



CLOUDBREAK LIFE OF MINE PUBLIC ENVIRONMENTAL REVIEW

April 2011



Fortescue
The New Force in Iron Ore

| Rev | Issue Date | Description of Revisions Made | Signatures | | |
|-----|------------|-------------------------------|-------------|-----------------|-----------------|
| | | | Originator | Checked | Approved |
| a | 26-11-10 | Draft Report | Les Egerton | Sean McGunnigle | Deidre Willmott |
| 0 | 14-3-11 | Final Draft Report | Les Egerton | Sean McGunnigle | Deidre Willmott |
| 1 | 6-4-11 | Final Report | Les Egerton | Sean McGunnigle | Deidre Willmott |

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Fortescue Metals Group Ltd proposes to expand mining at the Cloudbreak iron ore mine (Cloudbreak) located in the Pilbara region of Western Australia. The Proposal involves expansion of the approved mine to enable iron ore production to continue, at an increased rate of up to 50 Mtpa of iron ore for up to another 14 years. The expansion of the existing mining footprint will include additional mine pits, permanent above-ground waste landforms, tailings disposal, an overland ore conveyor, roads, drainage and other associated mine infrastructure. The Proposal also includes increasing the depth of mining and the volume of mine dewatering and subsequent injection of both brackish and saline water. Fortescue's current water management approach of separating brackish and saline water will be continued to allow injection to minimise potential effects on water quality in the receiving aquifers.

In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 6 weeks from 11 April 2011, closing on 23 May 2011.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Where to get copies of this document

Hard copies of the PER may be purchased at a cost of \$10.00 per copy, or a CD-ROM version will be provided free of charge. Copies of this document may be obtained from Fortescue Metals Group

Level 2, 87 Adelaide Terrace, EAST PERTH WA 6004

Ph: (08) 6218 8888

Email: cloudbreakexpansionper@fmgl.com.au

The document/s may also be accessed through the proponent's website at http://www.fmgl.com.au/IRM/content/project_environment_cloudbreakexpansionprojectper.htm

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind.

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name,
- address,
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: 23 May 2011

The EPA prefers submissions to be made electronically using the following email:

submissions.eia@epa.wa.gov.au.

Alternatively submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 33, CLOISTERS SQUARE WA 6850, Attention: Helen Dagnall; or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: Helen Dagnall; or
- faxed to (08) 6467 5556, Attention: Helen Dagnall.

If you have any questions on how to make a submission, please ring the EPA assessment officer, Helen Dagnall on 6467 5416.

EXECUTIVE SUMMARY

INTRODUCTION

The Proponent, Fortescue Metals Group Ltd (Fortescue) proposes to expand mining at the Cloudbreak iron ore mine (Cloudbreak) located in the Pilbara region of Western Australia. Changes proposed under the expansion process include an increase in ore production, development of new mine infrastructure and additional dewatering and water disposal activities over the life of mine.

This document is a Public Environmental Review (PER) for the Cloudbreak Expansion Proposal (the Proposal) and has been prepared in accordance with the Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002 of the *Environmental Protection Act 1986* (EP Act).

BACKGROUND

The Cloudbreak mine commenced production in 2008 and currently produces approximately 45 Mtpa of iron ore combined output with Christmas Creek, which is transported to Port Hedland for shipment. The existing mine at Cloudbreak is being implemented in accordance with Statement 721.

ASSESSMENT PROCESS

The Proposal was referred to the Environmental Protection Authority (EPA) under section 38 of the EP Act on 2 September 2010. On 4 October 2010, the EPA set the level of assessment for the Proposal as a PER with a six-week public review period. The Proposal has also been deemed a controlled action under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will be assessed through the Bilateral Agreement, which allows the Proposal to be assessed through a combined impact assessment process.

Fortescue is aiming to achieve a single Ministerial Statement pursuant to the EP Act that covers both the existing approved project and the expansion Proposal as an outcome of this assessment process.

THE PROPOSAL

The Proposal involves expansion of the approved mine to enable iron ore production to continue, at an increased rate of up to 50 Mtpa of iron ore for up to another 14 years. The expansion of the existing mining footprint will include additional mine pits, permanent above-ground waste landforms, tailings disposal, an overland ore conveyor, roads, drainage and other associated mine infrastructure. The expansion of Cloudbreak will include an increased footprint (30 ha to 45 ha) for improvements to accommodation facilities. The ore processing facility will be upgraded to include a “wet-front end” and ore wash plant, (to be expanded within the existing approved footprint). The Proposal also includes in-pit disposal of tailings from the beneficiation process which will not require any additional footprint.

The Proposal includes increasing the depth of mining and the volume of mine dewatering and subsequent injection of both brackish and saline water. Fortescue’s current water management approach of separating brackish and saline water will be continued to allow injection to minimise potential effects on water quality in the receiving aquifers.

The key characteristics of the Proposal are outlined in Table 1.

Table ES1 Summary of Key Characteristics of Proposal

| Relevant Characteristic | Approved Project Statement 721 | Proposed Changes (cumulative with the current approved project) |
|--------------------------|---|--|
| Main Activities | Iron ore strip mining, dewatering and injection, pit backfilling, ore processing, transport of ore to rail loading facility, ore loading to rail, mine rehabilitation and closure | Increase in the scale of these activities, plus addition of an ore washing facility, and conversion of OPF to a wet plant |
| Resource | 500 to 600 Mt Marra Mamba iron ore deposit | Approximately 700 Mt Marra Mamba iron ore deposit |
| Ore production | 45 Mtpa (combined with output from Christmas Creek and Mindy Mindy) | Up to 50 Mtpa wet product down-rail from the Cloudbreak OPF consisting of either: <ul style="list-style-type: none"> • 100% from Cloudbreak ROM ore feed • Up to 10 Mtpa from Christmas Creek ROM ore feed |
| Overburden | Approximately 1275 Mt | Approximately 3150 Mt |
| Tailings | Unspecified | In-pit disposal of up to 70 million m ³ |
| Life of mine | Approximately 12 years | Approximately 17 years (from commencement in 2008) |
| Area disturbed | 5500 ha 475 ha of open pit at any one time 350 ha for dewatering infrastructure at any one time | Up to 18 100 ha |
| Pit depth | Ranges from 0 m to 70 m | Up to 90 m |
| Dewatering requirements | Pit dewatering, excess water storage in ponds, water injection Mine dewatering up to 25 GL/yr Water injection up to 20 GL/yr | Mine dewatering up to 100 GL/yr Injection of all water that is not used for ore processing or dust suppression (up to 85 GL/yr) |
| Power | 40 MW diesel-fuelled power station (already approved) | No change |
| Greenhouse gas emissions | Approximately 7 kg CO ₂ -e per tonne of ore mined | Approximately 18 kg CO ₂ -e per tonne of ore mined (based on an average production rate of 35 Mtpa) |

STAKEHOLDER CONSULTATION

Stakeholder consultation on the Proposal has formed part of an ongoing and extensive stakeholder engagement program for Fortescue projects undergoing environmental approvals. The Fortescue stakeholder engagement program for the Cloudbreak Expansion Proposal was undertaken from June to November 2010 and is ongoing.

Key issues raised during the stakeholder consultation process were:

- potential impacts and management measures of water abstraction on ecological assets and nearby pastoral leases
- consideration of water sharing options with nearby sites in water management strategy
- management measures preventing the contamination of fresh groundwater once groundwater bores are installed
- current health of vegetation within Proposal area.

Water sharing options were considered as part of the life of mine water balance. However due to low demand for brackish/saline water (the majority of dewatering discharge from Fortescue operations), this option was not considered viable and therefore not included as part of the life of mine water management strategy. The other issues raised by stakeholders are addressed in this PER.

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

Environmental factors relevant to this Proposal were identified through the scoping process and are presented in this document along with additional environmental considerations identified during the detailed assessment process. The key environmental factors that have been addressed in this PER are:

- groundwater
- surface water
- vegetation and flora
- fauna
- conservation areas (proposed) and natural heritage, including potential impacts on the Nationally Important Wetland, Fortescue Marsh
- Aboriginal heritage
- landform, mine closure planning and rehabilitation
- matters of National Environmental Significance
- greenhouse gases.

The key environmental outcomes expected for each of these factors is outlined below.

GROUNDWATER

The Expansion Proposal and the cumulative effects of the Proposal and approved Project are expected to result in the following outcomes in relation to groundwater:

- 1) An estimated average rate of abstraction of 58 GL/yr, of which an estimated 47 GL/yr will be injected back into the aquifer and 11 GL/yr will be used for processing and dust suppression.
- 2) A total of 607 ha outside the maximum disturbance footprint associated with mining may be affected by greater than 1 m of mounding over the life of the Proposal that results in groundwater levels reaching within 2 m of the surface. No mounding greater than 1 m is expected to occur in the Fortescue Marsh.
- 3) A total of 2709 ha outside the maximum disturbance footprint with a depth to groundwater level initially less than 5 m may be affected by drawdown greater than 1 m over the life of the Proposal. Most drawdown occurs for periods of three years or less. A total of 150 ha of the Marsh may be affected by drawdown greater than 1 m for a period of less than three non-consecutive years.
- 4) Mounding and drawdown will slowly dissipate post-closure. Groundwater mounding will continue for between five and ten years post closure. Limited areas of drawdown will occur for at least 40 years post closure.
- 5) No impact is expected in terms of residence time of surface water in the Fortescue Marsh.
- 6) Impacts to groundwater salinity are expected to be minimal due to the geographically separated injection of saline and brackish water designed to match the quality of the receiving groundwater.
- 7) Any potential impact to station supply bores will be managed through well modification or substitution with an appropriate water source if water supply is affected.
- 8) Acidification of any potential Acid Sulphate Soils (ASS) may occur in marsh areas if drawdown occurs during dry climate periods. The potential for acidification will be prevented through the manipulation of the injection regime to maintain water levels.
- 9) Acid mine drainage is not expected to occur as dewatering will not target the Roy Hill Shale member below the ore body and generally the dewatering cone of depression will not extend into the Roy Hill Shale.
- 10) No impact is expected in terms of sinkhole formation.

These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Proposal will not be significantly affected. The key mitigation measure is the separation of saline and brackish water and managed injection that minimises mounding and drawdown effects and maintains a net abstraction of less than 15 GL/yr. Fortescue expects that the EPA objectives for this factor will be met.

SURFACE WATER

The Proposal and the cumulative effects of the approved project are expected to result in the following outcomes in relation to surface water:

- 1) No significant impact on water quality and quantity of water entering Fortescue Marsh.
- 2) Increases in velocity of peak flows in major creeklines during the later stages of mining, with velocities generally returning to close to the pre-development values following closure.
- 3) A post-closure effect of 170 ha of areas formerly inundated in the 1 in 100 year flood event may become dry and around 45 ha of previously dry areas become inundated. The change in the areas inundated in the 1 in 2 year event are less than 1 ha.
- 4) A post-closure effect of 300 ha of sheet flow area outside the approved footprint may be affected by shadowing and 20 ha subject to ponding.
- 5) Temporary decrease of up to 7% in catchment areas for the yintas and long term post-closure reduction of 2% or less.
- 6) All surface flow from potentially contaminated areas contained.
- 7) Possible increase in turbidity during high flow events, although flows in the area are already highly turbid.

These impacts are considered to be acceptable as the key environmental values surrounding the Proposal will not be significantly affected. The key mitigation measure is the progressive stabilisation and rehabilitation of final landforms, including the re-establishment of the major drainage lines at closure. Fortescue expects that the EPA objective for this factor will be met.

VEGETATION AND FLORA

The Proposal is expected to result in the following outcomes in relation to terrestrial fauna:

- 1) Approximately 12 600 ha of vegetation will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance within a 23 000 ha area combined with the approved project) with the majority of this occurring in Mulga woodland on flats and broad plains and Spinifex on ranges and hill slopes.

- 2) Up to 10 500 ha of Mulga vegetation will be directly affected by the Proposal with an additional 250 ha potentially indirectly affected by an altered surface water regime and groundwater mounding.
- 3) Up to 4 ha of Samphire vegetation communities (associated with the Priority 1 PEC) will be directly affected by the Proposal with an additional 13 ha potentially indirectly affected for two or more years through dewatering activities (groundwater drawdown).
- 4) Up to 473 ha of Coolibah and River Red Gum vegetation will be directly affected by the Proposal. No additional indirect impact from dewatering and injection activities (groundwater drawdown and mounding) is expected.
- 5) Clearing for the Proposal and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the “threshold level” of 30% of its pre-clearing extent.
- 6) No DRF will be affected by the Proposal and impacts to Priority flora are not expected to be significant.

FAUNA

The Proposal is expected to result in the following outcomes in relation to terrestrial fauna:

- 1) Approximately 12 600 ha of fauna habitat will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga, Snakewood and other Acacia woodland and Spinifex hills and ranges habitat.
- 2) There will be some loss of creek line habitat but very little clearing within halophyte shrubland and hummock grassland habitats.
- 3) There will likely be some localised impacts to the Priority fauna species Pebble-mound Mouse and Northern Short-tailed mouse due to clearing activities. However, these species are widespread in the region and the Proposal is unlikely to significantly affect their regional abundance or range.
- 4) Significant regional impact to fauna is highly unlikely as five of the six habitats that occur within the Proposal area also occur extensively outside the Proposal area. Clearing will be avoided in the rocky escarpment habitat which does not occur widely outside the Proposal area.
- 5) The Proposal itself will not conflict with the WC Act, as no fauna species will cease to exist or have its conservation status affected as a result of the implementation of the Proposal.
- 6) Significant regional impact to SRE species is not expected to occur as a result of the Proposal as it is likely species occurring within the Proposal area occur in the wider region.

- 7) A troglofauna survey will be undertaken to better understand the impacts to troglofauna communities in the Proposal area.
- 8) It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under either the WC Act or EPBC Act.

Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.

FORTESCUE MARSH WETLAND

The Fortescue Marsh is the largest ephemeral wetland in the Pilbara Bioregion: The Fortescue Marsh is a wetland of National Significance in the Directory of Important Wetlands in Australia and is listed as an “Indicative Place” on the Register of the National Estate.

The key threats to the ecology of the Fortescue Marsh from the Proposal are likely to be due to changes in groundwater levels and secondary effects on vegetation and fauna. However, hydrogeological modelling has predicted that any impact on marsh hydrology is unlikely to be significant and only small areas of vegetation may be affected.

It is expected that the integrity, function and environmental values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.

PROPOSED CONSERVATION RESERVE

The Fortescue Marsh and surrounding Pastoral Leases are earmarked for reservation by DEC under pastoral lease renewal arrangements scheduled for 2015, subject to discussion with Fortescue and other parties concerned.

A total of 7155 ha (3.1%) of vegetation within the Proposed Conservation Reserve will be disturbed under this Proposal, of which 6925 ha will be cleared and 230 ha may be indirectly affected. This area will be rehabilitated following closure. Should it be determined that the best use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this use.

Fortescue will also participate in the anticipated consultation process to be conducted by the Department of Environment and Conservation (DEC) as part of the establishment of a multi-user framework agreement with respect to the proposed conservation reserve.

It is expected that the potential impacts of the Proposal are consistent with Government planning for the Proposed Conservation Reserve which recognises mining interests in the area and that rehabilitation will be undertaken consistent with the long term management objectives for this area.

ABORIGINAL HERITAGE

The Proponent has committed to undertake ethnographic and archaeological surveys and investigations in consultation with the Traditional Owners, native title claimant groups and DIA prior to any ground disturbance to identify any potential sites of Aboriginal significance. The Proposal will be carried out in accordance with EPA Guidance Statement No. 41 through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group Land Access Agreements.

The outcome is expected to be limited to impacts on Aboriginal heritage sites to the extent permitted under the *Aboriginal Heritage Act 1972* section 18 consent to disturb.

LANDFORM, MINE CLOSURE PLANNING AND REHABILITATION

The Proposal is not likely to result in significant environmental impact following closure when management measures are considered. Ongoing investigations and monitoring undertaken during the life of mine will refine the management measures required to achieve the long term objectives of mine closure and in accordance with EPA's closure objective. The mine closure plan will be refined to reflect the changes in management measures. As sections of the mine are closed, the refined mine closure plan will be implemented to achieve documented objectives and monitoring to check implementation and measure outcomes.

The key likely long-term outcomes for closure are:

- final landforms will be non-polluting and have stabilised slopes of appropriate gradient and covered by vegetation re-established from respread topsoil and/or seed of local provenance
- the groundwater table will recover to a level and quality to that of pre-mining
- seepage from tailings storage facilities and waste rock dumps to be stable and not impact on groundwater or surface water quality
- altered surface water regimes will be stable and re-vegetated with stable self-sustaining ecosystems
- all areas disturbed for mining and infrastructure are rehabilitated following decommissioning and meet specified final land use criteria.

The management measures to appropriately decommission, decontaminate and rehabilitate disturbed areas are in place to mitigate the potential risks to final mine closure. During life of mine operations, investigations and the adaptive management approach will ensure that risks to closure are detected early and are addressed so as to meet the EPA's closure objective.

Fortescue is currently engaging with stakeholders, incorporating feedback into the ongoing closure planning process. Stakeholder input is integral throughout the life of mine to ensure their requirements are considered and support the closure planning process.

The long term outcomes for closure are considered to be acceptable according to the EPA's closure objective.

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The EPBC Act protects species listed under Schedule 1 of the Act and these are referred to as Matters of National Environmental Significance (MNES). The MNES that potentially occur within the Proposal area are all fauna species. The Proposal is expected to result in the following outcomes in relation to MNES:

- 1) Approximately 12 600 ha of potential MNES habitat will be disturbed by the Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga woodland and Spinifex on low hills habitat.
- 2) A maximum of 0.2% of the extent of potential Night Parrot and Mulgara habitat in the Cloudbreak survey areas (halophytic shrubland and hummock grassland along the edge of Fortescue Marsh) will be directly disturbed as a result of the Proposal.
- 3) A maximum of 8 ha of suitable habitat for the Greater Bilby and 10 911 ha (39%) of the area that may contain patches of suitable habitat will be directly disturbed. Areas that are suitable for Bilby are widely available at a regional level.
- 4) Clearing will be avoided in the rocky escarpment habitat which is habitat for the Northern Quoll.
- 5) It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under the EPBC Act.
- 6) It is unlikely that the Proposal will result in significant impacts to Migratory bird species listed under the EPBC Act.
- 7) Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal.
- 8) A Threatened Fauna Offset Plan will be developed to protect at least 3300 ha of habitat for threatened fauna species.

It is considered that with the management and mitigation measures in place, the Proposal will not significantly impact upon Matters of National Environmental Significance.

GREENHOUSE GASES

The Proposal is expected to result in the following outcomes in relation to greenhouse gases:

- 1) Emission of about 0.63 Mtpa of GHG emissions, equating to approximately 0.8% of the total GHG emissions in WA (based on 2007 estimates).
- 2) Increase in the emissions per tonne from the existing rate of 10 kg CO₂-e per tonne to 18 kg CO₂-e per tonne as a result of additional processing and concentrating of the ore prior to transport.

Fortescue is committed to an ongoing program of review and reporting of greenhouse gas abatement measures. It is anticipated that periodic reviews through the life of the Proposal will identify opportunities to further reduce greenhouse gas emissions over time.

NOISE

Noise was not considered a key relevant factor in the Environmental Scoping Document as the rate of mining is not increasing significantly as part of the Proposal and noise is not likely to increase substantially beyond that produced from the existing mine.

Noise at the Cloudbreak mine is managed under the Cloudbreak Environment Management Plan required to be implemented as a commitment under Statement 721 and is also managed in accordance with the Environmental Protection (Noise) Regulations 1997.

DUST

Dust was not considered a key relevant factor in the Environmental Scoping Document as the rate of mining is not increasing significantly as part of the Proposal and dust is not likely to increase substantially beyond that produced from the existing mine.

Dust at the Cloudbreak mine is managed under the Dust Management Plan required to be implemented as a commitment under Statement 721 and is also managed through the licence conditions under Part V of the EP Act.

ENVIRONMENTAL MANAGEMENT FRAMEWORK

In addition to implementing the requirements of specific environmental conditions set by the EPA if the Proposal is approved, the Proponent will minimise environmental impacts through:

- maintaining an Environmental Management System (EMS)
- implementing the Environmental Management Plan (EMP) for the Proposal
- regularly reviewing the performance of the EMS, EMP and developing environmental improvement plans for priorities identified in the reviews

- improving mechanisms to measure and minimise energy use and greenhouse gas emissions improving the efficiency of natural resource use
- continually updating mine plans and closure, progressively rehabilitating and measuring success
- training staff and contractors in environmental requirements and considerations of their work
- ensuring that stakeholder views are sought, respected and considered
- reporting regularly to stakeholders on performance
- aligning with the Fortescue Environmental Policy.

The proposed management of the key issues associated with the Proposal has been documented in the EMP (included as an Appendix to this PER) to be implemented to manage specific environmental aspects of the Proposal. Implementation of the Proposal in accordance with the EMP will ensure that the Proposal meets all respective environmental obligations including internal objectives, legislation, regulations, and conditions of approval relating to operation of the Proposal.

The EMP is comprised of management sub-plans that describe the specific environmental objectives and targets for each environmental factor, the management measures to be applied to avoid and minimise the environmental impact of the Proposal, monitoring measures to measure the performance of management against the targets, and contingency measures to mitigate unavoidable or accidental impact. The sub-plans are as follows:

- Groundwater Management
- Surface Water Management
- Fortescue Marsh Management
- Biodiversity Management
- Closure Management
- Cultural Heritage Management.

The EMP will be regularly reviewed and revised where appropriate.

IMPACT ASSESSMENT SUMMARY

Table 2 provides a summary of the potential impacts, proposed management commitments and environmental outcomes for each of the environmental factors assessed.

