climatic variation/baseline flow estimation)* Closure surface water regime does not sustain environmental flows to Coondewanna Flats or Weeli Wolli; * BHP inherits legacy surface water impacts

### Impact type
- Health and safety
- Environment
- Community
- Reputation
- Legal

### Impact type
- Uncontrolled Risk
- Uncontrolled Impact
- Preventative controls
- Mitigating controls
- Residual Risk Rating

#### Health and safety
- Water dependent receptors (riparian veg and Coondewanna Flats) value declines; surface water quality or quantity reporting downstream declines
- (water quantity and quality) (e.g., Coondewanna) (including baseline) - will inform into closure requirements* OSA Design Manual* Master Area design review process to verify that closure design guidance has been incorporated.* Flood protection design for closure (appropriate specifications e.g., design life)* Diversion design for closure (planned)* Climate change adaptation - ensuring designs (design standards) address climate variation.* Baseline surface water models includes sensitivity testing* Surface water assessments inform infrastructure design

#### Environment
- Stakeholder confidence declines
- * Maintain duty of care control measures

#### Community
- Stakeholder confidence declines
- * Maintain duty of care control measures

#### Reputation
- Stakeholder confidence declines
- * Maintain duty of care control measures

#### Legal
- Stakeholder confidence declines
- * Maintain duty of care control measures

#### Financial
- * Design and install reasonable duty of care control measures

#### Health and safety
- Multiple fatalities

#### Environment
- Stakeholder confidence declines
- * Maintain duty of care control measures

#### Community
- Stakeholder confidence declines
- * Maintain duty of care control measures

#### Reputation
- Stakeholder confidence declines
- * Maintain duty of care control measures

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**Note:**
- * indicates item(s) that are not applicable.
<table>
<thead>
<tr>
<th>Objective (Business, Project or Task Based)</th>
<th>Risk event</th>
<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity values do not achieve ecological criteria</td>
<td>Revegetation failure</td>
<td>Northern Flank risk is managed to achieve the Mining Area C Closure Objective</td>
<td>Legal</td>
<td>Prosecution (duty of care)</td>
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<td></td>
<td></td>
<td></td>
<td>Financial</td>
<td>Remedial cost, future approval requirements</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Health and safety</td>
<td>Stakeholder confidence declines, intended land use not achieved</td>
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<td></td>
<td></td>
<td></td>
<td>Environment</td>
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<td></td>
<td>Community Reputation</td>
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<td></td>
<td></td>
<td></td>
<td>Legal</td>
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</tbody>
</table>
## South Flank Risk Assessment