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Table ES2: Executive Summary of the Impacts and Proposed Management Commitments

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
|----------------------|---|---|---|--|--|--|
| Groundwater | <ul style="list-style-type: none"> To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards. | <ul style="list-style-type: none"> National Principles for the Provision of Water for Ecosystems (ANZECC/ ARMCANZ 1996) National Water Quality Management Strategy (ANZECC/ ARMCANZ 2000) State Water Quality Management Strategy 2001 Department of Water's Water Quality Protection Notes Statewide Policy No 5 – Environmental water provisions policy for Western Australia, EPA 2000. | <p>The Cloudbreak area and Fortescue Marsh are underlain by the fractured rock aquifers of the Roy Hill Shales (Fortescue 2010a). Above this lies the Marra Mamba Formation, this includes the ore body. The Marra Mamba Formation aquifer is unconfined to partially confined in the north and partially confined to confined in the south. The topmost layers of the aquifer are Tertiary Detritals including clays, silts, sands and gravels.</p> <p>Aquifers are recharged by direct infiltration of rainfall at outcrop regions of the Marra Mamba Formation and Tertiary Detritals, however, rainfall recharge is low in the Cloudbreak area, reflecting the generally low rainfall of the region (Fortescue 2010a).</p> <p>Groundwater levels at Cloudbreak vary from the mine site (where the watertable is approximately 409 to 415 mAHD) to the Fortescue Marsh margin (approximately 405 mAHD) (Fortescue 2010a).</p> <p>Groundwater in the Cloudbreak region ranges from brackish (<6000 mg/L Total Dissolved Solids [TDS]) in recharge areas to hypersaline in areas closer to the Fortescue Marsh and in fractured rock zones below the Marra Mamba Formation (>100 000 mg/L TDS) (Fortescue 2010a).</p> | <ul style="list-style-type: none"> Dewatering of mine pits will reduce groundwater levels, which may potentially: <ul style="list-style-type: none"> reduce the duration of surface water on the Fortescue Marsh and the presence of Yintas result in loss of water supply to station supply bores in the vicinity of the mine remove water from subterranean voids leading to the formation of sinkholes potential oxidisation of Potentially Acid Forming material resulting in acid mine drainage. Injection of dewatering water that may increase groundwater levels, which may potentially result in : <ul style="list-style-type: none"> surface discharge of groundwater if the aquifer at the injection zone is unable to receive the total quantity of water being injected. Changes in groundwater salinity due to injection of saline dewatering water. | <p>Groundwater will be managed in accordance with the Operating Strategy required by the DoW as part of the licensing process, which has been prepared by Fortescue for the management of mine dewatering and disposal at Cloudbreak (Fortescue 2009a).</p> <p>Key management strategies and proponent commitments relating to groundwater are:</p> <ul style="list-style-type: none"> manage saline and brackish dewatering and injection separately to protect aquifer water quality. progressive dewatering only in active mining areas to minimise dewatering requirements. monitor water levels and quality (including pH and salinity) prior to and during mining and post-closure (for three years on a six monthly basis), to address potential water quality issues including acidification of potential ASS. The monitoring results will be reviewed after 3 years and the need for any ongoing monitoring determined. Regulatory agencies will be consulted as a component of the review process. develop trigger criteria for water levels and modify operations should trigger criteria be breached. develop trigger criteria for water quality and undertake an investigation program should these criteria be breached. modify injection regime if required to mitigate potential effects of groundwater drawdown or mounding. establish a contingency plan in consultation with station manager/lease owners should station bore supply be affected by dewatering drawdown. develop a detection plan for sinkholes, should dolomite, calcrete and/or ferricrete with extensive voids, be encountered. <p>An adaptive management approach to groundwater management is being developed by Fortescue to monitor and respond to the actual water level changes as a result of dewatering and injection. This approach is described in the Groundwater Management Plan in Appendix A.</p> <p>Fortescue will develop a monitoring and contingency strategy for potential Acid Mine Drainage.</p> <p>Fortescue is also planning (and in some cases has already commenced) a series of investigations related to groundwater impacts. These investigations will include:</p> <ul style="list-style-type: none"> development of an eco-hydrological model of the Fortescue Marsh Samphire community to investigate soil moisture dynamics based on the marsh hydrogeological drilling program and soil profile assessments investigation of the geology and hydrogeology of the Fortescue Marsh investigation of Samphire use of groundwater and response to salinity changes and drying regimes investigation of the response of Mulga to drought, waterlogging and salinity stresses. <p>The findings of these investigations will inform mining operations in order to provide for ongoing vegetation protection and management. Fortescue will maintain an ongoing dialogue with regulatory authorities with respect to the implementation of these investigations and their outputs, which will be used to refine the EMP provided in Appendix A.</p> | <p>After mitigation measures as described in Appendix A, the Expansion Proposal and the cumulative effects of the current Proposal are expected to result in the following outcomes in relation to groundwater:</p> <ol style="list-style-type: none"> 1) An estimated average rate of abstraction of 58 GL/yr, of which an estimated 47 GL/yr will be injected back into the aquifer and 11 GL/yr will be used for processing and dust suppression. 2) A total of 607 ha outside the maximum disturbance footprint associated with mining may be affected by greater than 1 m of mounding over the life of the Proposal that results in groundwater levels reaching 2 m of the surface. No mounding greater than 1 m occurs in the Fortescue Marsh. 3) A total of 2709 ha outside the maximum disturbance footprint with a depth to groundwater levels initially less than 5 m may be affected by drawdown greater than 1 m over the life of the Proposal. Most drawdown occurs for periods of three years or less. A total of 150 ha of the Marsh may be affected by drawdown greater than 1 m for a period of less than three non-consecutive years. 4) Mounding and drawdown will slowly dissipate post-closure. Groundwater mounding will continue for between five and ten years post closure. Limited areas of drawdown will occur for at least 40 years post closure. 5) No impact is expected in terms of residence time of surface water in the Fortescue Marsh. 6) Impacts to groundwater salinity are expected to be minimal due to the geographically separated injection of saline and brackish water designed to match the quality of the receiving waters. 7) Any potential impact to station supply bores will be managed through well modification or substitution with an appropriate water source if water supply is affected. 8) Acidification of any potential ASS may occur in marsh areas if drawdown occurs during dry climate periods. The potential for acidification will be prevented through the manipulation of the injection regime to maintain water levels. 9) Acid mine drainage is not expected to occur as dewatering will not target the Roy Hill Shale member below the ore body and generally the dewatering cone of depression will not extend into the Roy Hill Shale. However, a monitoring and contingency strategy will be developed to address this risk. 10) No impact is expected in terms of sinkhole formation. <p>These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Proposal will not be significantly affected. The key mitigation measure is the separation of saline and brackish water and managed injection that minimises mounding and drawdown effects and maintains a net abstraction of less than 15 GL/yr. The impact of mounding and drawdown upon vegetation is discussed in Section 8.5.2. Fortescue expects that the EPA objective for this factor will be met.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Surface water | <ul style="list-style-type: none"> To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards. | <ul style="list-style-type: none"> National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996) National Water Quality Management Strategy (ANZECC/ARMCANZ 2000) Water Quality Protection Notes and Guidelines – Mining and Mineral Processing (2000) Department of Water's Water Quality Protection Notes Statewide Policy No 5 – Environmental water provisions policy for Western Australia, EPA 2000. | <p>The Proposal area is located in the Upper Fortescue River catchment. Surface water in the Proposal area drains in a southerly direction from the Chichester Range to the Fortescue Marsh. The Fortescue Marsh is an extensive, ephemeral wetland bounded by the Chichester Range to the north and the Hamersley Range to the south, occupying an area of approximately 1000 km² when in flood (Figure 4, Worley Parsons 2011). The Fortescue Marsh is within the internally draining upper catchment of the Fortescue River system.</p> <p>Surface water flow in and around the Proposal area takes several different forms including:</p> <ul style="list-style-type: none"> channel flow – convergent flow to large creek channels and adjacent floodplains sheet flow – overland flow in a broad shallow front. <p>Channel flow zones are associated with large catchments that predominantly drain the steep upland areas, rather than the flatter terrain closer to the Fortescue Marsh, Sheet flow occurs over extensive areas within and to the south of the Proposal area. Such flat areas occur where the terrain has been formed by remnant alluvial fans (Worley Parsons 2011).</p> <p>Surface water runoff entering the Marsh is generally considered to be of low salinity and turbidity, though turbidity increases after flooding (Aquaterra 2005). During flooding events, salts deposited from previous drying episodes are redissolved, and the water entering the Marsh becomes moderately saline (Fortescue 2009a).</p> | <ul style="list-style-type: none"> Disruption to channel and sheet flow surface water regimes through the diversion, ponding or capture of surface water flows by mine pits, waste landforms and linear infrastructure. Surface water discharge of dewater may occur as a contingency if injection infrastructure fails may cause surface water quality impacts and create new flow paths and erosion risk. Deterioration of surface water quality due to: <ul style="list-style-type: none"> drainage from mine waste facilities (increasing surface water turbidity and acidification of mine waste, should this occur) storage and use of hydrocarbons contaminating storm water discharge. erosion, earthworks and clearing. | <p>The key management strategies and proponent commitments relating to surface water are to:</p> <ul style="list-style-type: none"> divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible. separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release into injection. minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion and berms and perimeter drains to prevent stormwater entering waste landform areas. locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation. ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding. disposal of water via surface water flow paths will only occur during emergencies and when maintenance is required. ensure that chemical storage is undertaken in a manner that limits potential surface water contamination. manage clearing and earthworks to minimise erosion. at closure, the twelve major creek lines defined by Worley Parsons (2010) will be re-established in their original alignments and rehabilitated. | <p>After mitigation measures as described in Appendix A, the Proposal and the cumulative effects of the approved project are expected to result in the following outcomes in relation to surface water:</p> <ol style="list-style-type: none"> No significant impact on water quality and quantity of water entering Fortescue Marsh. Increases in velocity of peak flows in major creek lines during the later stages of mining, with velocities generally returning to close to the pre-development values following closure. A post-closure effect of 170 ha of areas formerly inundated in the 1 in 100 year event may become dry and around 45 ha of previously dry areas become inundated (Figure 46) (Worley Parsons 2011). The change in the areas inundated in the 1 in 2 year event is less than 1 ha. A post-closure effect of 300 ha of sheet flow area outside the approved footprint may be affected by shadowing and 20 ha subject to ponding. Temporary decrease of up to 7% in catchment areas for the yintas and long term post-closure reduction of 2% or less. All surface flow from potentially contaminated areas contained. Possible increase in turbidity during high flow events, although flows in the area are already highly turbid. At closure, the twelve major drainage lines defined by Worley Parsons (2011) will be re-established as close as practicable to their original alignments and levels and rehabilitated. <p>These impacts are considered to be acceptable as the key environmental values surrounding the Proposal will not be significantly affected. The key mitigation measure is the progressive stabilisation and rehabilitation of final landforms, including the re-establishment of the major drainage lines at closure. More information on closure management is provided in Section 13. It is expected that the EPA objective for this factor will be met.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Vegetation and Flora | <ul style="list-style-type: none"> To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. | <ul style="list-style-type: none"> National Strategy for the Conservation of Australia's Biological Diversity National Strategy for Ecologically Sustainable Development EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000) EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b) EPA Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004c). | <p>21 vegetation types have been mapped in the Proposal area (ENV 2011), none of which are considered to resemble Threatened Ecological Communities. The Fortescue Marsh which occurs to the south of the Proposal area is listed by DEC as a Priority 1 Priority Ecological Community. The condition of the vegetation within and in the vicinity of the Proposal area ranges from Excellent to Good.</p> <p>Significant vegetation communities in and adjacent to the Proposal area include:</p> <ul style="list-style-type: none"> Mulga communities, which are considered dependent on sheet flow Coolibah and River Red Gum Communities, which are considered ground-water dependent Samphire communities, which are associated with the Fortescue Marsh PEC (P1). <p>No Threatened species pursuant to the <i>Environment Protection and Biodiversity Conservation Act 1999</i> or, plant taxa gazetted as Declare Rare (DRF) pursuant to the <i>Wildlife Conservation Act 1950</i> are known from the Proposal area.</p> <p>Seven Priority flora listed by the DEC have been recorded within or adjacent to the Proposal area, these are: <i>Eremophila spongicarpa</i> (P1); <i>Gymnanthera cunninghamii</i> (P3); <i>Phyllanthus aridus</i> (P3); <i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3); <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) (P3); <i>Eremophila youngii</i> subsp. <i>Lepidota</i> (P4) and <i>Goodenia nuda</i> (P4).</p> | <ul style="list-style-type: none"> Vegetation clearing for mine pits, waste dumps, tailings facilities, infrastructure corridors, product stockpiles and processing facilities will lead to the direct disturbance of vegetation communities and may potentially affect Priority flora species. Dewatering of mine pits will lower watertables and potentially stress or cause death of groundwater-dependent vegetation communities. Injection of excess groundwater may result in groundwater mounding and potentially stress or kill vegetation communities due to waterlogging and/or salt accumulation in the vegetation root zone. Disruption of surface hydrology may affect vegetation communities that rely on surface water flows. | <p>A maximum of 12 600 ha of vegetation will be cleared by the Proposal. All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing.</p> <p>Potential impacts to significant vegetation communities, such as Mulga and Samphire communities, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in the EMP (Appendix A). The adaptive management approach is based on responding to information provided through implementation of a monitoring program and response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management framework outlined in Appendix A.</p> <p>Impacts to vegetation and flora will be managed under the Biodiversity Plan in the EMP (Appendix A). Key management measures include:</p> <ul style="list-style-type: none"> road and other access alignments and borrow pit areas are to be constructed to avoid DRF and Priority flora as far as practicable all DRF locations (if found) are to be demarcated on the ground with appropriate fencing, signage and flagging where clearing of DRF cannot be avoided: <ul style="list-style-type: none"> assess the local/regional conservation significance of the species prior to clearing consult with DEC regarding the proposed clearing translocation of individuals to nearby similar vegetation associations will be attempted if practicable, dependent on research advice from consultant botanists and the DEC seed and other propagules of DRF planned for clearing will be collected and used for revegetation where practicable collect seed from areas to be cleared within the Proposal area; for use in future rehabilitation clearing to be undertaken progressively. <p>Fortescue is also planning (and in some cases has already commenced) a series of investigations into the water use dynamics of Samphire and Mulga vegetation. These investigations will include:</p> <ul style="list-style-type: none"> development of an eco-hydrological model of the Fortescue Marsh Samphire community to investigate soil moisture dynamics based on the marsh hydrogeological drilling program and soil profile assessments investigation of Samphire use of groundwater and response to salinity changes and drying regimes investigation of the response of Mulga to drought, waterlogging and salinity stresses. <p>The findings of these investigations will inform mining operations in order to provide for ongoing vegetation protection and management. Fortescue will maintain an ongoing dialogue with regulatory authorities with respect to the implementation of these investigations and their outputs, which will be used to refine the EMP provided in Appendix A.</p> | <p>After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to vegetation and flora:</p> <ol style="list-style-type: none"> Approximately 12 600 ha of vegetation will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance within a 23 000 ha area combined with the approved project) with the majority of this occurring in Mulga woodland on flats and broad plains and Spinifex on ranges and hillslopes. Up to 10 500 ha of Mulga vegetation will be directly affected by the Proposal with an additional 250 ha potentially indirectly affected by an altered surface water regime and groundwater mounding. Up to 4 ha of Samphire vegetation communities (associated with the Priority 1 PEC) will be directly affected by the Proposal with an additional 13 ha potentially indirectly affected for two or more years through dewatering activities (groundwater drawdown). Up to 473 ha of Coolibah and River Red Gum vegetation will be directly affected by the Proposal. No additional indirect impact from dewatering and injection activities (groundwater drawdown and mounding) is expected. Clearing for the Proposal and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the "threshold level" of 30% of its pre-clearing extent. No DRF will be affected by the Proposal and impacts to Priority flora are not expected to be significant. |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Terrestrial Fauna | <ul style="list-style-type: none"> To maintain the abundance, diversity geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge. To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity. | <ul style="list-style-type: none"> EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b) EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a) EPA Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA 2009) EPA Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003) Draft Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007c). | <p>Five broad fauna habitats present within the Proposal area (Ecologia 2010a):</p> <ul style="list-style-type: none"> low halophytic shrubland hummock grassland on fringe of Fortescue Marsh low Mulga, Snakewood and other Acacia woodland Spinifex covered hills and ranges creek lines and wells with Acacia shrubland and/or eucalypt woodland. <p>Desktop studies have identified 238 species that either may potentially occur or have previously been recorded in the surveyed area. This total included 165 species of birds, 34 species of native mammals, nine introduced mammals, 96 species of reptiles and five amphibians. Surveys within the Cloudbreak area have recorded 62% of the native mammals, 84% of the birds and 80% of the amphibians potentially occurring.</p> <p>There is potential for 23 species of conservation significance to occur in the Proposal area. Twelve of these species have been recorded within the Proposal area.</p> <p>Seven potential SRE species have been previously recorded in the Proposal area.</p> | <ul style="list-style-type: none"> Vegetation clearing for development within the mining areas and installation of water conveyance infrastructure will directly remove fauna habitat. Trenching for burial of some pipelines may result in the loss/injury of individual fauna. Physical presence of linear infrastructure such as roads and pipelines may disrupt fauna linkages. Redistribution of surface water flows around the mine and its infrastructure may alter fauna habitat. Dewatering and injection activities may affect groundwater-dependent vegetation and affect the value of significant fauna habitat. Vehicle movements during construction and operation may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes. Presence of artificial water bodies may result in the impact to native fauna through increases in introduced fauna, entrapment, poisoning or alteration of fauna behaviour. Loss or disturbance of stygofauna or troglofauna habitat from mining of ore bodies and/or groundwater drawdown and injection. | <p>A maximum of 12 600 ha of habitat will be cleared by the Proposal.</p> <p>All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing.</p> <p>Impacts to significant fauna habitat such as Mulga Woodland and the Fortescue Marsh from groundwater mounding and drawdown will be managed under an Adaptive Management Framework.</p> <p>Management of potential impacts on fauna from this Proposal are also addressed in Biodiversity Plan in the Environmental Management Plan (Appendix A) and includes the following key management actions:</p> <ul style="list-style-type: none"> clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above) significant fauna habitat will be spatially identified and where appropriate demarcated on site all lined surface water storage will have fauna egress points vehicles speeds will be restricted across the Proposal area off road driving or driving on restricted access routes will be prohibited other than for emergency situations clearing will not be undertaken outside authorised areas rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards lighting will be directed onto construction or operational areas. | <p>After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to terrestrial fauna:</p> <ol style="list-style-type: none"> Approximately 12 600 ha of fauna habitat will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga, Snakewood and other Acacia woodland and Spinifex covered hills and ranges habitat. There will be some loss of creek line habitat but very little clearing within halophyte shrubland and hummock grassland habitats. There will likely be some localised impacts to the Priority fauna species Pebble-mound Mouse and Northern Short-tailed mouse due to clearing activities. However, these species are widespread in the region and the Proposal is unlikely to significantly affect their regional abundance or range. Significant regional impact to fauna is highly unlikely as the habitats that occur within the Proposal area also occur extensively outside the Proposal area. The Proposal itself will not conflict with the WC Act, as no fauna species will cease to exist or have its conservation status affected as a result of the implementation of the Proposal. Significant regional impact to SRE species is not expected to occur as a result of the Proposal as it is likely species occurring within the Proposal area occur in the wider region. A troglofauna survey will be undertaken to better understand the impacts to troglofauna communities in the Proposal area. It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under either the WC Act or EPBC Act. Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal potentially adding to the body of knowledge available on this rare species. <p>Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Fortescue Marsh Wetland Area | <ul style="list-style-type: none"> To protect the environmental values of areas identified as having significant environmental attributes. To maintain the integrity, functions and environmental values (of the Fortescue Marsh). | <ul style="list-style-type: none"> Environment Protection and Biodiversity Conservation Act 1999 Directory of Important Wetlands in Australia (Environment Australia 2001) Register of the National Estate The Japan Australia Migratory Bird Agreement (JAMBA), China Australia Migratory Bird Agreement (CAMBA) and Republic of Korea Australia Migratory Bird Agreement (ROKAMBA). | <p>The Fortescue Marsh is the largest ephemeral wetland in the Pilbara Bioregion:</p> <ul style="list-style-type: none"> the Fortescue Marsh is a wetland of National Significance in the Directory of Important Wetlands in Australia and is listed as an “Indicative Place” on the Register of the National Estate – Waterbirds the Marsh constitutes an arid wetland for waterbirds of national importance: 260 000 – 276 000 individuals from 47 species were recorded when the Marsh was inundated in 1999 & 2003. <p>The Fortescue Marsh is an intermittently inundated wetland with broad-scale inundation occurring approximately one year in ten for a period of three to six months. During smaller rainfall and runoff events, isolated pools form on the Fortescue Marsh at the main drainage inlets. Outflow from the marsh into the Lower Fortescue River does not occur.</p> <p>The marsh has recently been classified as a Priority 1 Priority Ecological Community.</p> <p>The Bilby (listed rare fauna) and other mammal species with conservation significance (Mulgara) are present on the apron to the Marsh.</p> | <ul style="list-style-type: none"> Dewatering and injection of groundwater may affect groundwater levels and vegetation health in areas with shallow groundwater such as the edge of the Fortescue Marsh. Installation of linear infrastructure, mine pits and waste landforms may result in interference with natural surface water flow regimes and increased erosion risk. | <p>Potential impacts to significant vegetation communities, such as Samphire communities within the marsh, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in Appendix A. The adaptive management approach is based on responding to information provided through implementation of hydrological and biological monitoring programs coupled with a response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management approach outlined in Appendix A.</p> <p>To support this monitoring and management framework, a water balance model for the Samphire communities of the Fortescue Marsh will be developed. This will be informed by the outputs of research projects undertaken by Fortescue and the University of Western Australia.</p> | <p>The key potential impact to the Fortescue Marsh from the Proposal is the potential for changes in groundwater levels and secondary effects on vegetation and fauna. However, hydrogeological modelling has predicted that any impact on marsh hydrology is unlikely to be significant and only small areas of vegetation may be affected.</p> <p>It is expected that the integrity, function, environmental and heritage values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Proposed Conservation Reserve (PCR) | <ul style="list-style-type: none"> To protect the environmental values of areas identified as having significant environmental attributes. | <ul style="list-style-type: none"> The National Strategy for the Conservation of Australia's Biological Diversity (Department of the Environment, Sports and Territories, 1996) National Objectives and Targets for Biodiversity Conservation 2001-2005 The Western Australian State Sustainability Strategy – Consultation Draft (CALM 2003). | <ul style="list-style-type: none"> The Marsh and surrounding Pastoral Leases are earmarked for reservation by DEC under pastoral lease renewal arrangements scheduled for 2015, subject to discussion with Fortescue and other parties concerned. This includes portions of the Life of Mine Footprint and Approved Footprint of the mine | <ul style="list-style-type: none"> Clearing and earthworks associated with mining will remove vegetation within the PCR. Dewatering of mine pits will lower watertables and potentially stress or cause death of groundwater-dependent vegetation communities within the PCR. Injection of excess groundwater may result in groundwater mounding and potentially stress or kill vegetation communities within the PCR due to waterlogging and/or salt accumulation in the vegetation root zone. Disruption of surface hydrology may affect vegetation communities in the PCR that rely on surface water flows. | <p>A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the PCR</p> <p>Potential impacts to significant vegetation communities within the PCR, such as Mulga Woodland and Samphire communities, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in Appendix A. The adaptive management approach is based on responding to information provided through implementation of hydrological and biological monitoring programs coupled with a response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management framework outlined in Appendix A.</p> <p>Fortescue undertook consultation with the DEC regarding the PCR as part of the site tour to Fortescue's mining activities between 26 and 28th July 2010. Ongoing consultation will occur with DEC regarding the PCR. The PCR consultation process is expected to include consolidation of all parties' commitments and obligations with respect to reserve management. Should it be determined that the best use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this use.</p> <p>In addition, Fortescue is committed to developing an offset package in consultation with the EPA and DEC which is consistent with and addresses the EPA Guidance Statement 19 and EPA Position Statement 9. This package will be targeted at enhancing the long term conservation value of the PCR through improved management and understanding of threatening processes.</p> | <p>The PCR would add local pastoral leases to the conservation estate upon lease expiry in 2015. The overall percentage of the PCR that will be affected by the mine is less than 4%. This area will be rehabilitated following closure. Should it be determined by Government that the end land use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this end land use.</p> <p>Fortescue will also participate in the anticipated consultation process to be conducted by DEC as part of the establishment of a multi-user framework agreement with respect to the PCR.</p> <p>It is expected that the potential impacts of the Proposal are consistent with Government planning for the PCR which recognises mining interests in the area and that rehabilitation will be undertaken consistent with the long term management objectives for this area.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Aboriginal Heritage | <ul style="list-style-type: none"> To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation. | <ul style="list-style-type: none"> Aboriginal Heritage Act 1972 (WA) Guidelines, Interaction between Section 18 of the Aboriginal Heritage Act 1972 (WA) and Part IV of the Environmental Protection Act 1986 EPA Guidance Statement No. 41: Assessment of Aboriginal Heritage. | <p>The Proposal area expansions are located within areas subject to the following Federal Court Native Title Claims:</p> <ul style="list-style-type: none"> Niyaparli (WC99/4) Palyku (WC99/16). <p>Approximately 1573 heritage sites are located within the Chichester Project area (Cloudbreak and Christmas Creek), including 567 salvaged sites. These sites comprise artifact, man-made structure, mythological, repository, ceremonial, grinding patch, midden, skeletal material/burial, engraving, historical, scarred tree and quarry sites. Artifact scatters account for over 80% of the identified sites within the Chichester Project area.</p> | <ul style="list-style-type: none"> Physical disturbance of the land surface during clearing and removal of topsoil and overburden has the potential to disturb heritage sites and affect ethnographic values. Presence of construction and operational personnel has the potential to disturb heritage sites and affect ethnographic values. Alteration of surface water flows has the potential to result in erosion of Aboriginal heritage sites. | <p>A Cultural Heritage Management Plan (CHMP) will be implemented within the Proposal area which will provide for Aboriginal monitors to oversee construction of the expansion within the relevant native title claims (Appendix A).</p> <p>An Aboriginal sites register will be used providing the description, location and condition of heritage sites within Fortescue Project areas.</p> | <p>The Proponent has committed to undertake ethnographic and archaeological surveys and investigations in consultation with the Traditional Owners, native title claimant groups and DIA prior to any ground disturbance to identify any potential sites of Aboriginal significance. The Proposal will be carried out in accordance with EPA Guidance Statement No. 41 (EPA 2004b) through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group LAAs.</p> <p>The outcome is expected to be limited to impacts on Aboriginal heritage sites to the extent permitted under the AH Act Section 18 consent to disturb.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Landform, Mine Closure Planning and Rehabilitation | <ul style="list-style-type: none"> To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values. To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge. | <ul style="list-style-type: none"> EPA Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA 2006b) Draft Guidelines for Preparing Mine Closure Plans (DMP 2010) Environmental Notes on Mining – Waste Rock Dumps (DMP 2009a) Other key government and industry guidelines relevant to mine closure and rehabilitation include: <ul style="list-style-type: none"> Strategic Framework for Mine Closure (ANZMEC and MCA 2000) Enduring Value – the Australian Minerals Industry Framework for Sustainable Development (Minerals Council of Australia 2004) Best Practice Environmental Management in Mining Series (EPA 1995, Environment Australia 1998, 2002). | <p>Implementation of the Proposal will result in an expansion of the existing mining footprint allowing for additional mine pits, permanent above ground landforms, waste landforms, run of mine (ROM), tailings disposal (including below ground disposal), conveyor, roads, drainage, sewage treatment, dewatering and injection infrastructure and other associated mine infrastructure to enable iron ore production of up to 50 Mtpa of iron ore from the Cloudbreak mine for approximately 14 years. It includes increasing the capacity of the power station, accommodation camp, ore processing facility (including beneficiation) and sewage treatment facilities, although these will be expanded within the existing footprint approved under Statement 721.</p> <p>The Proposal includes the in-pit disposal of tailings from the beneficiation process, therefore will not require any additional footprint.</p> <p>The anticipated final land use will either be pastoral grazing or part of future conservation areas as identified by the Pastoral Exclusion Zone. If the area is to become a conservation area, it is assumed that the area will be managed by the DEC. A process to consult effectively with the final land manager, to understand the expectations of the DEC for the conservation estate post closure and its influences on closure activities have been included within the Conceptual Mine Closure Plan and will influence closure planning (Appendix I).</p> | <ul style="list-style-type: none"> Waste dumps, mine pits and tailings facilities may affect surface or groundwater quality if their chemical composition is different to the receiving environment. Altered landform and the effect on surface water flows and erosion potential. Erosion potential of the altered landform and associated potential water quality effects. Rehabilitation of disturbed areas. | <p>Closure management will assist in ensuring that disturbed areas are safe and suitably rehabilitated for the long term end land use as determined in consultation with relevant stakeholders and the community. Fortescue's environmental objectives in relation to rehabilitation and closure are to:</p> <ul style="list-style-type: none"> establish a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment leave site in a safe, stable, non-polluting and tidy condition with no remaining plant or infrastructure that is not required for post-operational use minimise downstream impacts on vegetation due to interruption of drainage identify any potential long-term soil, surface water or groundwater pollution associated with the operations and formulate an action plan to address this develop a stakeholder consultation group prior to closure, to facilitate discussion of closure planning continue to monitor environmental performance during decommissioning, rehabilitation and post-closure stages of the project and take appropriate action until the approved completion criteria have been met. <p>The closure objectives will be achieved through the implementation of the decommissioning and rehabilitation measures specified in a Closure Management Plan to be developed two years prior to mine closure. A Conceptual Mine Closure Plan (Appendix I) has been developed, identifying the key aspects of closure that will require further investigation and refinement through the life of the Proposal and the high risks associated with these aspects.</p> | <p>The Proposal is not likely to result in significant environmental impact following closure when management measures are considered. Ongoing investigations and monitoring undertaken during the life of mine will refine the management measures required to achieve the long term objectives of mine closure and in accordance with EPA's closure objective. This will include implementation of the existing Conceptual Mine Closure Plan to achieve documented objectives and monitoring to check implementation and measure outcomes.</p> <p>The key likely long-term outcomes for closure are:</p> <ol style="list-style-type: none"> Final landforms will have stabilised slopes of appropriate gradient and covered by vegetation re-established from respread topsoil and/or seed of local provenance. The groundwater table will recover to a level and quality to that of pre-mining. Altered surface water regimes will be stable and re-vegetated with stable self-sustaining ecosystems. All areas disturbed for mining and infrastructure are rehabilitated following decommissioning and meet specified final land use criteria. <p>The management measures to appropriately decommission, decontaminate and rehabilitate disturbed areas are in place to mitigate the potential risks to final mine closure. During life of mine operations, investigations and the adaptive management approach will ensure that risks to closure are detected early and are addressed so as to meet the EPA's closure objective.</p> <p>Fortescue is currently engaging with stakeholders, incorporating feedback into the ongoing closure planning process. Stakeholder input is integral throughout the life of mine to ensure their requirements are considered and support the closure planning process.</p> <p>The long term outcomes for closure are considered to be acceptable according to the EPA's closure objective.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
|---|---|---|--|--|---|--|
| Matters of National Environmental Significance | <p>The Environment <i>Protection and Biodiversity Conservation Act 1999</i> objectives for Matters of NES are to:</p> <ul style="list-style-type: none"> provide for the protection of the environment, especially matters of national environmental significance promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources control the international movement of wildlife, wildlife specimens and products made or derived from wildlife. | <ul style="list-style-type: none"> Matters of National Environmental Significance, Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999 (DEWHA2009) Environment Protection and Biodiversity Conservation Act 1999. (DEWHA 2010) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Japan-Australia (JAMBA), China-Australia (CAMBA) and Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements. | <p>Six Threatened fauna species and seven Migratory bird species listed under the EPBC Act may occur in the Proposal area. Several of these species have been recorded within or adjacent to the Proposal area during previous fauna surveys. These potential species include:</p> <ul style="list-style-type: none"> Night Parrot (<i>Pezoporus occidentalis</i>) Northern Quoll (<i>Dasyurus hallucatus</i>) Pilbara Olive Python (<i>Liasis olivaceus barroni</i>) Mulgara (<i>Dasyercus cristicauda</i>) Greater Bilby (<i>Macrotis lagotis</i>) Orange Leaf-nosed bat (<i>Rhinonictis aurantius</i>) Fork-tailed Swift (<i>Apus pacificus</i>) Rainbow Bee-eater (<i>Merops ornatus</i>) White-bellied Sea-eagle (<i>Haliaeetus leucogaster</i>) Eastern Great Egret (<i>Ardea modesta</i>) Wood Sandpiper (<i>Tringa glareola</i>) Common Greenshank (<i>Tringa nebularia</i>) Red-necked Stint (<i>Calidris ruficollis</i>) Cattle Egret (<i>Ardea ibis</i>). | <ul style="list-style-type: none"> Vegetation clearing for development within the mining areas and installation of water conveyance infrastructure will directly remove fauna habitat. Trenching for burial of some pipelines may result in the loss/injury of individual fauna. Physical presence of linear infrastructure such as roads and pipelines may disrupt fauna linkages. Redistribution of surface water flows around the mine and its infrastructure may alter fauna habitat. Dewatering and injection activities may affect groundwater-dependent vegetation and affect the value of significant fauna habitat. Vehicle movements during construction and operation may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes. | <p>A maximum of 12 600 ha of potential habitat will be cleared by the Proposal</p> <p>All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing. Impacts to significant fauna habitat such as Mulga Woodland and the Fortescue Marsh from groundwater mounding and drawdown will be managed under an Adaptive Management Framework.</p> <p>Management of potential impacts on fauna from this Proposal are also addressed in Biodiversity Plan in the Environmental Management Plan (Appendix A) and includes the following key management actions:</p> <ul style="list-style-type: none"> clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above) significant fauna habitat will be spatially identified and where appropriate demarcated on site all lined surface water storage will have fauna egress points vehicles speeds will be restricted across the Proposal area off road driving or driving on restricted access routes will be prohibited other than for emergency situations clearing will not be undertaken outside authorised areas rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards lighting will be directed onto construction or operational areas. <p>Annual Night Parrot Surveys will continue throughout the life of the mine</p> <p>Rehabilitation and mine closure is to re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment in line with set closure objectives.</p> <p>Fortescue will develop an approach to offsetting the areas of preferred habitat for Matters of NES that will be potentially affected by Fortescue projects.</p> | <p>After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to MNES:</p> <ol style="list-style-type: none"> Approximately 12 600 ha of potential MNES habitat will be disturbed by the Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga woodland and Spinifex on low hills habitat. A maximum of 0.2% of the local extent of potential Night Parrot and Mulgara habitat (halophytic shrubland and hummock grassland along the edge of Fortescue Marsh) will be directly disturbed as a result of the Proposal. A maximum of 8 ha of suitable habitat for the Greater Bilby and 10 911 ha (39%) of the area that may contain patches of suitable habitat will be directly disturbed. Areas that are suitable for Bilby are broadly available at a regional level. Clearing will be avoided in the rocky escarpment habitat which is habitat for the Northern Quoll. It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under the EPBC Act. It is unlikely that the Proposal will result in significant impacts to Migratory bird species listed under the EPBC Act. Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal. A Threatened Fauna Offset Plan will be developed to protect at least 3300 ha of habitat for threatened fauna species. <p>It is considered that with the management and mitigation measures in place, the Proposal will not significantly impact upon Matters of National Environmental Significance.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
|-----------------------|---|--|---|--|--|--|
| Greenhouse Gas | <ul style="list-style-type: none"> To reduce emissions to a level which is as low as is practicable. | <ul style="list-style-type: none"> EPA Guidance Statement No. 12: Guidance Statement for Minimising Greenhouse Gas Emissions The Copenhagen Accord 2009. | <p>It is estimated that the Proposal will emit about 0.63 Mtpa of GHG emissions. This represents approximately 0.8% of the total GHG emissions in WA (based on 2007 estimates). The total greenhouse gas emissions for the Proposal are estimated to be approximately 631 000 tonnes CO₂-e/year representing approximately 18 kg CO₂-e per tonne of ore mined, based on the fuel consumption estimates provided and on an average mining rate of 35 Mtpa. This is an increase from the existing rate of 10 kg CO₂-e per tonne.</p> | <p>Greenhouse gas emissions are currently being released from the following activities at Cloudbreak:</p> <ul style="list-style-type: none"> combustion of diesel fuel for mining vehicles and remote power sources combustion of diesel fuel from Power Station combustion of explosive products decomposition of cleared vegetation and release of carbon from the soil. | <p>Greenhouse gas emissions from the Proposal will be reduced through implementation of a Greenhouse Gas Management Plan. Fortescue will develop and endorse energy intensity reduction targets. The Proponent will comply with its various obligations under the <i>National Greenhouse and Energy Reporting Act 2007</i> and the <i>Energy Efficiencies Opportunity Act 2006</i>.</p> | <p>Fortescue is committed to an ongoing program of review and reporting of greenhouse gas abatement measures. It is anticipated that periodic reviews through the life of the Proposal will identify opportunities to further reduce greenhouse gas emissions over time.</p> |
| Noise | <ul style="list-style-type: none"> To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards. | <ul style="list-style-type: none"> Environmental Protection (Noise) Regulations 1997 EPA Draft Guidance Statement No. 8 (EPA 2007a). | <p>The Project area is relatively remote from sensitive premises.</p> | <p>The mining areas are expected to be sufficiently remote to not impact on any nearby residences.</p> | <p>Use low-noise equipment where practicable.</p> <p>Monitor blast noise near sensitive receptors to determine allowable blasting mass.</p> <p>Monitor the effects of blast noise on birdlife and other fauna using the Fortescue Marsh.</p> | <p>Noise emissions from this Proposal are not expected to result in additional noise impacts to that of the approved project.</p> |
| Dust | <ul style="list-style-type: none"> To ensure that emissions do not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards. | <ul style="list-style-type: none"> Ambient Air Quality National Emission Protection Measure (NEPM) Draft State Environmental (Ambient Air) Policy 2009. | <p>The Project is in an arid area where background dust levels are relatively high.</p> <p>Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads and pastoral activities.</p> | <p>Mining, handling of ore and overburden, and exposed cleared areas have the potential to create a dust nuisance for workers and adjacent land users. Due to the remoteness of the sites, the potential for dust impacts on neighbours is expected to be low.</p> | <p>Update of the <i>Chichester Operations Dust Management Plan</i> will be prepared prior to the commencement of construction and operations and will include such measures as:</p> <ul style="list-style-type: none"> the incorporation of dust control measures into project design the use of water carts on high traffic areas progressive rehabilitation of disturbed areas optimisation of vehicle movements daily visual inspections to ensure dust control management measures are effective regular vegetation surveys to assess ongoing dust impacts ambient dust monitoring where appropriate. | <p>Dust emissions from this Proposal are not expected to result in additional impacts to that of the approved project.</p> |

CONTENTS

| | | |
|------------|--|-----------|
| 1. | INTRODUCTION..... | 1 |
| 1.1 | Proposal Overview | 1 |
| 1.1.1 | Background | 1 |
| 1.1.2 | Location | 1 |
| 1.1.3 | Description..... | 2 |
| 1.2 | The Proponent..... | 2 |
| 1.3 | Purpose and Scope of this Document | 2 |
| 1.4 | Rationale for Proposal | 3 |
| 1.4.1 | Demand for Product..... | 3 |
| 1.4.2 | Benefits of Proposal | 3 |
| 1.4.3 | Consequences of Not Proceeding | 4 |
| 1.5 | Environmental Approvals..... | 4 |
| 1.5.1 | Western Australian Environmental Impact Assessment Process | 4 |
| 1.5.2 | Australian Government Environmental Impact Assessment | 5 |
| 1.5.3 | Other Environmental Approvals..... | 6 |
| 1.6 | Other approvals | 6 |
| 2. | OVERVIEW OF EXISTING ENVIRONMENT | 8 |
| 2.1 | Bio-physical Setting | 8 |
| 2.2 | Socio-Economic Setting..... | 10 |
| 2.3 | Key Conservation Values | 11 |
| 3. | DESCRIPTION OF PROPOSAL | 12 |
| 3.1 | Development Overview And Key Characteristics Of Proposal..... | 12 |
| 3.1.1 | Existing Development at Cloudbreak | 12 |
| 3.1.2 | Proposal Overview | 13 |
| 3.1.3 | Development Schedule..... | 15 |
| 3.2 | Exclusions from the Proposal | 15 |
| 3.3 | Consideration of Alternatives | 15 |
| 3.4 | Description of Resource..... | 15 |
| 3.5 | Description of Mining Operations | 16 |
| 3.5.1 | Pit Sequencing | 16 |
| 3.5.2 | Site Preparation..... | 16 |
| 3.5.3 | Pit Dewatering | 17 |
| 3.5.4 | Injection..... | 19 |
| 3.5.5 | Mining..... | 19 |
| 3.5.6 | Ore Transfer | 20 |

| | | |
|-----------|---|-----------|
| 3.5.7 | Ore Processing..... | 21 |
| 3.5.8 | Tailings Management..... | 23 |
| 3.5.9 | Backfilling Pits..... | 25 |
| 3.5.10 | Support Infrastructure and Consumables..... | 25 |
| 4. | STAKEHOLDER CONSULTATION | 30 |
| 4.1 | Stakeholder Engagement Process..... | 30 |
| 4.2 | Stakeholder Comments And Proponent Responses | 32 |
| 4.3 | Ongoing Consultation..... | 37 |
| 5. | FRAMEWORK FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSAL..... | 38 |
| 5.1 | Identification Of Key Factors And Significance..... | 38 |
| 5.2 | Relevant Factors | 39 |
| 5.3 | Consistency With Environmental Principles..... | 39 |
| 5.4 | Consistency With Expectations Of Epa For Environmental Impact Assessment | 41 |
| 6. | GROUNDWATER IMPACT ASSESSMENT | 43 |
| 6.1 | Relevant Environmental Objectives, Policies, Guidelines, Standards And Procedures | 43 |
| 6.1.1 | EPA Objectives..... | 43 |
| 6.1.2 | Legislation, Policy and Guidance..... | 43 |
| 6.2 | Potential Sources Of Impact | 48 |
| 6.3 | Findings Of Surveys And Investigations..... | 49 |
| 6.3.1 | Cloudbreak Hydrogeology | 49 |
| 6.4 | Evaluation Of Options Or Alternatives To Avoid Or Minimise Impact | 53 |
| 6.5 | Assessment Of Likely Direct And Indirect Impacts..... | 54 |
| 6.5.1 | Development of Numerical Model | 56 |
| 6.5.2 | Changes in Quantity | 57 |
| 6.5.3 | Changes in Groundwater Levels | 58 |
| 6.5.4 | Impacts on Surface Water Residence Time in Fortescue Marsh | 65 |
| 6.5.5 | Impacts on Groundwater Quality..... | 65 |
| 6.6 | Cumulative Impacts..... | 69 |
| 6.7 | Management Measures And Performance Standards | 70 |
| 6.7.1 | Management Actions | 70 |
| 6.7.2 | Proposed Future Investigations | 71 |
| 6.8 | Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures | 71 |
| 7. | SURFACE WATER IMPACT ASSESSMENT | 73 |
| 7.1 | Relevant Environmental Objectives, Policies, Guidelines, Standards And Procedures | 73 |
| 7.1.1 | Water Resource Policies and Guidances | 73 |
| 7.2 | Potential Sources of Impact..... | 74 |
| 7.3 | Findings of Surveys and Investigations..... | 75 |
| 7.3.1 | Surface Water Flow Processes..... | 76 |