<table>
<thead>
<tr>
<th>Objective (Business, Project or Task Based)</th>
<th>Risk event</th>
<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
</table>
| Final landform (OSA) surface stability failure | Erosion or weathering event exposes buried waste rock and releases waste rock and/or sediment onto downslope areas | -Poor waste characteristics knowledge  
-Drivesure schedule doesn’t consider waste destination based on model coding  
-Design does not incorporate known waste characterisation erosion parameters  
-not constructed as designed or no Design  
-Drive for progressive rehab constrained by operational infrastructure results in steeper slopes.  
-Pits not closed out to allow infill, resulting in more explicit OSAs  
-Understanding dewatering rates and how that impacts mining rates  
-Mining schedules short hauls and doesn’t segregate or stockpile waste (volumes)  
-Compliance to plan for waste scheduling | Financial | Remedial cost, future approval conditions, compensatio n for closing highway | 4 | -Mines Closure Design Guidance (OSA final landform design parameters based on lab and field data)  
-Ongoing MM waste dump design testing/knowledge from MAC  
-Waste characterisation activities (partially complete)  
-Source to destination scheduling  
-Rehab work pack sign off; Compliance to plan  
-Backfill as preferred waste disposal option, as much as practicable  
-Lower height and wider waste dumps (conservative slope angle) | Remediation of OSA failure |
<table>
<thead>
<tr>
<th>Objective (Business, Project or Task Based)</th>
<th>Risk event</th>
<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
</table>
| Final landform (pit wall) failure is managed to meet the Closure Objectives | Final pit wall fails beyond the abandonment bund, or agreed abandonment structure (Grand Central and Vista only) | - Abandonment bund position incorrect for pit wall slope (hard rock, unconsolidated material)  
- Pit slope design criteria had unknown/unidentified risks e.g. Groundwater regime different from design case  
- Constraints prevented abandonment bund from being located appropriately | Financial | Remedial cost, future approval conditions | 2 | - Pit wall stability analysis FoS 1.15-1.2 based on risk review with subject matter experts  
- Master Area design review process to verify that geotech design guidance has been incorporated.  
- Geotechnical monitoring equipment to monitor stability of the area, including prisms, extensometers and radar | - Buttress slope to increase stability  
- Re-establish abandonment bund  
- Tactical and/or strategic design changes to improve stability in the area should instabilities arise | |
| | | | Health and safety | See public access risk | | | | |
| | | | Environment | | | | | |
| | | | Community | | | | | |
| | | | Reputation | Stakeholder confidence declines | | | | |
| | | | Legal | | | | | |
| Final landform (pit wall) failure is managed to meet the Closure Objectives | Final pit wall fails beyond the abandonment bund, or agreed abandonment structure | - Abandonment bund position incorrect for pit wall slope (hard rock, unconsolidated material)  
- Pit slope design criteria had unknown/unidentified risks e.g. Groundwater regime different from design case | Financial | Remedial cost, future approval conditions, compensatio for closing highway | 5 | - Pit wall stability analysis FoS 1.5 (Highway), 1.15-1.2 FoS for other areas based on risk review with subject matter experts | - Restablish abandonment bund  
- Tactical and/or strategic design changes to improve stability in the area should instabilities arise | |
<table>
<thead>
<tr>
<th>Objective (Business, Project or Task Based)</th>
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<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and safety</td>
<td>Constraints prevented abandonment bund from being located appropriately</td>
<td>Public access risk</td>
<td>-Master Area design review process to verify that geotech design guidance has been incorporated. -Buttress slop to increase stability based on further geotechnical assessment - Geotechnical monitoring equipment to monitor stability of the area, including prisms, extensometers and radar</td>
<td></td>
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<tr>
<td>Environment</td>
<td>-Regional cumulative influence level of confidence is poor; assumptions (including third party and baseline of Weeli Wolli) incorrect -Inadequate sensitivity testing within predictive assessments (eg hydro parameters) -Geochemical dynamics poorly understood (eg dispersive or density driven flow) -AMD poorly understood or classified</td>
<td>Remedial cost, future approval conditions</td>
<td>-3D numerical groundwater flow model under various closure scenarios - inform pit closure strategy. -Significant receptors hydrological conceptual models (i.e. Ben’s Oasis and Weeli Wolli) -Third party data sharing. -Monitoring network -Central Pilbara Water Resource</td>
<td>-Post-operation aquifer augmentation (if required) -Demonstrate groundwater recovery trajectory (to manage lack of baseline knowledge)</td>
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<tr>
<td>Objective (Business, Project or Task Based)</td>
<td>Risk event</td>
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<td>Mitigating controls</td>
<td>Residual Risk Rating</td>
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</tr>
<tr>
<td>Surface water flows are managed to meet Closure Objectives</td>
<td>Surface water flow and quality offsite does not meet acceptable limits</td>
<td>- Regional cumulative (Hope Downs &amp; MAC) influences poorly considered or known within predictive assessments; - Final landform design inadequate (diversion structure, pit wall, OSA); - Waste rock geochemistry poorly characterised and integrated into predictive assessments; - Inadequate flood protection (minor watercourse capture)</td>
<td>Environment</td>
<td>Water dependent receptor value (Weeli Wolli) declines, sub fauna impacts</td>
<td></td>
<td>Management Plan/Adaptive management; - Backfill to AWT, if required to manage unacceptable impacts; - Water surplus management during operations; - AMD understanding (geochemical sampling, resource/mine model coding); - AMD waste scheduling in mine plan; - WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
<td>- Reinstatement of diversions to maintain flow to downstream receptors i.e. Conndewanna Flats, Weeli Wolli Spring, Fortescue Marsh</td>
<td>Green</td>
</tr>
<tr>
<td>Surface water flows are managed to meet Closure Objectives</td>
<td></td>
<td>- AMD not adequately scheduled or contained during mining; - Uncertainty of impact pathway on Ben’s Oasis</td>
<td>Environment</td>
<td>Environment</td>
<td>Management Plan/Adaptive management; - Backfill to AWT, if required to manage unacceptable impacts; - Water surplus management during operations; - AMD understanding (geochemical sampling, resource/mine model coding); - AMD waste scheduling in mine plan; - WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
<td>- Reinstatement of diversions to maintain flow to downstream receptors i.e. Conndewanna Flats, Weeli Wolli Spring, Fortescue Marsh</td>
<td>Green</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Cultural values of Weeli Wolli spring declines</td>
<td>Community</td>
<td>Cultural values of Weeli Wolli spring declines</td>
<td></td>
<td>Management Plan/Adaptive management; - Backfill to AWT, if required to manage unacceptable impacts; - Water surplus management during operations; - AMD understanding (geochemical sampling, resource/mine model coding); - AMD waste scheduling in mine plan; - WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
<td>- Reinstatement of diversions to maintain flow to downstream receptors i.e. Conndewanna Flats, Weeli Wolli Spring, Fortescue Marsh</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Stakeholder confidence declines, intended land use not achieved</td>
<td>Reputation</td>
<td>Stakeholder confidence declines, intended land use not achieved</td>
<td></td>
<td>Management Plan/Adaptive management; - Backfill to AWT, if required to manage unacceptable impacts; - Water surplus management during operations; - AMD understanding (geochemical sampling, resource/mine model coding); - AMD waste scheduling in mine plan; - WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
<td>- Reinstatement of diversions to maintain flow to downstream receptors i.e. Conndewanna Flats, Weeli Wolli Spring, Fortescue Marsh</td>
<td>Green</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Remedial cost, future approval conditions</td>
<td>Legal</td>
<td>Remedial cost, future approval conditions</td>
<td></td>
<td>Management Plan/Adaptive management; - Backfill to AWT, if required to manage unacceptable impacts; - Water surplus management during operations; - AMD understanding (geochemical sampling, resource/mine model coding); - AMD waste scheduling in mine plan; - WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
<td>- Reinstatement of diversions to maintain flow to downstream receptors i.e. Conndewanna Flats, Weeli Wolli Spring, Fortescue Marsh</td>
<td>Green</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Financial</td>
<td>Remedial cost, future approval conditions</td>
<td>4</td>
<td>Management Plan/Adaptive management; - Backfill to AWT, if required to manage unacceptable impacts; - Water surplus management during operations; - AMD understanding (geochemical sampling, resource/mine model coding); - AMD waste scheduling in mine plan; - WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
<td>- Reinstatement of diversions to maintain flow to downstream receptors i.e. Conndewanna Flats, Weeli Wolli Spring, Fortescue Marsh</td>
<td>Green</td>
</tr>
<tr>
<td>Objective (Business, Project or Task Based)</td>
<td>Risk event</td>
<td>Causes</td>
<td>Impact type</td>
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<td>Mitigating controls</td>
<td>Residual Risk Rating</td>
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<td>--------------------------------------------</td>
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</tr>
<tr>
<td>Environment</td>
<td>Water dependent receptors (riparian veg and Coondewanna Flats) value declines; surface water quality or quantity reporting downstream declines</td>
<td>verify that closure Design guidance has been incorporated.</td>
<td>-Flood protection Design for closure (appropriate specifications e.g., Design life)</td>
<td>-Climate change adaptation - ensuring designs (Design standards) address Climate variation -Baseline Surface water models includes sensitivity testing -Surface water assessments inform infrastructure Design -AMD understanding (geochemical sampling, resource/mine model coding) -AMD waste scheduling in mine plan -WAIO Closure Mine Design Guidance Procedure (PAF dump design)</td>
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<tr>
<td>Community</td>
<td>Visual impacts from vegetation die off – visually noticed by community</td>
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<tr>
<td>Reputation</td>
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<tr>
<td>Revegetation failure risk is managed to achieve</td>
<td>Biodiversity values do not achieve ecological criteria</td>
<td>-Landform growth media for germination is ineffective -Incorrect species selection -OSA erosion -Poor seed quality and</td>
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<tr>
<td>Financial</td>
<td>Remedial cost, future approval requirement s</td>
<td>3</td>
<td>-Topsoil reconciliation and waste characterisation -WAIO Rehabilitation Strategy</td>
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November 2016
### Objective (Business, Project or Task Based)