| | | |
|-------|---|------------|
| 7.4 | Evaluation of options or alternatives to avoid or minimise impact..... | 78 |
| 7.5 | Assessment of likely Direct and Indirect Impacts..... | 79 |
| 7.5.1 | Physical Presence of Infrastructure..... | 79 |
| 7.5.2 | Water Quality Impacts from Mine Infrastructure..... | 85 |
| 7.5.3 | Potential Impacts due to Injection of Excess Dewatering Water | 87 |
| 7.5.4 | Surface Flow as a Contingency for Dewater Injection System | 87 |
| 7.5.5 | Potential Impacts due to Chemical Storage | 87 |
| 7.5.6 | Potential Impacts due to Clearing and Earthworks..... | 88 |
| 7.6 | Cumulative Impacts..... | 88 |
| 7.7 | Management Measures and Performance Standards..... | 89 |
| 7.8 | Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures..... | 90 |
| 8. | VEGETATION AND FLORA IMPACT ASSESSMENT | 91 |
| 8.1 | Relevant environmental objectives, policies, guidelines, standards and procedures..... | 91 |
| 8.1.1 | EPA Objective for Vegetation and Flora | 91 |
| 8.1.2 | Policies and Guidances..... | 91 |
| 8.2 | Potential Sources of Impact..... | 95 |
| 8.3 | Findings of Surveys and Investigations..... | 95 |
| 8.3.1 | Studies Undertaken | 95 |
| 8.3.2 | Vegetation | 96 |
| 8.3.3 | Flora..... | 101 |
| 8.4 | Evaluation of options or alternatives to avoid or minimise impact..... | 104 |
| 8.5 | Assessment of likely direct and indirect impacts | 105 |
| 8.5.1 | Vegetation Clearing | 105 |
| 8.5.2 | Groundwater Drawdown and Mounding..... | 111 |
| 8.5.3 | Alteration to Surface Water Regime..... | 114 |
| 8.5.4 | Summary of predicted direct and indirect impacts | 116 |
| 8.6 | Cumulative Impacts..... | 118 |
| 8.7 | Management Measures and Performance Standards..... | 120 |
| 8.7.1 | Ground Disturbance | 120 |
| 8.7.2 | Adaptive Management of Groundwater | 120 |
| 8.7.3 | Environmental Management Plan..... | 121 |
| 8.7.4 | Proposed Future Investigations | 121 |
| 8.8 | Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures..... | 122 |
| 9. | TERRESTRIAL FAUNA IMPACT ASSESSMENT | 123 |
| 9.1 | Relevant environment objectives, policies, guidelines, standards and procedures..... | 123 |
| 9.1.1 | EPA Objectives..... | 123 |
| 9.1.2 | EPA Statements and Guidelines..... | 123 |
| 9.1.3 | State Regulatory Framework | 124 |

| | | |
|-------------|--|------------|
| 9.1.4 | International Agreements | 124 |
| 9.2 | Potential Sources of Impact | 125 |
| 9.3 | Finding of Surveys and Investigations | 125 |
| 9.3.1 | Studies Undertaken | 125 |
| 9.3.2 | Land Systems | 127 |
| 9.3.3 | Terrestrial Fauna Habitats | 127 |
| 9.3.4 | Occurrence of Vertebrate Fauna | 130 |
| 9.3.5 | Vertebrate Species of Conservation Significance | 132 |
| 9.3.6 | Occurrence of Short-Range Endemic (SRE) Invertebrates | 134 |
| 9.3.7 | Occurrence of Subterranean Fauna | 135 |
| 9.4 | Evaluation of options or alternatives to avoid or minimise impact | 136 |
| 9.5 | Assessment of Likely and Direct Impacts | 137 |
| 9.5.1 | Clearing of Habitat | 137 |
| 9.5.2 | Dewatering and Injection | 140 |
| 9.5.3 | Alteration to Surface Water Flow Regimes | 140 |
| 9.5.4 | Trenching and Injection Infrastructure | 141 |
| 9.5.5 | Vehicle Movements | 141 |
| 9.5.6 | Presence of Artificial water bodies | 141 |
| 9.5.7 | Impacts to Fauna of Conservation Significance | 143 |
| 9.6 | Cumulative Impacts | 152 |
| 9.7 | Management measures and performance standards | 153 |
| 9.7.1 | Ground Disturbance | 153 |
| 9.7.2 | Adaptive Management of Groundwater | 153 |
| 9.7.3 | Environmental Management Plan | 153 |
| 9.8 | Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures | 154 |
| 10. | FORTESCUE MARSH WETLAND IMPACT ASSESSMENT | 156 |
| 10.1 | Relevant environmental objectives, policies, guidelines, standards and procedures | 156 |
| 10.1.1 | EPA Objectives | 156 |
| 10.1.2 | Legislation, Policy and Guidance | 156 |
| 10.2 | Potential Sources of Impact | 160 |
| 10.3 | Findings of surveys and investigations | 160 |
| 10.3.1 | Fortescue Marsh Vegetation | 161 |
| 10.3.2 | Fortescue Marsh Fauna | 161 |
| 10.3.3 | Further Investigations | 161 |
| 10.4 | Evaluation of options or alternatives to avoid or minimise impact | 162 |
| 10.5 | Assessment of likely direct and indirect impacts | 162 |
| 10.5.1 | Surface Water | 162 |
| 10.5.2 | Groundwater | 163 |
| 10.5.3 | Vegetation and Flora | 163 |
| 10.5.4 | Terrestrial Fauna | 164 |

| | | |
|--------|---|------------|
| 10.6 | Cumulative Impacts | 164 |
| 10.7 | Management Measures and Performance Standards | 165 |
| 10.8 | Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures | 165 |
| 11. | PROPOSED CONSERVATION RESERVE IMPACT ASSESSMENT | 166 |
| 11.1 | Relevant environmental objectives, policies, guidelines, standards and procedures | 166 |
| 11.1.1 | EPA Objectives | 166 |
| 11.1.2 | Legislation, Policy and Guidance | 166 |
| 11.2 | Potential Sources of Impact | 167 |
| 11.3 | Findings of Surveys and Investigations | 168 |
| 11.4 | Evaluation of options or alternatives to avoid or minimise impact | 168 |
| 11.5 | Assessment of likely direct and indirect impacts | 168 |
| 11.6 | Cumulative Impacts | 170 |
| 11.7 | Management Measures and Performance Standards | 170 |
| 11.8 | Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures | 171 |
| 12. | ABORIGINAL HERITAGE | 172 |
| 12.1 | Impact Assessment, Relevant Environmental Objectives, Policies, Guidelines, Standards And Procedures | 172 |
| 12.1.1 | EPA Objective for Aboriginal Heritage | 172 |
| 12.1.2 | Regulatory Framework | 172 |
| 12.2 | Potential Sources Of Impacts | 173 |
| 12.3 | Findings Of Surveys And Investigations | 173 |
| 12.3.1 | Archaeological and Ethnographic | 173 |
| 12.3.2 | Native Title | 174 |
| 12.4 | Assessment Of Likely Direct And Indirect Impacts | 175 |
| 12.4.1 | Native Title | 175 |
| 12.4.2 | Disturbance to Land Surface | 175 |
| 12.4.3 | Disturbance by Personnel | 176 |
| 12.4.4 | Indirect Disturbance | 176 |
| 12.5 | Management Measures And Performance Standards | 177 |
| 12.5.1 | Cultural Heritage Management Plan | 177 |
| 12.5.2 | Fortescue Operations Aboriginal Sites Register | 178 |
| 12.6 | Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures | 178 |
| 13. | LANDFORM, MINE CLOSURE PLANNING AND REHABILITATION | 180 |
| 13.1 | Relevant Environment Objectives, Policies, Guidelines, Standards And Procedures | 180 |
| 13.1.1 | EPA Objectives | 180 |
| 13.1.2 | EPA Guidance Statement No. 6 | 180 |
| 13.1.3 | Other Guidelines | 181 |

| | | |
|-------------|--|------------|
| 13.2 | Potential Sources Of Impact | 181 |
| 13.3 | Findings Of Investigations..... | 182 |
| 13.3.1 | Mine Waste Geochemistry | 182 |
| 13.3.2 | Life of Mine Tailings Storage Facility Design..... | 182 |
| 13.3.3 | Ongoing Investigations | 183 |
| 13.4 | Evaluation Of Options Or Alternatives To Avoid Or Minimise Impact | 183 |
| 13.4.1 | Waste Landforms | 183 |
| 13.4.2 | End Land Use | 183 |
| 13.4.3 | Tailings Storage | 184 |
| 13.5 | Closure Management Measures And Performance Standards..... | 184 |
| 13.5.1 | Closure Objectives..... | 184 |
| 13.5.2 | Closure Planning..... | 185 |
| 13.5.3 | Closure Considerations for Specific Aspects of the Proposal | 190 |
| 13.6 | Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures | 197 |
| 14. | MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE IMPACT ASSESSMENT | 198 |
| 14.1 | Relevant Environment Objectives, Policies, Guidelines, Standards And Procedures | 198 |
| 14.1.1 | Australian Government Protection | 198 |
| 14.1.2 | International Agreements..... | 198 |
| 14.2 | Potential Sources Of Impact | 199 |
| 14.3 | Findings Of Surveys And Investigations..... | 199 |
| 14.3.1 | Night Parrot (<i>Pezoporus occidentalis</i>) - Endangered | 201 |
| 14.3.2 | Northern Quoll (<i>Dasyurus hallucatus</i>) – Endangered | 204 |
| 14.3.3 | Greater Bilby (<i>Macrotis lagotis</i>) – Vulnerable | 208 |
| 14.3.4 | Mulgara (<i>Dasycercus cristicauda</i> / <i>Dasycercus blythi</i>) – Vulnerable | 211 |
| 14.3.5 | Pilbara Leaf-nosed Bat (<i>Rhynonictis aurantia</i>) - Vulnerable..... | 215 |
| 14.3.6 | Pilbara Olive Python (<i>Liasis olivaceus barroni</i>) – Vulnerable..... | 217 |
| 14.3.7 | Eastern Great Egret (<i>Ardea modesta</i>) - Migratory | 219 |
| 14.3.8 | Other Migratory Birds | 221 |
| 14.4 | Assessment Of Likely Direct And Indirect Impacts..... | 224 |
| 14.4.1 | Habitat loss, edge effects and fragmentation | 224 |
| 14.4.2 | Vertebrate pests | 228 |
| 14.4.3 | Alteration of surface water regimes | 229 |
| 14.4.4 | Alteration of groundwater hydrology..... | 230 |
| 14.4.5 | Noise and disturbance..... | 231 |
| 14.4.6 | Table of Cross References for Matters of NES | 231 |
| 14.5 | Cumulative Impacts..... | 232 |
| 14.6 | Management Measures And Performance Standards | 233 |
| 14.6.1 | Ground Disturbance | 233 |
| 14.6.2 | Adaptive Management of Groundwater | 233 |

| | | |
|--------|---|------------|
| 14.6.3 | Environmental Management Plan..... | 233 |
| 14.6.4 | Rehabilitation and Mine Closure | 234 |
| 14.6.5 | Threatened Fauna Offset Plan | 234 |
| 14.7 | Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures | 235 |
| 15. | GREENHOUSE GASES IMPACT ASSESSMENT | 237 |
| 15.1 | Relevant Environment Objectives, Policies, Guidelines, Standards And Procedures | 237 |
| 15.1.1 | EPA Guidance Statement No. 12 | 237 |
| 15.1.2 | International Agreements | 238 |
| 15.2 | Potential Sources Of Impact | 238 |
| 15.3 | Findings Of Surveys And Investigations..... | 238 |
| 15.4 | Evaluation Of Options Or Alternatives To Avoid Or Minimise Impact | 239 |
| 15.4.1 | Solar Energy | 239 |
| 15.4.2 | Wind Energy | 239 |
| 15.4.3 | Geothermal Energy | 240 |
| 15.5 | Assessment Of Likely Direct And Indirect Impacts..... | 240 |
| 15.6 | Management Measures And Performance Standards | 241 |
| 15.6.1 | Offsets | 242 |
| 15.7 | Predicted Environmental Outcomes Against Environmental Objectives, Policies, Guidelines, Standards And Procedures | 243 |
| 16. | NOISE IMPACT ASSESSMENT | 244 |
| 17. | DUST IMPACT ASSESSMENT | 245 |
| 18. | SUMMARY OF LIKELY ENVIRONMENTAL MEASURES AND CONTROLS | 246 |
| 18.1 | Environmental Management Framework..... | 246 |
| 18.1.1 | Overview | 246 |
| 18.1.2 | Environmental Policy..... | 246 |
| 18.1.3 | Environmental Management System (EMS) | 247 |
| 18.1.4 | Environmental Management Plan (EMP) | 247 |
| 18.2 | Summary Of Likely Environmental Control Instruments | 248 |
| 18.3 | Summary Of Potential Impacts, Proposed Management Commitments And Environmental Outcomes | 250 |

LIST OF TABLES

| | | |
|------------------|---|------------|
| Table 1: | Other Environmental Approvals Required | 6 |
| Table 2: | State and Local Legislation | 7 |
| Table 3: | Key Characteristics of Proposal..... | 14 |
| Table 4: | Proposed Development Schedule..... | 15 |
| Table 5: | Water Balance under an Average Rainfall Scenario..... | 18 |
| Table 6: | Tailings Properties | 24 |
| Table 7: | Indicative Desalination Waste Stream Composition (15 GL/yr production)..... | 28 |
| Table 8: | Summary of Consultation Undertaken to Date and Key Topics raised regarding Proposal | 33 |
| Table 9: | Principles of Environmental Protection..... | 40 |
| Table 10: | Statement of Expectations for EIA | 42 |
| Table 11: | Department of Water Policies and Guidances Relevant to Managing Groundwater Quality..... | 45 |
| Table 12: | Department of Water Receiving Water Quality Criteria | 48 |
| Table 13: | Development stages and approximate start and end dates | 79 |
| Table 14: | Sheet Flow Area outside the Approved Footprint Impacted by Shadowing and Susceptible to Ponding in the 1 in 100 year event | 84 |
| Table 15: | Vegetation Associations in the Proposal Area as Mapped by Beard (1975) | 96 |
| Table 16: | Vegetation Communities within the Cloudbreak Survey Area. | 97 |
| Table 17: | Priority Flora Recorded in Proposal Area | 101 |
| Table 18: | Maximum Disturbance to Vegetation Communities within the Proposal Area | 108 |
| Table 19: | Impacts on Beard (1975) Vegetation Associations (based on Shepherd <i>et al</i> [2002] and CAR [2010]) | 109 |
| Table 20: | Predicted Impact to Vegetation That May Support Priority Flora | 111 |
| Table 21 | Maximum Direct and Indirect Disturbance to Vegetation Communities | 117 |

| | | |
|------------------|--|------------|
| Table 22: | Potential Cumulative Direct Impact Calculations for Mulga .. | 118 |
| Table 23: | Potential Cumulative Direct Impact Calculations for Samphire | 118 |
| Table 24: | Potential Cumulative Direct Impact Calculations for Groundwater Dependent Vegetation..... | 119 |
| Table 25: | Land Systems of the Cloudbreak Area | 127 |
| Table 26: | Habitats of the Proposal Area..... | 128 |
| Table 27: | Occurrence of Terrestrial Fauna within the Cloudbreak Survey Area (source: Ecologia 2010a)..... | 130 |
| Table 28: | Summary of Potential Presence of Conservation Significant Species | 132 |
| Table 29: | Potential SRE species recorded within and adjacent to the Proposal area | 135 |
| Table 30: | Maximum Disturbance to Fauna Habitats within the Proposal Area..... | 138 |
| Table 31: | Regional Impacts on Land Systems from the Proposal and Cumulatively with the Approved Project and Christmas Creek | 139 |
| Table 32: | Maximum Direct Disturbance of Habitats of EPBC Listed Species within the Cloudbreak Survey Area | 144 |
| Table 33: | Summary of DEC Advice Regarding the Values of the Fortescue Marsh | 159 |
| Table 34 | Direct and indirect impacts on broad vegetation types in the Proposed Conservation Reserve | 169 |
| Table 35: | Aboriginal Heritage Sites Located within the Chichester Project Area..... | 174 |
| Table 36: | Closure Objectives and Targets | 186 |
| Table 37: | Closure Monitoring Measures | 189 |
| Table 38: | Waste Landform Operational and Closure Parameters..... | 191 |
| Table 39: | Summary of Potential Presence of Conservation Significant Species | 200 |
| Table 40 | Summary of survey effort for Night Parrot in the Cloudbreak Survey Area..... | 203 |
| Table 41: | Summary of survey effort for Northern Quoll in the Cloudbreak Survey Area. | 206 |
| Table 42: | Summary of survey effort for Greater Bilby in the Cloudbreak Survey Area..... | 210 |

| | | |
|------------------|---|------------|
| Table 43: | Summary of survey effort for Mulgara in the Cloudbreak Survey Area..... | 214 |
| Table 44: | Summary of survey effort for Pilbara Leaf-nosed Bat in the Cloudbreak Survey Area | 216 |
| Table 45: | Summary of survey effort for Pilbara Olive Python in the Cloudbreak Survey Area | 218 |
| Table 46: | Summary of survey effort for Eastern Great Egret in the Cloudbreak Survey Area | 220 |
| Table 47: | Maximum Direct Disturbance of Habitats within the Cloudbreak Survey Area by the Proposal | 224 |
| Table 48: | Table of Cross References for Matters of NES | 232 |
| Table 49: | Estimated Annual Greenhouse Gas Emissions | 240 |
| Table 50: | Estimated Greenhouse Gas Emissions in Western Australia - 2007..... | 240 |
| Table 51: | Benchmarking Greenhouse Gas Intensity of Iron Ore Mining | 241 |
| Table 52: | Statutory and Environmental Management Controls for the Proposal | 249 |
| Table 53: | Summary of the Impacts and Proposed Management Commitments..... | 251 |

LIST OF PLATES

| | | |
|-----------------|---|-----------|
| Plate 1: | Surface miner with trucks | 20 |
| Plate 2: | Brackish Injection Bore..... | 55 |
| Plate 3: | Yinta on the Fortescue Marsh..... | 76 |
| Plate 4: | Goman Creek | 77 |
| Plate 5: | Dewatering injection pipelines | 85 |

LIST OF FIGURES

| | |
|-------------------|--|
| Figure 1: | Location of Cloudbreak |
| Figure 2: | Cloudbreak Expansion Proposal Area |
| Figure 3: | Flowchart of Public Environmental Review Procedure |
| Figure 4: | Climate of Newman |
| Figure 5: | Geological and Hydrogeological Cross Section |
| Figure 6: | Native Title Areas |
| Figure 7: | Cloudbreak Expansion Proposal Indicative Layout |
| Figure 8: | Conceptual Mining Method |
| Figure 9: | Indicative Pit Sequencing Over Life of Mine |
| Figure 10: | Indicative Conveyors and Satellite Hub Location and Staging |
| Figure 11: | Indicative Injection Areas and Infrastructure |
| Figure 12: | Strip Mining Method |
| Figure 13: | Process Flow Diagram |
| Figure 14: | In-pit Tailings Storage Facility Embankment Design |
| Figure 15: | In-pit Tailings Storage Facility Locations |
| Figure 16: | Typical Workshop and Fuel Farm Layout |
| Figure 17: | Indicative Fuel Farm Layout |
| Figure 18: | Conceptual Hydrogeology of the Cloudbreak Area |
| Figure 19: | Water Volumes Abstracted and Injected under an Average Climate Scenario |
| Figure 20: | Groundwater Contours Year 3 (Average Climate) |
| Figure 21: | Groundwater Contours Year 8 (Average Climate) |
| Figure 22: | Groundwater Contours Year 10 (Average Climate) |
| Figure 23: | Groundwater Contours Year 11 (Average Climate) |
| Figure 24: | Groundwater Contours Year 13 (Average Climate) |
| Figure 25: | Groundwater Contours Year 14 (Average Climate) |
| Figure 26: | Groundwater Contours Post Closure Year 1 (Average Climate) |

- Figure 27:** Groundwater Contours Post Closure Year 10 (Average Climate)
- Figure 28:** Groundwater Contours Post Closure Year 20 (Average Climate)
- Figure 29:** Groundwater Contours Post-Closure Year 30 (Average Climate)
- Figure 30:** Groundwater Contours Post Closure Year 40 (Average Climate)
- Figure 31:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore Artificial_West for Average, Dry and Wet Rainfall Scenarios
- Figure 32:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore CBX02_WT for Average, Dry and Wet Rainfall Scenarios
- Figure 33:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore CB04_S for Average, Dry and Wet Rainfall Scenarios
- Figure 34:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore CBX07_S for Average, Dry and Wet Rainfall Scenarios
- Figure 35:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore CBX10a_WT for Average, Dry and Wet Rainfall Scenarios
- Figure 36:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore CBX13_WT for Average, Dry and Wet Rainfall Scenarios
- Figure 37:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore Artificial_Middle for Average, Dry and Wet Rainfall Scenarios
- Figure 38:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore A2 (UWA Marsh Bore) for Average, Dry and Wet Rainfall Scenarios
- Figure 39:** Comparison of Simulated Baseline Water Level and Operational Water Level at Bore B2 (UWA Marsh Bore) for Average, Dry and Wet Rainfall Scenarios
- Figure 40:** Potential Cumulative Impacts
- Figure 41:** Surface Water Features

| | |
|-------------------|---|
| Figure 42: | Extent of Inundation in the 1 in 100 Year Flood Event – Pre-Mining Scenario |
| Figure 43: | Extent of Inundation in the 1 in 100 Year Flood Event – Stage 7 |
| Figure 44: | Extent of Inundation in the 1 in 100 Year Flood Event – Stage 10 |
| Figure 45: | Extent of Inundation in the 1 in 100 Year Flood Event – Stage 16 |
| Figure 46: | Extent of Inundation in the 1 in 100 Year Flood Event – Post-Closure Scenario |
| Figure 47: | Sheetflow Shadow and Ponding Zones – Stage 5 |
| Figure 48: | Sheetflow Shadow and Ponding Zones – Stage 10 |
| Figure 49: | Sheetflow Shadow and Ponding Zones – Stage 14 |
| Figure 50: | Sheetflow Shadow and Ponding Zones – Post-Closure |
| Figure 51: | Detailed Vegetation Mapping (sheet 1) |
| Figure 52: | Detailed Vegetation Mapping (sheet 2) |
| Figure 53: | Detailed Vegetation Mapping (legend) |
| Figure 54: | Locations of Priority Flora Species |
| Figure 55: | Broad Vegetation Mapping |
| Figure 56: | Near Surface Groundwater Mounding for the Life of the Mine Shown Over Vegetation Types |
| Figure 57: | Near Surface Groundwater Drawdown for the Life of the Mine Shown Over Vegetation Types |
| Figure 58: | Mulga Communities Affected by Sheet-Flow for Two or More Consecutive Years |
| Figure 59: | Vegetation Communities Potentially Susceptible to Ponding Due to Presence of Mine Pits and Waste Landforms |
| Figure 60: | Extent of Fauna Surveys |
| Figure 61: | Land Systems of the Cloudbreak Area |
| Figure 62: | Fauna Habitat Types of the Cloudbreak Survey Area |
| Figure 63: | Fauna Habitat Types Within 30 km of the Cloudbreak Area |
| Figure 64: | SRE or Potential SRE Species Recorded within the Proposal Area |
| Figure 65: | Presence or Absence of Stygofauna in bores sampled in the Cloudbreak Project Expansion Search Area |

| | |
|-------------------|---|
| Figure 66: | Occurrence of Troglofauna Collected as Stygofauna By-catch in vicinity of the Cloudbreak Expansion Project |
| Figure 67: | Conservation Significant Mammals Recorded within the Cloudbreak Survey Area |
| Figure 68: | Conservation Significant Birds Recorded within the Cloudbreak Survey Area |
| Figure 69: | DEC Proposed Conservation Reserve 2015 |
| Figure 70: | Land Use and Tenure |
| Figure 71: | Location of Permanent Waste Landforms |
| Figure 72: | Location of Heavy Industrial Infrastructure |
| Figure 73: | Location of Light Industrial Infrastructure |
| Figure 74: | Regional Habitat and Locations - Night Parrot |
| Figure 75: | Habitat Map - Night Parrot |
| Figure 76: | Regional Habitat and Locations – Northern Quoll |
| Figure 77: | Habitat Map - Northern Quoll |
| Figure 78: | Regional Habitat and Locations – Greater Bilby |
| Figure 79: | Habitat Map – Greater Bilby |
| Figure 80: | Regional Habitat and Locations – Mulgara |
| Figure 81: | Habitat Map – Mulgara |
| Figure 82: | Regional Habitat and Locations – Pilbara Leaf-nosed Bat |
| Figure 83: | Habitat Map – Pilbara Leaf-nosed Bat |
| Figure 84: | Regional Habitat and Locations – Pilbara Olive Python |
| Figure 85: | Recordings in Pilbara – Eastern Great Egret |
| Figure 86: | Recordings in Pilbara – Rainbow Bee -eater |
| Figure 87: | Recordings in Pilbara – Cattle Egret |
| Figure 88: | Recordings in Pilbara – Oriental Plover |
| Figure 89: | Recordings in Pilbara – Fork-tailed Swift |
| Figure 90: | Recordings in Pilbara –White-Bellied Sea Eagle |
| Figure 91: | Recordings in Pilbara – Wood Sandpiper |
| Figure 92: | Recordings in Pilbara – Common Greenshank |
| Figure 93: | Recordings in Pilbara – Red-necked Stint |
| Figure 94: | Habitat Map – Migratory Birds |

LIST OF APPENDICES

(PROVIDED ON CD)

| | |
|--------------------|---|
| Appendix A: | Environmental Management Plan |
| Appendix B: | Cloudbreak Flora and Vegetation Reports |
| Appendix C: | Cloudbreak Fauna Assessments |
| Appendix D: | Cloudbreak SRE Invertebrate Fauna Assessments |
| Appendix E: | Cloudbreak Hydrogeological Assessment for Water Management Scheme |
| Appendix F: | Peer review and model appraisal: Hydrogeological Assessment for the Cloudbreak Water Management Scheme |
| Appendix G: | Cloudbreak Life of Mine Expansion Surface Water Investigation and Impact Assessment |
| Appendix H: | Cloudbreak life of Mine Tailings Storage Facility Design |
| Appendix I: | Cloudbreak Mine Closure Plan |

1. INTRODUCTION

The Proponent, Fortescue Metals Group Ltd (Fortescue) proposes to expand mining at the Cloudbreak iron ore mine (Cloudbreak) located in the Pilbara region of Western Australia. Changes proposed under the expansion process include an increase in ore production, development of new mine infrastructure and additional dewatering and water disposal activities over the life of mine.

This document is a Public Environmental Review (PER) for the Cloudbreak Expansion Proposal (the Proposal) and has been prepared in accordance with the Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002 of the *Environmental Protection Act 1986* (EP Act).

1.1 PROPOSAL OVERVIEW

1.1.1 Background

The Cloudbreak mine, which commenced production in 2008, includes mining of open pits, ore processing, access roads, accommodation village, airport and transport of a maximum of 45 million tonnes per annum (Mtpa) of iron ore to Port Hedland for shipment. The current rate of ore production is approximately 38 Mtpa from the mine. Ore from Fortescue's Christmas Creek mine is also processed at Cloudbreak, resulting in a total of 45 Mtpa being currently shipped from Cloudbreak to Port Hedland.

The Cloudbreak mine was originally approved under Part IV of the EP Act subject to the conditions in Ministerial Statement 721. Subsequent to this approval, additional project components such as a power station and tailings facility have been referred to the Environmental Protection Authority (EPA) and also approved under Part V of the EP Act. Amendments to the Proposal footprint and increased reinjection have been approved under section 45C of the EP Act; most recently in July 2010. The amended footprint (the Approved Footprint) has been taken as the baseline case against which assessment of additional potential impact resulting from implementation of the Proposal has been made.

The Cloudbreak mine was originally referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2005. Approval for the mine site was granted pursuant to EPBC 2005/2205.

1.1.2 Location

The Cloudbreak mine site is located in the Pilbara region of Western Australia approximately 120 km north of Newman (Figure 1). The site is within the Mulga Downs and Hillside pastoral leases. The mine site is located approximately 2.5 km from the Fortescue Marsh at the closest point.

1.1.3 Description

The Proposal includes expansion of the existing mining footprint for additional mine pits, permanent waste landforms, tailings disposal, an overland ore conveyor, roads, drainage, sewage treatment, and other associated mine infrastructure to enable iron ore production to continue at an increased rate of up to 50 Mtpa of iron ore for approximately 14 years (Figure 2). The expansion of Cloudbreak will include an increased footprint (30 ha to 45 ha) for improvements to accommodation facilities. Upgrading the ore processing facility to include a “wet-front end” and wash plant, which are to be expanded within the existing approved footprint. The Proposal includes in-pit disposal of tailings from the beneficiation process which will not require any additional footprint.

The Proposal includes increasing the depth of mining and the volume of mine dewatering and subsequent injection of both brackish and saline water. Fortescue’s current water management approach of separating brackish and saline water will be continued to allow injection to minimise potential effects on water quality in the receiving aquifers.

1.2 THE PROPONENT

The proponent for the Proposal is Fortescue Metals Group Limited. The contact person for the Proposal is:

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1.3 PURPOSE AND SCOPE OF THIS DOCUMENT

The purpose of this document is to present an environmental review of the Proposal, including a detailed description of the key components, environmental impacts and proposed environmental management measures for relevant environmental aspects identified by the Environmental Scoping Document. A cumulative environmental impact assessment of the Proposal and the existing Cloudbreak Project is also included.

This PER includes:

- a description of the existing environment (Section 2)
- a detailed description of the Proposal (Section 3)
- a description of the stakeholder engagement and consultation process undertaken for the Proposal (Section 4)
- a factor-by-factor assessment of the environmental impact of the Proposal (Section 6 to Section 15)
- a description of key environmental management measures and controls (Section 18).

1.4 RATIONALE FOR PROPOSAL

Fortescue has identified a requirement to extend the mine footprint and redefine the ore processing methods on the basis of an improved understanding of the extent and nature of the resource.

1.4.1 Demand for Product

The international demand for iron ore has experienced strong growth in the last five years, predominantly driven by increased steel production in China. In the last 10 years, steel production in China has increased from approximately 100 Mtpa to over 450 Mtpa. China's importation of iron ore has increased at the same rate to meet this steel production rate (DMP 2009b). The increased demand resulted in the quantity of iron ore produced in Western Australia increasing from 195 million tonnes in 2003 to 303 million tonnes in 2008, valued at \$31.2 billion (DMP 2009b).

The long term demand for iron ore is not likely to change as China and India continue to urbanise even though the market has contracted in response to the global financial crisis. There will be continued long term growth in the steel industry, notwithstanding fluctuations in steel demand.

1.4.2 Benefits of Proposal

The Proposal will result in community benefits for Australia and Western Australia through:

- royalties and taxation payments from the sale of iron ore products
- employment and training opportunities
- encouragement in the growth of ancillary industries in WA.

The Proposal will provide contractual and full-time employment opportunities to local communities and further employment opportunities will be created by the flow-on effects to service industries and other sectors of the economy.

Fortescue is committed to providing jobs and employment to local indigenous people through its' Vocational Training and Employment Centre developed as part of Land Access Agreement negotiations between Fortescue and traditional claimant groups. The Centre works by identifying employment opportunities within Fortescue, and with contractors who work with Fortescue, then developing courses using TAFE and other training organisations to provide indigenous people in the Pilbara with the necessary skills for those jobs.

1.4.3 Consequences of Not Proceeding

The consequences of not proceeding with this Proposal would be the early closure of the Cloudbreak Mine, and the need to open another mine to balance the loss of production to Fortescue.

1.5 ENVIRONMENTAL APPROVALS

1.5.1 Western Australian Environmental Impact Assessment Process

The Proposal was referred to the Environmental Protection Authority (EPA) under section 38 of the EP Act on 2 September 2010, with supporting information on the proposed scope of the environmental impact assessment. On 4 October 2010, the EPA set the level of assessment for the Proposal as a PER with a six-week public review period.

The Proponent submitted a preliminary Environmental Scoping Document on 2 June 2010, which detailed the potential environmental impacts, their significance and possible management response, proposed scope of work to obtain information for the PER, key legislation, stakeholder consultation program, proposal and assessment schedule, study team and peer review mechanisms. The final Environmental Scoping Document was approved by the EPA on 4 March 2011.

The PER has been prepared in accordance with the Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002 for environmental assessment prescribed under the EP Act. The purpose of the PER is to present an Environmental Impact Assessment of the key environmental aspects of the Proposal in accordance with the approved Environmental Scoping Document. The Environmental Impact Assessment process is based on conformance with various relevant EPA Position Statements and Guidance Statements in determining the significance of the environmental effects of the Proposal.

Following a six-week public review, the EPA will provide the Proponent with copies of any submissions received. The Proponent will be required to prepare a summary of the key issues and matters raised in the submissions and respond to these to the satisfaction of the EPA.

The EPA will assess the PER document, submissions, Proponent response to submissions, and obtain advice from any other persons it considers appropriate and submit its assessment report to the Minister for the Environment.

The Minister will publish the EPA report as soon as the Minister is reasonably able to do so after receiving it. As provided for under Section 100(2) of the EP Act, any person may lodge an appeal to the Minister for the Environment against the findings or recommendations of the EPA assessment report within 14 days of the publication of the report. Subsequent to the determination of appeals (if any), the Minister will then decide whether or not the Proposal should be implemented and if so, under what conditions.

Fortescue is aiming to achieve a single Ministerial Statement pursuant to the EP Act that covers both the existing approved project and the expansion Proposal as an outcome of this assessment process.

The procedure for a PER level of assessment is outlined in Figure 3.

1.5.2 Australian Government Environmental Impact Assessment

The Commonwealth EPBC Act provides for the protection of nationally and internationally important flora, fauna, ecological communities and heritage places; defined as Matters of National Environmental Significance (NES). Under the EPBC Act, a proposal or action which will, or is likely to, have a significant impact on a matter of NES is required to be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for a decision as to whether the proposal constitutes a 'controlled action'. If the Proposal is deemed a 'controlled action', implementation will consequently be subject to an approval from the Federal Minister for Sustainability, Environment, Water, Population and Communities (Environment Minister).

Matters of NES include:

- World and National Heritage Places
- Wetlands of international importance
- listed Threatened species and communities
- listed Migratory species
- Nuclear actions
- Commonwealth marine areas and land.

The Proposal was referred to the SEWPAC on 8 October 2010 for consideration under the EPBC Act. On 17 November 2010, SEWPAC advised that the action was considered to be a 'controlled action' under the EPBC Act.

The Proposal will be assessed through the Bilateral Agreement. The Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia provides for the accreditation of the Western Australian environmental impact assessment process to ensure an integrated and coordinated approach for actions requiring approval under both the EPBC Act and the EP Act.

1.5.3 Other Environmental Approvals

Additional environmentally related approvals required are outlined in Table 1.

Table 1: Other Environmental Approvals Required

| Decision Making Authority | Approval Required | Legislation |
|--|---|--|
| Department of Water | 26D Licence to construct wells for dewatering and injection 5C Licence to take water | Rights in Water and Irrigation (RIWI) Act 1914 |
| Department of Environment and Conservation | Works Approvals/Licensing | Part V of the EP Act |
| Department of Minerals and Petroleum | Mining Proposals | Mining Act 1978 |

1.6 OTHER APPROVALS

The existing Cloudbreak Mine operates subject to approvals under the legislation shown in Table 2.

Any mining, associated works, or clearing undertaken for the proposed infrastructure will require assessment and approval in accordance with the *Mining Act 1978* (WA), subject to the provisions of the *Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006* and requirements of the EP Act.

Construction and operation of the Desalination Plant and fuel farms will require a Works Approval and licensing under Part V of the EP Act and the *Dangerous Goods Safety Act 2004*. The upgrade of the Ore Processing Facility to include washing will require an amendment to the existing license under Part V of the EP Act.

Under Section 18 of the *Aboriginal Heritage Act 1972*, consent from the Minister would be required to disturb Aboriginal sites.

Table 2: State and Local Legislation

| Title | General Description |
|---|--|
| <i>Aboriginal Heritage Act 1972</i> | The protection of Aboriginal Heritage sites. |
| <i>Conservation and Land Management Act 1984</i> | Provisions for the use, protection and management of certain public lands and waters and the flora and fauna thereof. |
| <i>Contaminated Sites Act 2003</i> | Provides for the identification, recording and remediation of contaminated sites. |
| <i>Dangerous Goods Safety Act 2004</i> | Relates to the management of dangerous goods, including their storage, handling and transportation. |
| <i>Environmental Protection Act 1986 (EP Act)</i> | Creation of the Environmental Protection Authority (EPA), for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment. |
| <i>Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006</i> | Ratification and authorisation of the implementation of an agreement between the State and Fortescue regarding the mining of iron ore by Fortescue in the Pilbara region of the State. |
| <i>Land Administration Act 1997</i> | Management of crown land. |
| <i>Local Government Act 1995</i> | Provides for a system of local government. |
| <i>Main Roads Act 1930</i> | Requirements related to the construction of roads. |
| <i>Mining Act 1978</i> | Regulation of mining activities. |
| <i>Native Title (State Provisions) Act 1999</i> | Recognises native title in lands. |
| <i>Occupational Safety and Health Act 1984</i> | Provisions for occupational health and safety standards. |
| <i>Rights in Water and Irrigation Act 1914</i> | Relates to the regulation, management, use and protection of water resources. |
| <i>Soils and Land Conservation Act 1945</i> | Relates to the conservation of soil and land resources, and to mitigate the effects of erosion, salinity and flooding. |
| <i>Waterways Conservation Act 1976</i> | The conservation and management of designated water and of the associated land and environment. |
| <i>Wildlife Conservation Act 1950</i> | Provision for the conservation and protection of wildlife. |

2. OVERVIEW OF EXISTING ENVIRONMENT

2.1 BIO-PHYSICAL SETTING

The climate of the Pilbara is arid tropical, characterised by low and variable rainfall, high daily temperatures, high diurnal temperature variability and high evaporation rates. Summer months extend from October to April, when maximum daily temperatures can exceed 35°C. The winter months extend from May to September, with temperatures ranging from approximately 7°C to 23°C (BoM 2010) (Figure 4).

Average annual rainfall is approximately 300 mm at nearby Newman (120 km south) and is characterised by frequent, low-intensity events related to localised thunderstorms and tropical upper air disturbances, as well as occasional annual high-intensity events associated with tropical cyclones (BoM 2010).

Average annual (pan) evaporation in the area is approximately 3600 mm per year (Department of Agriculture 2003), which greatly exceeds annual rainfall and consequently contributes to the arid environment.

The Proposal area is located in the Hamersley Basin area of the Pilbara Craton. The landscape is dominated by the Chichester Range which is comprised of the south dipping Marra Mamba Formation (MMF). The MMF is unconformably overlain by a Quaternary/Tertiary sedimentary sequence and underlain by the Roy Hill Shales (Figure 5). In the south of the Proposal area, the Oakover and Wittenoom formations lie between the MMF and the Quaternary/Tertiary sedimentary sequence (Figure 5). The ore body occurs within the mineralised MMF (Figure 5).

The east-west running Fortescue Valley lies between the Chichester and Hamersley ranges (Figure 2). At the base of the valley lies the Fortescue Marsh and the Chichester Plains. The Proposal is located on the Chichester Plains.

An inventory of the Land Systems occurring in the Pilbara region was completed by van Vreeswyk *et al.* (2004). The Land Systems present in the vicinity of the Proposal area in topographic order are:

- Newman Land System – rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands
- McKay Land System – hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard Spinifex grasslands
- Jamindie Land System – stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with Spinifex understorey
- Christmas Land System – stony alluvial plains supporting Snakewood and Mulga shrublands with sparse tussock grasses

- Cowra Land System – plains fringing the Marsh land system and supporting Snakewood and Mulga shrublands with some halophytic undershrubs
- Marsh Land System – lake beds and flood plains subject to regular inundation supporting Samphire shrublands, salt water couch grasslands and halophytic shrublands.

The dominant land systems within the Proposal area are the Newman, Christmas and Jamindie land systems (Ecologia 2010a).

The predominant soils of the region are Tertiary aged colluvium, characterised by angular fragments of Banded Iron Formation (BIF), chert and shale. The hill flanks consist of ferruginous gravelly soils that form extensive sheets of scree. The floodplains of the Fortescue Valley have sheets of silty and sandy soils with clay contents increasing in the low lying areas of the Fortescue Marsh.

Rainfall runoff from the Chichester Range flows through the Proposal area in a southerly direction towards the Fortescue Marsh. Rainfall runoff on the Chichester Plains (encompassing the Proposal area) tends to form overland flow paths without defined water courses. The water courses and sheetflow areas frequently support scrub and Mulga woodlands, particularly in the lower lying areas. The Fortescue River and other main channels entering the marsh typically support Eucalypt woodland in their floodplains (ENV 2011).

The Fortescue Marsh is included in the Australian Heritage Commission Register of the National Estate as an “Indicative Place”, and in the Directory of Important Wetlands in Australia (Environment Australia 2001).

The Fortescue Marsh is ephemeral and available data indicates that the marsh is predominantly a surface water system with groundwater levels that are below the ground surface. In low-lying areas, particularly along the Fortescue Marsh, Fortescue River and major creek systems, groundwater is typically less than 10 m below ground level (mbgl). Upslope from these low-lying areas groundwater levels are typically more than 20 mbgl.

Cloudbreak groundwater chemistry data shows groundwater in the resource area is generally brackish and becomes increasingly saline towards the Fortescue Marsh and with depth (Fortescue 2010a). Groundwater in the Cloudbreak region ranges from marginally brackish (>500 mg/L Total Dissolved Solids [TDS]¹) in upslope recharge areas to hypersaline in areas closer to the Fortescue Marsh and in fractured rock zones below the Marra Mamba Formation (>100 000 mg/L TDS) (Fortescue 2010a).

¹ For reference, seawater is approximately 30 000 to 35 000 mg/L TDS

The Proposal area occurs within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this province is typically open, and frequently dominated by Spinifex, Wattles and occasional Eucalypts. Vegetation comprises a mosaic of low woodland with Mulga in valleys and hummock grasslands, low open tree steppe with Snappy Gum (*Eucalyptus leucophloia*) over Limestone Spinifex (*Triodia wiseana*), and Kanji (*Acacia pyrifolia*) over Soft Spinifex (*Triodia pungens*) and Limestone Spinifex hummock grasslands.

The condition of the vegetation in the Proposal area ranges from Good to Excellent in condition as per Trudgen (1991) condition scale (ENV 2011, Mattiske 2005b).

Six broad fauna habitats occur in the Proposal area, which support terrestrial fauna assemblage typical of the eastern Pilbara (Ecologia 2011a). These fauna habitats are:

- low halophytic shrubland
- hummock grassland on fringe of Fortescue Marsh
- low Mulga, Snakewood and other Acacia woodland
- Spinifex-covered hills and ranges
- creek lines and wells with Acacia shrubland and/or Eucalypt woodland
- Rocky escarpments.

Surveys conducted in and around the Proposal area recorded 63 herpetofauna, 139 birds and 31 mammals (including eight introduced mammals) (Ecologia 2010a).

2.2 SOCIO-ECONOMIC SETTING

The Proposal area is located within the Shire of East Pilbara. The surrounding land uses are mining and pastoral. The closest residence, Marillana Station (located 40 km from the Proposal area), is not close enough to be affected by dust or noise from the Proposal.

The site is located within the Mulga Downs and Hillside operational pastoral leases.

The Proposal area is subject to two native title claims, one each by the Nyiyaparli and Palyku claimant groups (Figure 6). Fortescue has signed protocols with each of these claimant groups to establish procedures under which Aboriginal heritage surveys and native title negotiations are carried out.

There are a number of other mines in the Fortescue Marsh area, being:

- Fortescue's Christmas Creek mine, located immediately to the east of the Proposal area
- Roy Hill (proponent, Hancock Prospecting, located east of Christmas Creek)
- Marillana (proponent Brockman Resources, located on the southern side of the Fortescue Marsh) (Figure 1).