<table>
<thead>
<tr>
<th>Objective (Business, Project or Task Based)</th>
<th>Risk event</th>
<th>Causes</th>
<th>Impact type</th>
<th>Uncontrolled Risk Description</th>
<th>Uncontrolled Impact</th>
<th>Preventative controls</th>
<th>Mitigating controls</th>
<th>Residual Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closure Objectives</td>
<td>availability -Drought events -Weed establishment -OSA surface stability failure</td>
<td>Health and safety Environment</td>
<td>Stakeholder confidence declines, intended land use not achieved</td>
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<td></td>
<td>-WAIO Rehabilitation Standard and seed management protocols -Growth Media Atlas and growth media trials. -Weed management program. -Botanic Gardens &amp; Park Authority: Restoration Seed Bank: address long-term management of seed collection, storage, and germination strategies -Development of agreed ecological completion criteria</td>
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<td>Site security measures meet the Closure Objectives</td>
<td>Unauthorised (reasonable) public access into a closed site occurs</td>
<td>Financial Health and safety Environment Community Reputation Legal</td>
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</table>
| Regulatory and Stakeholder Acceptance of closure solution | Unable to achieve acceptable solution to stakeholders | -Change of regulatory expectations  
- Minimise closure cost solution primary driver  
- Post relinquishment agreed land management structure fails | Financial | Remedial cost, future approval conditions | 2 | - Ongoing consultation (pre-, during and post-mining) with key stakeholder i.e. Banjima and other TO groups, Regulators (DMP, EPA etc)  
- Adaptive management of closure plan | * Ripping and re-seeding where required |  |
Appendix E: WAIO AMD Management Standard
Appendix F: BHP Billiton Iron Ore Rehabilitation Standard
Appendix G: Preliminary Southern Flank AMD Risk Assessment