Fortescue is also planning to undertake duplications of sections of its railway between Port Hedland and Christmas Creek. This action is currently being assessed by SEWPAC.

Cumulative impacts of the Proposal with these projects have been undertaken based on publicly available information on the activities proposed at these mines and proposed Fortescue rail duplications.

2.3 KEY CONSERVATION VALUES

The Fortescue Marsh has been identified as a 'Nationally Important Wetland' and is listed as an 'indicative place' on the Register of the National Estate due to its importance as a habitat for migratory birds. This is the key area of conservation significance in the vicinity of the Proposal and supports a number of significant flora and fauna species. Mulga communities are also considered locally significant as they are at the northern extent of their range in this area.

Department of Environment and Conservation (DEC) is proposing that portions of the Mulga Downs, Hillside, Marillana and Roy Hill stations associated with the Fortescue Marsh be excluded from the renewal of pastoral leases in 2015 and be added to the conservation estate (or managed by conservation agreement).

3. DESCRIPTION OF PROPOSAL

3.1 DEVELOPMENT OVERVIEW AND KEY CHARACTERISTICS OF PROPOSAL

3.1.1 Existing Development at Cloudbreak

The existing mine at Cloudbreak is being implemented in accordance with Statement 721. The key characteristics of the approved mine are outlined in Table 3.

The current status of mining at Cloudbreak is:

- 5500 ha approved for clearing
- mining from five mine pits
- current rate of production is approximately 38 Mtpa for Cloudbreak alone and 45 Mtpa combined with Christmas Creek.

Mining at Cloudbreak is carried out using open pit strip mining; progressively opening new pits and backfilling old ones. This method minimises waste double handling and allows progressive closure and rehabilitation of pits and waste landforms. The overall mining, backfilling and rehabilitation processes can be summarised as:

- mine pits and schedules are developed from geological data to optimise recovery
- areas are cleared of vegetation and pre-stripped of topsoil; both of which are stockpiled and used in progressive rehabilitation activities
- overburden is broken up by drill and blast methods and then trucked out to permanent storage areas or backfilled into the pit, depending on availability of space
- groundwater levels are required to be lowered, ahead of mining, to beneath the pit floor to enable safe access to the ore, with surplus water reinjected into various aquifers through a series of pipes and injection bores
- both bulk (face shovels) and selective (excavators & surface miners) methods are used to recover the ore, which is then transported to an ore processing facility (OPF) by trucks and/or conveyors
- the OPF involves screening, crushing, blending, removal of sand and clay from the ore, with a new wet (washing) plant proposed for the expansion
- processed ore is then fed into carriages via a train loader, where it is hauled to Port Hedland by train for shipping
- once exhausted, the backfilled pits are contoured and rehabilitated, as are any external above ground permanent storage areas. Due to a bulking factor, there will be a greater volume of waste than original material; therefore there will need to be permanent waste landforms above the current surface elevations.

In 2009/10, a total of 24 gigalitres (GL) of dewatering occurred, of which 3.5 GL was used for ore processing and dust suppression and 19 GL was reinjected into the aquifer.

The existing project also includes power production, accommodation facilities and sewerage treatment facility. The mine currently employs 2400 people.

3.1.2 Proposal Overview

The Proposal involves expansion of the approved mine to enable iron ore production of up to 50 Mtpa of iron ore for up to 14 years. Key characteristics of the Proposal are outlined in Table 3 together with the key characteristics of the approved mine. The Proposal includes:

- expansion of the existing mining footprint to encompass proposed mine pits and infrastructure outlined in Figure 2
- increase in the total area of the Cloudbreak Project to 18 100 ha, of which 12 600 ha is outside the approved footprint (Figure 2)
- increase in the maximum depth of mining from 70 metres below ground level (mbgl) to 90 mbgl
- increase in the net abstraction for mine dewatering from 25 GL per year (GL/yr) up to approximately 100 GL/yr and subsequent injection of excess water
- conversion of the current dry-run ore OPF to a wet plant
- addition of a wash plant to wash saline ore for processing at the OPF in the later years of Cloudbreak operations
- potential transport (via truck) from the adjacent Christmas Creek mine of up to 10 Mtpa of run of mine (ROM) ore for processing at the Cloudbreak OPF to meet product and blending requirements
- potential increase in the disposal of tailings from the OPF process, partially being residual treatment by-products from the wash plant in later years (to be disposed of in-pit)
- potential need for a reverse osmosis water treatment plant to provide water of a quality suitable to be used in the wash plant, and disposal of the wastewater produced in the wash plant via injection into the appropriate groundwater aquifer
- increase in the capacity of the accommodation camp and sewage treatment facilities
- permanent above ground overburden and mining waste landforms.

All additional ore processing and accommodation facilities will occur within the existing footprint approved under Statement 721.

The key characteristics of the Proposal are outlined in Table 3 and an indicative layout presented in Figure 7.

Table 3: Key Characteristics of Proposal

| Relevant Characteristic | Approved Project Statement 721 | Proposed Changes (cumulative with the current approved project) |
|--------------------------|---|--|
| Main Activities | Iron ore strip mining, dewatering and injection, pit backfilling, ore processing, transport of ore to rail loading facility, ore loading to rail, mine rehabilitation and closure | Increase in the scale of these activities, plus addition of an ore washing facility, and conversion of OPF to a wet plant |
| Resource | 500 to 600 Mt Marra Mamba iron ore deposit | Approximately 700 Mt Marra Mamba iron ore deposit |
| Ore production | 45 Mtpa (combined with output from Christmas Creek and Mindy Mindy) | Up to 50 Mtpa wet product down-rail from the Cloudbreak OPF consisting of either: <ul style="list-style-type: none"> 100% from Cloudbreak ROM ore feed Up to 10 Mtpa from Christmas Creek ROM ore feed |
| Overburden | Unspecified | Approximately 3150 Mt |
| Tailings | Unspecified | In-pit disposal of up to 70 million m ³ |
| Life of mine | Approximately 12 years | Approximately 17 years (from commencement in 2008) |
| Area disturbed | 5500 ha 475 ha of open pit at any one time 350 ha for dewatering infrastructure at any one time | Up to 18 100 ha |
| Pit depth | Ranges from 0 m to 70 m | Up to 90 m |
| Dewatering requirements | Pit dewatering, excess water storage in ponds, water injection Mine dewatering up to 25 GL/yr Water injection up to 20 GL/yr | Mine dewatering up to 100 GL/yr Injection of all water that is not used for ore processing or dust suppression |
| Power | 40 MW diesel-fuelled power station (already approved) | No change |
| Greenhouse gas emissions | Approximately 7 kg CO ₂ -e per tonne of ore mined | Approximately 18 kg CO ₂ -e per tonne of ore mined (based on an average production rate of 35 Mtpa) |

3.1.3 Development Schedule

Expansion of mining at Cloudbreak will commence in August 2011 and is proposed to continue until 2024 (Table 4).

Table 4: Proposed Development Schedule

| Date | Comment |
|-------------------------|---|
| August 2011 | Mining rates to progressively increase as higher strip ratios encountered. |
| 2014 | Implementation of the first satellite crushing hub and overland conveyors to the OPF. |
| 2016-2018 | Implementation of the second satellite crushing hub, main services hub and overland conveyors to the OPF. |
| 2019-2020 | Implementation of washing technology at the OPF (to remove salts from the ore). Implementation of desalination plant to supply water for the wash plant. |
| 2019-2021 | Implementation of the third satellite crushing hub and overland conveyors to the OPF. |
| 2024 (approximately) | Mining ceases. Required rehabilitation continues. |

3.2 EXCLUSIONS FROM THE PROPOSAL

Implementation of all aspects of the Cloudbreak mining proposal approved under Statement 721, including approved amendments, is excluded from this Proposal.

3.3 CONSIDERATION OF ALTERNATIVES

The alternative option would be to close the Cloudbreak mine once the currently approved project has been completed. Extending the life of the mine allows for more efficient use of existing mine infrastructure and long term community and employment benefits.

3.4 DESCRIPTION OF RESOURCE

The Cloudbreak deposit is located in the Chichester Range. Mineralisation is mostly confined to the Nammuldi Member of the Marra Mamba Formation. The Marra Mamba iron ore mineralisation in the Chichester Range sits close to the surface with minimal overburden and extends to approximately 90 m depth.

The mineralogy of the units of the Chichester deposits is dominated by iron oxides (greater than 55%) with the minerals present being goethite, hematite and to a lesser extent martite, together with ochreous goethite and hematite mixtures. Sampling indicates that the waste rock and remaining material should be classified as non-acid forming (Campbell and Associates 2005). The Roy-Hill-Shales are classified as potentially acid forming, however, open-pit mining will not extend deep enough to intersect the Roy-Hill-Shales.

3.5 DESCRIPTION OF MINING OPERATIONS

The mining methodology proposed is the same as that approved under Statement 721, with the exception of increased dewatering. The mining model is based on strip mining as described below and illustrated in Figure 8.

3.5.1 Pit Sequencing

Fortescue has developed a pit sequence for mining in order to deliver an iron ore product that meets agreed customer specifications. Product is mined and blended to provide the required target ROM ore and product tonnages and grades for each year of the life of mine. The blending optimisation ensures maximum possible resource utilisation. An indicative Life of Mine pit sequence is shown in Figure 9.

Overland conveyors will be installed over a number of stages as mining moves west to transport ROM ore to the existing OPF (Figure 10). Movement of the mining activities westwards along the ore body will necessitate establishment of satellite hubs to support the mining activities (Section 3.5.10).

3.5.2 Site Preparation

Clearing

The total area of disturbance for the Proposal will be up to 18 100 ha of which 5500 ha is already approved for disturbance (Figure 2). Pre-stripping will be undertaken to remove the top 100 mm of soil (topsoil) and vegetation as one layer, to reduce the risk of topsoil blowing away. Topsoil and vegetation from pre-stripping operations will be stockpiled and used in progressive rehabilitation activities. Areas subject to weed infestations will be cleared separately and the soil and vegetation from these areas will be buried to prevent further weed infestations.

Removal of Overburden

The term 'overburden' is used for the material between the topsoil layer and the ore body, and may include both soil and rock. This includes a thin layer of soil or regrowth material which is important to provide soil chemistry and structure to effectively re-grow vegetation during rehabilitation. The regrowth material will be removed separately and placed in rehabilitation areas.

Following the removal of regrowth material, the rock overburden will be removed through the use of drilling and blasting, shovels, excavators and trucks. Approximately 60 000 tonnes per annum (tpa) of bulk explosives will be used for blasting, which will be undertaken in accordance with current operational procedures.

Mine pits will be developed in thin strips generally in the order of 150 m by 700 m, where different mining activities may occur in different strips at the same time (Figure 8). For example while removal of overburden is occurring in one area, mining of ore may be occurring somewhere else in the pit. Once the initial strips have been mined, overburden will be placed in the mined-out sections of the pit and rehabilitation will be undertaken progressively on these areas. The starter pit phase for a new pit will typically last one to two years, as the initial strips are developed. During this period, it will be necessary to place the overburden in a permanent storage area located outside the mine pit area. Once the initial strips have been mined, overburden will be placed in the mined-out sections of the pit.

The volume of overburden and mine waste will exceed the pre-disturbance volume of the mined pits (voids) by approximately 30%. This is because the volume of the overburden when broken and transported is greater than the volume of the overburden plus ore in situ. Excess overburden will be placed in permanent storage areas outside the mine pit area.

An estimated 3150 Mt of overburden will be placed in permanent storage areas near the pits, covering approximately 1160 ha in total. The final design height of the permanent storage areas will be based on the surrounding topography in the specific area. The overburden storage areas will be rehabilitated and revegetated as part of Fortescue's standard procedures, in line with the Mine Closure Plan.

The Rahco overburden transport system will also be utilised where appropriate. The Rahco comprises of mobile in-pit sizers, mobile conveyor units and a mobile stacker. During mining, overburden will be fed by excavators directly into a mobile sizer, where the material will be crushed to a size that will allow it to be transported by the conveyor units. The conveyor units will transport the crushed overburden over a distance of approximately 500 m where it is placed, by the mobile stacker, in overburden storage areas. The Rahco is capable of transporting up to 50 Mtpa of overburden and is powered by a dedicated mobile 8 MW diesel power station.

3.5.3 Pit Dewatering

The groundwater table at Cloudbreak lies within the alluvium and mineralised Marra Mamba Formation (MMF) above a portion of the available ore (Figure 5). Cloudbreak groundwater chemistry data shows groundwater in the resource area is generally fresh to brackish and becomes increasingly saline towards the Fortescue Marsh and with depth (Fortescue 2010a) (Figure 5).

Dewatering is therefore required to lower groundwater levels below the base of each of the pits (in the alluvium and MMF) to enable access to ore required below the water table. Limited dewatering is being undertaken as part of the approved project. The Proposal involves mining of ore to 90 mbgl, deeper than the current approved 70 mbgl. The increased mining depth will result in an increase in the volume of groundwater to be abstracted and subsequently reinjected into the aquifer.

The ore body will be dewatered ahead of the advancing mining faces using bores, with some sump dewatering in the pit to deal with seepage and rainfall. The average total abstraction volumes will be approximately 58 GL/yr, however, in some years there may be up to 91 GL/yr of groundwater abstracted under an average rainfall scenario (Table 5). Modelling has indicated that up to 100 GL/yr may be required in a wet rainfall scenario with approximately 85 GL/yr to be injected.

Table 5: Water Balance under an Average Rainfall Scenario

| Year | Total Volume Abstracted (GL) | Total Volume Re-injected (GL) | Brackish Injection (GL) | Saline Injection (GL) | Net abstraction (GL) |
|--------------|------------------------------|-------------------------------|-------------------------|-----------------------|----------------------|
| 1 | 38 | 26 | 8 | 18 | 12 |
| 2 | 31 | 22 | 6 | 16 | 9 |
| 3 | 43 | 35 | 9 | 26 | 8 |
| 4 | 66 | 55 | 12 | 43 | 11 |
| 5 | 55 | 45 | 9 | 36 | 10 |
| 6 | 58 | 48 | 8 | 40 | 10 |
| 7 | 79 | 73 | 11 | 62 | 6 |
| 8 | 44 | 34 | 4 | 30 | 10 |
| 9 | 91 | 80 | 8 | 72 | 11 |
| 10 | 58 | 45 | 4 | 41 | 13 |
| 11 | 90 | 81 | 6 | 75 | 9 |
| 12 | 42 | 29 | 2 | 27 | 13 |
| 13 | 32 | 20 | 1 | 19 | 12 |
| 14 | 84 | 71 | 4 | 67 | 13 |
| Mean | 58 | 47 | 7 | 41 | 11 |
| Total | 811 | 664 | 93 | 571 | 147 |

An average 47 GL/yr of the water that is abstracted will be re-injected (Table 5). The remaining 11 GL/yr of the abstracted groundwater will be used within the mine operation. This is referred to as the 'net abstraction'. Approximately 6 GL/yr of abstracted fresh/brackish water is expected to be used in ore processing and approximately 4 GL/yr for other mine site purposes such as dust control. Excess fresh/brackish water and saline water will be injected back into the aquifer at strategic locations to minimise drawdown impacts on groundwater-dependent ecosystems. Further details of dewatering and injection volumes and procedures are provided in Section 6.5.2.

3.5.4 Injection

Fresh to brackish and saline waters will be abstracted and injected separately. This separation prevents saline groundwater being injected into fresher parts of the aquifer, where it could impact upon vegetation and the future potential use of groundwater for stock watering. “Fresh to brackish” water in this case is considered to have salinity less than 6000 mg/L. Saline water has salinity greater than 6000 mg/L. Excess fresh to brackish water is currently injected into two injection areas east and west of the active mining areas. Injection occurs into the Marra Mamba Formation. This method will be continued under this Proposal.

Excess saline groundwater will be injected into the Oakover Formation, at locations between the mining area and the Fortescue Marsh. The focal point for saline injection will mirror the location of mining as part of the strategy to reduce the potential drawdown from mine dewatering near the Fortescue Marsh.

Locations of brackish water injection will change throughout the mine life, as the mine pits move and some earlier mining areas will become injection areas. Indicative injection areas and infrastructure over the Life of Mine are shown in Figure 11.

The Proposal will expand the injection volume from approximately 20 GL/yr to approximately 83 GL/yr (Table 5). The volume of injection is expected to vary between 20 and 83 GL/yr, depending on the depth of mining and the ore processing water requirements. The net volume abstracted (groundwater abstracted minus the groundwater injected) is estimated to be between 6 and 13 GL/yr.

3.5.5 Mining

Mining at Cloudbreak will continue to be carried out as open pit strip mining using the same methodology as described for the approved Project. The pits are developed progressively, where a starter pit is opened (with overburden from the starter pit placed in a small overburden stockpile). As the mining face progresses, the open pit is progressively backfilled and rehabilitated (Figure 12). This option presents a cost-effective method of backfilling the pit with overburden during the life of the mine and reduces the required size of the waste rock dumps placed external to the pits. Progressive rehabilitation practices can be utilised as topsoil is removed ahead of mining and placed directly onto final contoured backfilled areas in one operation, as an integrated mining practice.

The methodology for undertaking strip mining is summarised in the following sections and is graphically presented in Figure 12.

Surface Miners

The majority of the ore will be mined using surface miners (Plate 1). Surface miners can cut to an accuracy of 0.1 m and can extract ore without the need for drilling, blasting, or primary crushers to crush ore. Ore is loaded from the surface miner into trucks for transfer to the OPF.



Plate 1: **Surface miner with trucks**

Excavator

Small excavators mining will also be used to mine from a pit face, which is usually between 3 to 5 m high. Excavators will be used to access ore where it is not viable to use a surface miner (e.g. constrained areas requiring small cuts). This method allows selective excavation of narrow bands of material.

3.5.6 Ore Transfer

Currently, ore is transferred to the OPF from the ROM pad through the use of trucks. As mining moves west, haul distances to the OPF will become excessive and an overland conveyor system will be installed to transport ore to the OPF. Approximately 27 km of conveyors will be required to convey the ore to the OPF for the Proposal (Figure 7).

The conveyor system extends to the west of the OPF and consists of the following:

- a main services hub
- two Satellite Crushing Hubs
- seven delivery conveyors from the crushing stations to the OPF.

The satellite hubs are discussed in more detail in Section 3.5.10.

3.5.7 Ore Processing

The OPF is able to produce three market products; namely lump, special and rocket fines. Future demand will dictate whether all three products will be produced, however, rocket and special fines are currently the primary products being produced.

The Ore Processing Facility currently includes:

- a screenhouse containing product and scalping screens which are gravity fed
- crushers including secondary and tertiary crushers
- stockpiles with three types of processed ore based on size, which are small grain rocket fines, larger special fines and high grade lump, being the largest particles
- de-sanding facility that separates sand and clay from the rocket fines to produce a higher grade fine product and waste material (tailings)
- train loader that contains processed ore which is fed from the stockpiles by a slewing stacker onto an apron feeder.

A process flow diagram is shown in Figure 13.

Following processing, ore is transported by train to Port Hedland for shipping.

Conversion to Wet Plant

The OPF currently has a dry front end, where ore is separated into types without water. The Proposal includes the conversion of the OPF to a wet front-end plant to enable processing of wet and sticky ore more efficiently. This will allow Fortescue to convert more marginal parts of the ore body into saleable product.

Pre-conversion production rates through the OPF are up to 45 Mtpa. Post-conversion, production rates through the OPF will be constrained to approximately 35 Mtpa (of wet lump and fines) through the wet front-end. However, subject to mining rates and market demand, dry lump and fines may be produced by bypassing the wet front-end for a certain amount of ROM ore. This could increase the overall production rate to 50 Mtpa.

The conversion to a wet plant will result in greater water usage (approximately 6 GL/yr) due to the increased water requirement for scrubbing and additional wet screening processes.

The wet plant will result in increased tailings comprising of fine (silt size) and coarse (sand size) residue streams which will be co-disposed of as slurry in designated tailings storage facilities (Section 3.5.8). Approximately 6 Mtpa of tailings residue will be generated by the converted OPF.

Wash Plant

Fortescue proposes to install washing technology in the OPF to remove salt (sodium chloride) from ore that will be mined in the later stages of the mine life. The removal of salt is to remove impurities that are undesirable in the steel making process. Iron ore is generally first subjected to a sintering process – where the ore is turned into a material that can be fed into blast furnaces. Chlorine in the iron ore (in the form of sodium chloride) can be converted to carcinogenic by-products (dioxins) during the sintering process. Washing the ore prior to sintering reduces the amount of dioxins released during the sintering process (up-stream processing). Washing of hyper-saline ore will require up to 11 GL of water in years 10, 11 and 13, and 18 GL in year 14.

Water for the wash plant will be sourced from dewatered groundwater that will be processed via a Reverse Osmosis (RO) desalination system prior to use.

The resulting saline effluent stream will be processed (see below) and then injected into saline aquifers as part of on-going hydrological management.

Saline Effluent Treatment and Disposal

The saline effluent from the wash plant will be treated to reduce the level of suspended solids prior to disposal of effluent. The method includes the follow processes:

- pre-treatment by chlorination or aeration
- coagulation of suspended solids by the addition of alum and polymers
- flocculation
- clarification by allowing solids to settle in a pond or basin
- filtration using a sand or crushed anthracite based filter medium
- post-chlorination.

The effluent from saline ore washing will be piped to the saline injection system for injection. All saline water (from desalination, wash water and dewatering of saline aquifers) will be kept separate from brackish waste streams and injected into saline aquifers, thereby minimising the effect on the quality of the receiving aquifers. It is likely there will be some mixing of the brine with saline dewatering discharge (salinity greater than 6000 mg/L) in transfer ponds or pipes at most times; however this will depend on the infrastructure arrangement at the time and may not always occur.

Salinity of the effluent from saline ore washing may vary between 12 000 and 25 000 mg/L. The salt content of the effluent is derived from saline pore water in the ore, which is the undrained water content after dewatering. This is higher than the predicted maximum salinity of the bulk pit water at 9000 mg/L (Fortescue 2010a), but within the range of the water quality in the saline Oakover aquifer in which it will be injected, which has a salinity greater than 50,000 mg/L underneath the Fortescue Marsh (Appendix E). Further description of the saline injection process is provided in Section 6.5.

The process will produce sludge as a waste product. There will be two sources of sludge at the plant. The major source of sludge (approximately 95%) will be from the clarification process. The remaining 5% will come from the wash water waste reclamation process. Sludge from both sources will be thickened to reduce sludge volume and maximise water recovery prior to being directed to holding tanks and ultimately pumped to a tailings storage facility.

The volume of sludge produced is estimated at 15 000 to 30 000 m³ of solids over the life of the mine. This is small compared to the estimated 70 000 000 m³ of tailings to be produced over the life of the mine. There will not be a need for additional storage facilities to accommodate the sludge created from the ore washing facility as there will be sufficient capacity available from the identified tailings storage facilities.

3.5.8 Tailings Management

The in-pit method of tailings disposal has been adopted at Cloudbreak. The operation of in-pit tailings storage facilities (in-pit TSFs) involves controlled deposition of tailings into, and recovery of water from, mined out areas within pits to maximise density of the deposited tailings.

The tailings management approach will typically involve above watertable deposition in mined-out pits in proximity to the OPF. There may be concurrent mining activity and tailings deposition for any given pit. This is achieved by construction of in-pit mine waste embankments to separate the tailings storage from the active and future mining areas. There will be two basic embankment designs, depending on the width available (Figure 14). The first design comprises compacted fill sourced from waste dumps near the pit. The second design has a downstream mine waste zone dumped in the pit during mining operations, with a nominal 15 m wide compacted upstream zone.

In both designs, the mine pits will be backfilled with overburden to a level above the watertable prior to tailings deposition. Tailings will be primarily discharged as a slurry and deposited in discrete layers from multiple discharge points. The discharge point will be regularly moved to ensure an even development of the tailings beach. Tailings discharge will be carried out such that supernatant water will drain towards a decant pump in the pit directing the water to a pond away from the embankments. The supernatant pond will be a small size to assist in reducing seepage and evaporation from the surface of the pond and increase the tailings density.

There are several operational techniques which will allow Fortescue to be flexible in regards to tailings management throughout the Life of Mine. As part of on-going operations, Fortescue will determine the location of pits to be designated as in-pit TSFs in sufficient time to allow their construction and use. Should there be an indication of a shortage of available tailings storage space then Fortescue will be able, in good time, to determine a suitable alternative location for the tailings within the mine footprint.

When the desalination plant is commissioned, it may be appropriate to have two in-pit TSFs operating at the same time in which deposition is cycled between the two facilities. This will ensure that deposition of the saline material is not concentrated in a particular area. If there is a concern that the final tailing surface is saline, then encapsulation of this material will be carried out by either covering it with mine waste material or using a non-permeable material such as clay or a HDPE liner.

As the mine pit will be surrounded by bund walls, the only water entering the TSF will be from incident rainfall. During operation, the facility will have sufficient freeboard capacity to contain any incident rainfall. Towards the end of the life of the TSF, the facility will have adequate freeboard available to store the design storm event of a 1 in 100 year average recurrence interval (ARI), 72-hour storm (345 mm), plus 200 mm and an operational freeboard of 300 mm (Coffey 2010). TSF design is discussed in detail in Appendix H.

Tailings Properties

Up to 6 Mtpa of tailings will be disposed of in in-pit TSFs as part of this Proposal. Prior to the upgrade of the plant to a 'wet' plant, tailings volumes have been approximately 7% of the ROM ore. Under the new wet plant scenario, the waste volume will increase to approximately 15% of the ROM ore fed into the OPF and comprise two components, termed fine and coarse residue. The 'fine' and 'coarse' residue are combined in the thickeners, which is then pumped as a dense residue stream at approximately 50-60% solids (Coffey 2010; Figure 13). The tailings properties are outlined in Table 6.

Table 6: Tailings Properties

| Characteristic | Anticipated Property |
|--------------------------------------|---|
| Average slurry density ex-plant | 55% solids (range 45-60%) |
| Final tailings dry density (average) | 1.5 t/m ³ |
| Particle size distribution | 51% less than 75 microns in diameter (design) |
| Hydraulic Conductivity | 10 ⁻⁷ m/s (estimated) |
| Tailings beach slope | 1% |

Disturbance during the pumping and storing of tailings will be minimised. Pipelines to and from the pit will be bunded to prevent the uncontrolled spillage of tailings or return water into the surrounding area in the event of pipeline failure.

The indicative locations of the in-pit TSFs required for the Proposal are outlined in Figure 15.

Decommissioning

On decommissioning, the exposed tailings surface will be covered with mine waste and rehabilitated with local flora species. Monitoring will be carried out of any ongoing settlement due to tailings consolidation. Modelling indicates that post-depositional settlement will occur over 3-8 years for the proposed in pit TSFs (Coffey 2010). The fine nature and low permeability of the tailings make them ideal for use in rehabilitation. Through selective placement of residue, infiltration rates in some areas can be better controlled with the likely effect that rehabilitation outcomes can be improved. This is particularly the case where Mulga vegetation is being re-established, as Mulga is dependent on soil moisture derived from surface water flows.

3.5.9 Backfilling Pits

Overburden and waste rock will be used to infill the open cut pits created during the mining process. The strip ratio will be an average of approximately 6 units of waste to 1 unit of ore over the Life of Mine.

When material is removed during mining, it expands as it is broken up and air spaces form between the particles, measured as a 'bulking factor'. The bulking factor will vary depending on the material. The average bulking factor at Cloudbreak is approximately 30% which will result in a larger volume of waste than the resultant void volume. As not all of the waste can be returned to the mine pits, permanent waste landforms will be required.

It is unlikely that any significant subsidence will occur in the short term in the backfilled areas, given the compaction caused by various types of mobile equipment traversing the area prior to the spreading of relocated topsoil. Excess material will be deposited in permanent waste landforms which will be designed to resemble the surrounding topography as closely as practicable, as outlined in Section 13.5.3.

3.5.10 Support Infrastructure and Consumables

Satellite Hubs

The movement of the mining activities westward will necessitate the establishment of three satellite hubs to support mining activities. These satellite hubs will consist of:

- crushing/sizing facilities
- workshops, offices, and crib rooms
- fuel farms
- communications equipment (Figure 10).

Crushing/sizing Facilities

The crushing and sizing facilities will consist of a series of crushers designed to handle standard sized ore and large ROM oversize rocks generated in drill and blast operations, pit floor windrow cleanup and pit wall batter scraping at the mine. The crushing and sizing process will size material to less than 250 – 300 mm such that it can be transported by conveyor to the OPF.

These hubs will be established at the same time as installation of each leg of the overland conveyor system. Each hub will require approximately 14 ha of disturbance.

The existing administration, technical planning and associated office complex will remain at its existing location.

Workshop Areas

Each workshop area will consist of workshops, stores, stores compound, laydown area, crib rooms, offices, first aid rooms, washdown bay and amenities (Figure 16). The workshop will be suitably sized to maintain the truck fleet, excavators, surface miners, road trains and ancillary equipment.

Fuel Farms

Approximately 4 multi-unit farms of 10 tanks will be required, each farm having its own fuel dispensing island (Figure 17). Refuelling will take place on a suitably designed concrete pad to ensure any spillage is captured and treated to avoid any contamination of soil or water systems. Each fuel farm will be bunded to hold a minimum 110% of the combined tank capacity.

The lube bay will consist of similar tanks of smaller dimension and hold oil, hydraulic oil, waste oil and grease. The tanks will be bunded to hold a minimum 110% of the combined tank capacity.

The fuel storage and dispensing facility would be located close to the workshop and mining crib rooms. The modulated construction of the fuel farms allows the tanks to be relocated to more remote satellite areas if required.

Communications

Telecommunications such as telephone, facsimile, internet and data transmission will be required at each workshop facility and mining crib room. A tower will be required at each hub to enable communications to the main office complex.

UHF radio network towers will also be required to enable communications between operators of mobile equipment, supervisors, technical and maintenance personnel. Local repeater towers or trailers will be used for more remote areas.

The telecommunications and radio infrastructure will be established at the same time as each of the hubs.

Water Supply

Current water supplies to the mine include:

- potable water supply from mine bores and camp bores
- fresh/brackish water supply from dewatering for operational purposes
- fresh/brackish and saline water supply from dewatering for dust suppression.

The current mine water use is approximately 3.5 GL/yr. Approximately 6 GL/yr will be required for operation of the converted OPF and up to an additional 4 GL/yr for mine dust suppression to support the larger number of work fronts that will be required. This water will be sourced from fresh/brackish groundwater abstracted during dewatering operations.

Desalination Plant

A desalination plant is proposed to supplement process water supply late in the project life, when fresh water demand will be increased by the need to “wash” saline ore. The facility will be required to supply between approximately 11 GL/yr and 18 GL/yr of fresh or brackish water commencing in Year 10. The plant will desalinate saline groundwater abstracted during dewatering.

A preliminary study was completed to scope the design of an appropriate plant and determine its operating characteristics. The operating basis was the processing of dewatering discharge of salinity up to 50 000 mg/L through a reverse osmosis (RO) plant, with ultra filtration pre-treatment to manage biological and suspended solid content. The plant incorporates pumps, membrane units, tanks, skid-mounted ultra-filtration units, an energy recovery system, online monitoring and controls and connecting pipework. The dimensions of the plant would be in the order of 700 m by 300 m. Most of the infrastructure would be skid-mounted for ease of installation and decommissioning.

The major waste streams from the desalination plant occur from the ultra-filtration pre-treatment and the concentrated brines. Periodic waste streams from in-situ cleaning operations will also occur. Indicative waste stream volumes and compositions for feed water of 50 000 mg/L and supply of 15 GL/yr are given in Table 7.

The vast majority of the dissolved and suspended materials in waste streams will be concentrated from the natural input water. The major introduced chemical present in the waste stream will be membrane cleaning solutions, being diluted acid and alkali at pH 2 to 10 that will be neutralised prior to discharge with the rest of the wastes. These may occur at 6 to 8 mg/L in the brine reject water. Other introduced chemicals in the major waste streams (reject brine and the ultrafiltration backwash) are expected to occur at less than 1 mg/L. All waste streams will be assessed further when design is advanced, and will be managed appropriately.

Brine will be piped to the saline injection system for injection. All saline water (from desalination, wash water and dewatering of saline aquifers) will be kept separate from brackish waste streams and injected into saline aquifers, thereby minimising the effect on the quality of the receiving aquifers. It is likely there will be some mixing of the brine with saline dewatering discharge (salinity greater than 6000 mg/L) in transfer ponds or pipes at most times; however this will depend on the infrastructure arrangement at the time and may not always occur.

The salinity of the brine from the reverse osmosis plant may be between 50 000 to 84 000 mg/L. The effluent is equivalent to saline dewatering and will be managed by injection to the Oakover calccrete aquifer. Further description of the saline injection process is provided in Section 6.5.

The power requirement for the plant is estimated to be on average 7.5 MW, which can be accommodated within the existing power station. This excludes potential energy recovery systems that may reduce power usage by up to 30%.

Table 7: Indicative Desalination Waste Stream Composition (15 GL/yr production)

| Stream Source | Average Quantity (kL/d) | Typical Composition | Frequency |
|---------------------------------------|-------------------------|---|-------------------------------------|
| Ultrafiltration & pre-filter backwash | 7 000 kL/d | 50 000 mg/L TDS (total dissolved salts) , ~100 mg/L TSS (total suspended solids) , pH 6-8 | Continuous (backwash every 45min) |
| Reverse Osmosis brine | 60 000 kL/d | TDS 84 000 mg/L, pH 7-8 | Continuous |
| Ultrafiltration CEB* & CIP * | 800 kL/d | pH 2-10, 0.1% chlorine | CEB once per day, CIP every 30 days |
| Reverse Osmosis CIP | 40 kL/d | pH 2-10 | Every 3-6 months |

*CEB = Chemically enhanced backwash, CIP = Clean in progress

Haul Roads

Additional haul roads and service roads will be required to link mine pits to the crushing plant and rail load out areas (Figure 7).

Power Supply

The Cloudbreak diesel power station should not increase in size from the previously assessed and approved 40 MW capacity.

Explosives

Approximately 60 000 tpa of bulk explosive will be required at the Cloudbreak operations.

The existing explosives compound will be relocated to suitable locations around the hubs, giving consideration to storage volumes and safe, operating distances and procedures.

Workforce

Operations workforce numbers are unlikely to increase from current levels of 2400, with approximately 1200 to 1400 on-site at any one time. Construction or non-production maintenance contractors average around 100 workers on-site at any one time; however, numbers will increase to up to 250 for periods where infrastructure upgrades are undertaken.

There is a single accommodation village at Cloudbreak which houses the full workforce. The village currently has 1641 rooms and by February 2011 will have 1721 rooms. Further increases are not planned at this stage; however, the footprint is likely to increase from 30 ha to 45 ha for improvements. These improvements will include:

- additional accommodation and change rooms
- reconfiguring the accommodation from construction style configuration (rooms in a row) to pod style setup (oval shape)
- additional water and wastewater treatment facilities to manage an extra 300 workers.

The clearing required for the village improvements has been considered in the total area of clearing requested.

4. STAKEHOLDER CONSULTATION

Stakeholder consultation on the Proposal has formed part of an ongoing and extensive stakeholder engagement program for Fortescue projects undergoing environmental approvals. The overarching objectives of the program are:

- to disclose the Cloudbreak Expansion Proposal to all interested parties with sufficient detail such that they are able to raise issues and concerns and obtain feedback at the project development stage
- to establish relationships with key stakeholders that enable ongoing dialogue through implementation and regulation of the Proposal.

4.1 STAKEHOLDER ENGAGEMENT PROCESS

The Fortescue stakeholder engagement program for the Cloudbreak Expansion Proposal was undertaken from June to November 2010 and is ongoing. Key stakeholders were identified through Fortescue experience in the Pilbara on previous and other current projects, and project managers have collaborated to support each other's stakeholder engagement through joint identification of stakeholders and integrated engagement activities. Fortescue also adopted the recommendations of State government agencies on stakeholders that should be included in the program. The following key stakeholders were identified:

Government agencies

- Department of Environment, Water, Heritage and the Arts (DEWHA now SEWPAC)
- Office of Environmental Protection Authority (OEPA)
- Department of Environment and Conservation (DEC) (both Perth and Regional Karratha offices)
- Department of Mines and Petroleum (DMP)
- Department of State Development (DSD)
- Department of Water (DoW) (both Perth and Regional Karratha offices)
- Department of Indigenous Affairs (DIA)
- Conservation Commission of Western Australia
- Pilbara Development Commission
- Shire of Ashburton
- Shire of East Pilbara
- Pastoral Lands Board.

Non-government organisations

- Conservation Council of Western Australia
- World Wildlife Fund - Australia
- Wildflower Society of Western Australia
- Wilderness Society.

Community and surrounding land users

- Nyiyaparli Working Group (Traditional Owners)
- Palyku Working Group (Traditional Owners)
- Hillside Station
- Mulga Downs Station.

In addition to ongoing one-on-one telephone and email liaison, Fortescue employed the following modes of engagement in the development of the Cloudbreak Expansion Proposal:

- face-to-face meetings
- site visits
- direct mail
- group emails
- teleconferencing
- telephone contact.

The program included participation in two extended briefing sessions for government decision-making authorities at which the Cloudbreak Expansion Proposal was presented and discussed along with the Solomon and Christmas Creek proposals. The purpose of these briefings was to present stakeholders with the entirety of Fortescue plans so that impacts could be considered with an appropriate level of context. Integrated engagement ensured efficient use of stakeholders' available time and resources by avoiding multiple briefings for multiple projects.

4.2 STAKEHOLDER COMMENTS AND PROPONENT RESPONSES

The Fortescue approach, which integrates stakeholder engagement between current proposals, meant development of the Cloudbreak Expansion Proposal occurred with early awareness of the issues and concerns of potentially affected stakeholders. Stakeholder input continued to aid development of the Cloudbreak Expansion Proposal throughout the engagement period and enabled Fortescue to develop management measures to address particular issues. Fortescue views the continuation of established stakeholder engagement as an integral part of managing the project into the future.

The consultation activities undertaken to date and the issues raised are summarised in Table 8. In addition, Fortescue also engaged in ongoing and *ad hoc* interactions with stakeholders on a one-to-one basis. Some non-government organisations advised that due to resource constraints they were unable to take up the Fortescue invitation to engage.

Table 8: Summary of Consultation Undertaken to Date and Key Topics raised regarding Proposal

| Date | Stakeholder | Purpose | Topics Raised | Proponent Response |
|-----------------|--|--|---|---|
| 26-28 July 2010 | Department of Environment and Conservation (Perth and Karratha) | Site visit to Cloudbreak and Christmas Creek to see areas that will be affected by the Proposal. | <p>Borrow pit design, placement and rehabilitation, especially along the first 120 km of the rail and the need to now remediate the legacy left after construction. (The construction footprint post Rail Camp 2 to the Cloudbreak mine was very good in comparison to areas further north).</p> <p>The Cloudbreak access road and issues principally associated with road design, borrow pit design and placement, and topsoil/vegetation management and the need to strategically address and mitigate these impacts while being cognisant of the footprint of future mine/pit developments.</p> <p>Concerns about the flora and vegetation communities on the north side of the marsh.</p> | <p>The progressive rehabilitation of disturbed areas has been addressed in this PER. Section 13 outlines the decommissioning, decontamination and revegetation of these areas. A Conceptual Mine Closure Plan is included within Appendix I.</p> <p>Potential impacts to vegetation and flora have been considered and addressed in Section 8.2 of the PER, with management measures outlined in Section 8.7. The Fortescue Marsh has been considered with potential sources of impact to the Marsh addressed in Section 10, with management measures outlined in Section 10.7. A Biodiversity Management Plan is included within Appendix A.</p> |
| 15 July 2010 | Department of State Development, Department of Mines and Petroleum | Combined projects briefing to provide overview of projects in the East Pilbara, including Cloudbreak, and to discuss the environmental factors and investigations for the project. | <u>Department of State Development, Department of Mines and Petroleum:</u> Potential impacts and management measures of water abstraction on ecological assets and nearby pastoral leases. | Potential impacts and management measures of water abstraction have been considered in this PER in Section 6.2 and Section 6.7 respectively. A Groundwater Management Plan is also included within Appendix A. |
| 13 August 2010 | Department of Environment and Conservation, Department of Water | Combined projects briefing to provide overview of projects in the East Pilbara, including Cloudbreak, and to discuss the environmental factors and investigations for the project. | <p><u>Department of Water, Department of Environment and Conservation:</u> Potential impacts and management measures of water abstraction on ecological assets and nearby pastoral leases.</p> <p>Consideration of water sharing options with nearby sites in water management strategy.</p> | <p>Potential impacts and management measures of water abstraction have been considered in this PER in Section 6.2 and Section 6.7 respectively. A Groundwater Management Plan is also included within Appendix A.</p> <p>Water sharing options were considered as part of the life of mine water balance. However due to low demand for brackish/saline dewater (the majority of dewater from Fortescue operations), from water users in the region, this option was not considered viable and therefore not included as part of the life of mine water management strategy.</p> |

| Date | Stakeholder | Purpose | Topics Raised | Proponent Response |
|-------------------|-------------------------|---|---------------|-----------------------|
| 21 September 2010 | Conservation Commission | Email to provide a project update and a detailed briefing in the form of a PowerPoint presentation. The email also invited further engagement and provided options for how to engage. | No response. | No response required. |
| 21 September 2010 | Shire of Ashburton | Email to provide a project update and a detailed briefing in the form of a PowerPoint presentation. The email also invited further engagement and provided options for how to engage. | No response. | No response required. |
| 21 September 2010 | Shire of East Pilbara | Email to provide a project update and a detailed briefing in the form of a PowerPoint presentation. The email also invited further engagement and provided options for how to engage. | No response. | No response required. |
| 21 September 2010 | Conservation Council | Email to provide a project update and a detailed briefing in the form of a PowerPoint presentation. The email also invited further engagement and provided options for how to engage. | No response. | No response required. |
| 21 September 2010 | World Wildlife Fund | Email to provide a project update and a detailed briefing in the form of a PowerPoint presentation. The email also invited further engagement and provided options for how to engage. | No response. | No response required. |

| Date | Stakeholder | Purpose | Topics Raised | Proponent Response |
|-------------------|---|---|---|---|
| 21 September 2010 | Wildflower Society of Western Australia | Email to provide a project update and a detailed briefing in the form of a PowerPoint presentation. The email also invited further engagement and provided options for how to engage. | No response. | No response required. |
| 18 October 2010 | Wildflower Society of Western Australia | Presentation to provide a detailed briefing on the Proposal and to discuss the environmental factors and investigations for the project. | No specific topics raised. | No response required. |
| 19 October 2010 | Department of Water (Karratha) | Face to face meeting to discuss the project and the hydrogeological model and expected environmental impacts from the Proposal. | No specific topics raised. | No response required. |
| 21 October 2010 | Niyiparli Working Group | Presentation to provide a detailed briefing on the Proposal and to discuss the environmental factors and investigations for the project. | Management measures preventing the contamination of fresh groundwater once groundwater bores are installed. Current health of vegetation within Proposal area. | Management measures have been implemented to prevent the contamination of groundwater during the installation of groundwater bores. During the installation of bores, a gravel like substance is used to seal the bore, preventing water moving upwards into fresher groundwater. Results of ongoing monitoring of vegetation health within the Proposal area has demonstrated that there are no health impacts on the vegetation as a result of the mining activities. The management measures to prevent the decline in health of vegetation has also been addressed in Section 8.7 of this PER. |
| 2 November 2010 | Palyku Working Group | Presentation to provide a detailed briefing on the Proposal and to discuss the environmental factors and investigations for the project. | No specific topics raised. | No response required. |
| 17 November 2010 | Department of Sustainability, Environment, Water, Populations and Community | Face to face meeting in Canberra to provide a general overview and update of the Proposal. | No specific topics raised. | No response required. |
| 18 November 2010 | Appeals Convenor | Face to face meeting to provide a general briefing of the Proposal. | No specific topics raised. | No response required. |

| Date | Stakeholder | Purpose | Topics Raised | Proponent Response |
|------------|---------------------|---|----------------------------|-----------------------|
| April 2011 | Hillside Station | Direct mail to provide project update and briefing. Correspondence also invited further engagement and provided options on how to engage. | No response at this stage. | No response required. |
| April 2011 | Mulga Downs Station | Direct mail to provide project update and briefing. Correspondence also invited further engagement and provided options on how to engage. | No response at this stage. | No response required. |

4.3 ONGOING CONSULTATION

Fortescue will continue to maintain established communication channels and stakeholder relations throughout the life of the Cloudbreak project. The engagement program established with stakeholders regarding the Proposal prior to its referral to the EPA will be continued as a normal part of Fortescue business practices.

5. FRAMEWORK FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSAL

5.1 IDENTIFICATION OF KEY FACTORS AND SIGNIFICANCE

Key environmental factors were identified through the scoping process and an Environmental Scoping Document. The scoping process included:

- review of the outcomes of EPA Bulletin 1216 for the original proposal (Pilbara Iron Ore and Infrastructure Project: Cloud Break (no beneficiation))
- stakeholder consultation for the original proposal
- agency consultation and comments on management plans
- results of environmental investigations
- Environmental Scoping Document assessment and approval by the EPA.

This process identified the key environmental factors listed in Section 5.2. These factors are addressed in detail in this PER in accordance with the requirements of the Environmental Scoping Document.

A cumulative environmental impact assessment for the Cloudbreak Expansion Proposal and the existing Cloudbreak Project as approved under Ministerial Statement 721, the approved Christmas Creek Project and proposed expansion to Christmas Creek has been included within each individual factor section.

Key issues were identified through an assessment of each of the factors likely to be affected by the Proposal, with comparison to the impact from the previous Cloudbreak project approved under Statement 721. An assessment of the factors was outlined in the referral documentation.

5.2 RELEVANT FACTORS

The environmental factors considered likely to be impacted by the Proposal are:

- groundwater
- surface water
- vegetation and flora
- fauna
- conservation areas (proposed) and natural heritage, including the Fortescue Marsh
- Aboriginal heritage
- landform, mine closure planning and rehabilitation
- greenhouse gases
- Matters of National Environmental Significance.

The impacts on the factors of air quality and noise are not considered to have changed substantially between the previously approved and current proposals. As such, it was considered that these factors did not warrant assessment in this PER.

The potential impacts on the relevant factors and their proposed management are assessed in sections 6 to 15.

5.3 CONSISTENCY WITH ENVIRONMENTAL PRINCIPLES

The EP Act sets out five principles by which protection of the environment is to be achieved in Western Australia. These principles, and the manner in which Fortescue has sought to apply them in the design and planned implementation of the Proposal, are outlined in Table 9.

Table 9: Principles of Environmental Protection

| Principle | Consideration Given in Project | Relevant Sections in Document |
|--|--|-------------------------------|
| 1. Precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: <ul style="list-style-type: none"> careful evaluation to avoid, where practicable, serious or irreversible damage to the environment an assessment of the risk-weighted consequences of various options. | <p>The Proponent recognises the importance of minimising environmental impacts as it is vital in ensuring Fortescue's longevity, success, growth and positioning in the domestic and global markets. Fortescue aims to gain a level of achievement beyond our legal obligations. This will be achieved by successful management of potential risks.</p> <p>The Proponent maintains an environmental management system (EMS) that addresses all of its activities with a potential to affect the environment. The key elements of the EMS include assessing environmental risk arising from environmental aspects with the intention of identifying issues early in the process to enable planning for avoidance and/or mitigation.</p> <p>Part of this process includes undertaking detailed site investigations of the biological and physical environs. Where these investigations identify significant conservation issues, management measures are incorporated into the project design to avoid, where practicable, and/or minimise any potential impacts.</p> <p>As a result, this Proposal has been designed to minimise potential impacts to the key environmental values of the local flora, vegetation, fauna and Fortescue Marsh.</p> <p>The Proponent is supporting University of Western Australia to develop a better understanding of Fortescue Marsh and associated Samphire plant communities and a study with the Department of Environment and Conservation and CSIRO to improve understanding of Mulga vegetation communities.</p> <p>Following a sighting of the endangered Night Parrot near Cloudbreak in 2005, the Proponent has been sponsoring regular surveys to identify and better understand the Night Parrot; but there have been no further sightings to date.</p> | All factor sections |
| 2. Intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. | <p>The Proponent's decision making processes incorporate sustainability principles and the implementation of new and better technologies where feasible. The proponent aims to inspire an ethic and attitude that strives for continuous improvement and ongoing learning.</p> <p>Fortescue encourages employees to engage in positive attitudes and behaviour concerning respect for the environment. We recognise sustainability cannot be achieved without the contribution and action of the entire team.</p> | 3.2 |
| 3. Conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration. | <p>Conservation of biological diversity and ecological integrity is fundamental to the Proponent's approach to environmental management and is a major environmental consideration for the Proposal.</p> <p>Biological investigations have been undertaken by the Proponent early in the project planning process to identify values of environmental conservation significance required to be protected from disturbance. This Proposal has been designed to minimise potential impacts to the key environmental values of the surrounding flora and vegetation and the Fortescue Marsh.</p> <p>The Proponent has committed to restoring disturbed environments upon decommissioning, as well as ongoing rehabilitation of vegetation around Cloudbreak. The aim of all rehabilitation is to establish sustainable endemic vegetation units consistent with reconstructed landforms and surrounding vegetation.</p> <p>The Proponent is also undertaking monitoring of groundwater and surface water in the area to determine impacts, as well as funding ongoing studies into the Fortescue Marsh.</p> | 8, 9, 10, 11, 13 |

| Principle | Consideration Given in Project | Relevant Sections in Document |
|--|--|---|
| 4. Improved valuation, pricing and incentives mechanisms Environmental factors should be included in the valuation of assets and services. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems. | The Proponent acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when and wherever possible. For example: <ul style="list-style-type: none"> • environmental factors have played a major role in determining infrastructure locations; • the Proponent has put in place procedures that will ensure that pollution-type impacts are minimised as far as practicable • the cost of rehabilitation and closure requirements has been incorporated into the costs of the product from the commencement of operation. | 8, 9, 10 |
| 5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment. | The Proponent's approach to waste management is to, in order of priority: <ul style="list-style-type: none"> • avoid and reduce at source • reuse and recycle • treat and/or dispose. The Proponent operates an appropriately licensed landfill for the disposal of general domestic solid wastes. The Proponent has a comprehensive recycling program on-site which includes the recycling of aluminium cans, scrap steel, plastic, batteries, light globes, fluorescent tubes, polyethylene pipe, office paper and cardboard. | This is addressed in existing management plans and is not specifically addressed in the PER |

5.4 CONSISTENCY WITH EXPECTATIONS OF EPA FOR ENVIRONMENTAL IMPACT ASSESSMENT

Table 10 sets out the EPA expectations for environmental impact assessment of proposals, with a summary of how these matters are considered in this environmental impact assessment, together with a cross reference to the relevant sections.

Table 10: Statement of Expectations for EIA

| Expectations | Consideration Given in Project | Relevant Sections in Document |
|---|---|---|
| a) Proponents will use best practicable measures and genuine evaluation of options or alternatives in siting, planning and designing their proposals to avoid, and where this is not possible, to minimise impacts on the environment. | Options and alternatives have been evaluated for each factor under the relevant section. | 6.4, 7.4, 8.4, 9.4, 10.4, 11.4, 12.4, 13.4 |
| b) The onus is with the proponents to describe the environmental impacts of their proposals, and to use their best endeavours to demonstrate that the unavoidable impacts are environmentally acceptable, taking into account cumulative impacts in the region. | Environmental impacts have been described for each factor under the relevant section. Unavoidable impacts have been demonstrated to be environmentally acceptable. Cumulative Impacts have been addressed specifically for each factor in the PER. | 6.5, 6.6, 7.5, 7.6, 8.5, 8.6, 9.5, 9.6, 10.5, 10.6, 11.5, 11.6, 12.4, 13.4. |
| c) Proponents will use best practicable measures and mitigation to manage adverse environmental impacts. | Best practicable measures and mitigation have been evaluated for each factor under the relevant section. Mitigation measures are provided in each factor section to outline how potential impacts will be mitigated through consideration of the EPA mitigation sequence of avoid, minimise, reduce, rectify and offset. | 6.7, 7.7, 8.7, 9.7, 10.7, 11.7, 12.5, 13.5 |
| d) Proposals will meet relevant environmental objectives and standards. | The Proposal has been assessed against relevant environmental objectives and standards as described in each factor section | 6.8, 7.8, 8.8, 9.8, 10.8, 11.8, 12.6, 13.6 |
| e) In all EIA, there will be opportunities for effective stakeholder consultation, including engagement with the local community during the assessment of the proposal. Proponents should adequately engage in consultation with stakeholders who may be interested in, or affected by their proposals, early in the EIA process. | Stakeholder consultation has been undertaken, as described in Section 4. | 4 |
| f) Assessment will be based on sound science and documented information. It is essential that proponents allow adequate time and resources to carry out the necessary surveys and investigations as part of the EIA. | This PER is a result of extensive assessments of geology, hydrology, flora, vegetation and fauna within the project area and Fortescue Marsh. Relevant documentation can be found in the appendices and the references. | Appendices and references |
| g) Proponents will identify management measures for all key environmental factors during the assessment, to demonstrate whether the proposal can be implemented to meet the EPA's environmental objectives. | Environmental measures and controls have been implemented through this Proposal and the associated Environmental Management Plans that address the management of groundwater, flora, fauna and the Fortescue Marsh. | 18 |
| h) In all EIA, performance standards will be established, communicated and agreed at the beginning of the EIA process, and these will be monitored, reviewed and reported against. | Performance standards are provided as part of the management programme for the Proposal. | 18.3 |
| i) Proponents will implement continuous improvement in environmental performance and will apply best practicable measures for environmental management in implementing their proposals. | Best practicable measures for environmental management will be implemented through this Proposal and the associated Environmental Management Plans that address the management of groundwater, flora, fauna and the Fortescue Marsh. FMG is supporting ongoing research into the hydrology and ecology of the marsh, and the outcomes of this work will be used to inform future management plans for the site. | 18 |

6. GROUNDWATER IMPACT ASSESSMENT

6.1 RELEVANT ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

6.1.1 EPA Objectives

The EPA applies the following objectives in assessing proposals that may affect groundwater:

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

6.1.2 Legislation, Policy and Guidance

Legislation

The *Rights in Water and Irrigation Act 1914* (RIWI Act) makes provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes. Within this, the Act requires the construction of wells and groundwater abstractions (including dewatering) in proclaimed areas to be licensed. The Proposal lies within the proclaimed Pilbara Groundwater Area and is subject to such licensing, which is administered by the DoW under delegation from the Minister for Water. Groundwater abstraction licences typically specify annual limits on the groundwater volumes that may be abstracted and include a range of conditions, including requirements for monitoring and reporting on aquifer behaviour. The approval of an abstraction license will require the DoW to approve a Water Management Plan and Operating Strategy, in line with the Pilbara Water in Mining Guideline (DoW 2009) and Pilbara Regional Water Plan (DoW 2010b).

The *Country Areas Water Supply Act 1947* does not apply at Cloudbreak, as the area is not part of a proclaimed Water Reserve or Catchment Area for public water supply.

There is no Federal water legislation relevant to this Proposal.

Water Resource Policies and Guidances

National

In 1996, the Australian and New Zealand Environment and Conservation Council (ANZECC) together with the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) developed the National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996). These national principles aim to improve the approach to water resource allocation and management and to incorporate the water requirements of the environment in the water allocation process. The overriding goal of the principles is to provide water for the environment to sustain and, where necessary, restore the ecological processes and biodiversity of water-dependent ecosystems.

Water quality guidelines for the protection of marine and freshwater ecosystems have been released under the auspices of the National Water Quality Management Strategy (NWQMS) (ANZECC/ARMCANZ 2000). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and are applied to five geographical regions across Australia and New Zealand. The NWQMS is supported by the Guidelines for Groundwater Protection in Australia (ARMCANZ and ANZECC 1995), which outlines a framework for protecting groundwater in Australia. The Guidelines require the identification of beneficial uses for groundwater in aquifers, and policy to manage these issues.

A series of guidelines on national water quality management has also been released by the Natural Resource Management Ministerial Council (NRMMC) and, in some cases, in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State

The Government of Western Australia developed the State Water Quality Management Strategy in 2001 to supplement the National Water Quality Management Strategy with the objective “to achieve sustainable use of the Nation’s water resources by protecting and enhancing their quality while maintaining economic and social development”.

The State Water Quality Management Strategy proposes that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions can then require implementation of the Water Conservation Plan to an agreed schedule.

In 2000, the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP) developed a series of Water Quality Protection Notes and Guidelines for mining and mineral processing. These guidelines address a range of mine site issues including dewatering, installation of groundwater monitoring wells, water quality monitoring, stormwater management and acid mine drainage.

The Proposal footprint does not overlay any drinking water source protection areas and as a consequence, DoW has no regulatory role with respect to groundwater quality associated with the Proposal. However, it provides a centre of advice to Government on all water matters, including to the EPA, and has a number of associated guidance statements related to groundwater quality as listed in Table 11.

Table 11: Department of Water Policies and Guidances Relevant to Managing Groundwater Quality

| Legislation or Guideline | Intent |
|--|---|
| Statewide Policy No 5 – Environmental water provisions policy for Western Australia, 2000 | This policy informs DoW how water will be provided and managed to protect ecological values and sustainable development consistent with the requirements of the <i>Rights in Water and Irrigation Act 1914</i> and the <i>Environmental Protection Act 1986</i> . The policy incorporates the concepts of Ecological Water Requirements and Ecological Water Provisions for water dependent environments in terms of both water quantity and quality regimes. |
| Water Quality Protection Note No 26: Liners for containing pollutants, using synthetic membranes | This note applies to synthetic lining of structures used for holding low hazard materials that may pollute water resources. These structures include: <ul style="list-style-type: none"> ponds used for waste-water treatment, and mineral processing fluids solid materials holding areas such as mining residues. The note sets out the required properties of the liner, together with construction and other requirements for their use to ensure the efficacy of the liner(s). |
| Water Quality Protection Note No 27: Liners for containing pollutants, using engineered soils | This note describes soil liner attributes and construction methods for sealing ponds, mining residue storage areas and other material holding facilities where the stored matter could harm the environment if fluids escape in sufficient quantities. The note sets out the requirements for design, material selection, construction, certification, and monitoring and management to ensure the efficacy of the liner(s). |
| Water Quality Protection Note No 28: Mechanical servicing and workshops | This note applies to the design, installation and operation of mechanical servicing and workshop facilities for: <ul style="list-style-type: none"> motor vehicles earthmoving machinery industrial plant (e.g. pumps and generators) similar equipment where harmful fluids could escape into the environment and potentially contaminate water resources. The note sets out the requirements for construction, operation, management, monitoring and reporting to minimise the potential for adverse discharges to the environment. |
| Water Quality Protection Note No 30: Groundwater monitoring wells | This note sets out the requirements for the siting, construction and sampling of screened or slotted casing groundwater monitoring wells. |
| Water Quality Protection Note No 51: Industrial wastewater management and disposal | This note applies to mineral processing, vehicle and plant servicing, water and wastewater treatment works including contaminated stormwater, cooling water, process waters and wash-down waters. The note sets out the requirements for the design and construction, operation and management, monitoring, contingency planning, emergency response and reporting associated with the handling, treatment and removal of the industrial wastewater. The note sets out indicative wastewater discharge quality criteria to waterways. |
| Water Quality Protection Note No. 52: Stormwater management at industrial sites | This note applies to management of stormwater on light, general and heavy industrial sites throughout Western Australia. The note sets out the requirements for stormwater system design, management, treatment, disposal and contingency planning. |
| Water Quality Protection Note No 65: Toxic and hazardous substances - storage and use | This note applies to the storage and use of substances that if released into the environment in significant quantities, may harm living things that are dependent on clean water resources. The note sets out the requirements for siting, construction, stormwater management, accident management, emergency response and closure. |

| Legislation or Guideline | Intent |
|--|---|
| Water Quality Protection Note No. 68: Mechanical equipment washdown | This note applies to any facilities and procedures used to clean vehicles, earth moving plant and other mechanical equipment. The note sets out the requirements for siting, construction, management and waste disposal. |
| Water Quality Protection Guidelines No. 1: Water quality management in mining and mineral processing: An overview | Provides an overview of the application of the various specific Water Quality Protection Guidelines, including those listed below. |
| Water Quality Protection Guidelines No. 2: Mining and Mineral Processing - Tailings facilities | <p>These guidelines are designed to be used to manage the impact of tailings containment facilities on the quality of the region's water resources.</p> <p>These guidelines apply to mining or mineral processing operations where the disposal of tailings occurs. These guidelines do not apply to overburden dumps and mineral leaching facilities.</p> <p>The guidelines set out the requirements for tailings disposal containment facility design and site assessment, operation, accidents and emergencies, monitoring, reporting and decommissioning.</p> <p>The safety and environmental aspects of tailings disposal are regulated by the DMP through the <i>Mining Act 1978</i>, <i>Mining Act Regulations 1981</i>, <i>Mines Safety and Inspection Act 1994</i> and <i>Mine Safety and Inspection Regulations 1995</i>.</p> |
| Water Quality Protection Guidelines No. 3: Mining and Mineral Processing - Liners for waste containment | <p>These guidelines are designed to be used for the construction of liners required to contain chemicals, ores or waste.</p> <p>These guidelines apply to any operation where liners are required to protect the quality of water resources in the vicinity of mining and mineral processing operations.</p> <p>The guideline lists the types of material that can be used, their attributes and applicability and monitoring requirements.</p> |
| Water Quality Protection Guidelines No. 4: Mining and Mineral Processing - Installation of minesite groundwater monitoring wells | <p>These guidelines are designed to be used for the construction of wells which monitor groundwater at mineral and mining operations.</p> <p>These guidelines apply to construction of wells for projects that have the potential to impact on groundwater levels and water quality. They also apply where baseline groundwater quality data are being established prior to the development of a project.</p> <p>The guidelines set out the requirements for design, construction, sampling and decommissioning of groundwater monitoring wells.</p> |
| Water Quality Protection Guidelines No. 5: Mining and Mineral Processing - Minesite water quality monitoring | <p>These guidelines are designed to be used for establishing and operating minesite water monitoring programs in order to protect the quality of the region's water resources.</p> <p>The guidelines apply where a program is used to monitor changes in water quality resulting from a mining operation involving, for example, handling of chemicals and disposal of wastes.</p> <p>The guidelines set out the requirements for design, construction, sampling techniques, monitoring frequency, water quality criteria and reporting.</p> |
| Water Quality Protection Guidelines No. 6: Mining and Mineral Processing - Minesite stormwater | <p>These guidelines are designed to be used for managing stormwater so the region's water resources are protected. These guidelines are to apply where rainfall on minesite areas is likely to impact on the quality of water resources. This includes runoff generated from land such as stockpiles, process plants, dumps, haul roads and rehabilitated areas.</p> <p>The guidelines provide a high level outline of the requirements for the management of stormwater on a minesite.</p> |
| Water Quality Protection Guidelines No. 7: Mining and Mineral Processing - Mechanical servicing and workshop facilities | <p>These guidelines are designed to be used in the operation and disposal of waste from mechanical servicing facilities to ensure the quality of the region's water resources are protected. These guidelines apply to all sites where mechanical servicing of vehicles or equipment occurs. They cover, but their scope is not limited to, mining workshops, treatment plants and machinery servicing facilities.</p> <p>The guidelines set out the requirements for workshop areas, operation, disposal of liquid wastes, storage and disposal of solid wastes, and spill containment.</p> |

| Legislation or Guideline | Intent |
|--|---|
| Water Quality Protection Guidelines No. 8: Mining and Mineral Processing - Laboratory waste discharge | <p>These guidelines are designed to be used to ensure the quality of the region's water sources are protected where disposal of laboratory wastewater to a sewer system is not possible.</p> <p>These guidelines apply to all laboratories where disposal of wastewater to a sewer system is not available. It is specifically directed to minesite analytical facilities and bulk commercial analytical laboratories that service the mining and exploration industries.</p> <p>The guidelines detail the management requirements for the disposal of laboratory waste by discharge to the environment.</p> |
| Water Quality Protection Guidelines No. 9: Mining and Mineral Processing - Acid mine drainage | <p>These guidelines are designed to be used where there is the potential to generate acid mine water, or where acid mine water exists and has the potential to impact on the quality of the region's water resources.</p> <p>These guidelines apply to mining and mineral process operations that have the potential to generate acidic mine water, or where acid mine water exists.</p> <p>The guidelines set out the requirements for prevention, disposal and monitoring of acid mine drainage.</p> <p>The discharge of acid mine drainage is regulated by the DMP through the <i>Mining Act 1978</i>.</p> |
| Water Quality Protection Guidelines No. 10: Mining and Mineral Processing - Above-ground fuel and chemical storage | <p>These guidelines are designed to minimise the potential impacts on water resources from poorly managed aboveground fuel and chemical storage facilities.</p> <p>These guidelines apply to all mine sites where the volume of above-ground storage of fuel or toxic/ harmful chemicals exceeds 250 L.</p> <p>Above-ground tanks are regulated by the DMP under the <i>Dangerous Goods Safety Act 2004</i> and relevant regulations.</p> |
| Water Quality Protection Guidelines No. 11: Mining and Mineral Processing - Mine dewatering | <p>These guidelines are designed to be used to manage the impact of minesite dewatering on the quality of the region's water resources.</p> <p>These guidelines apply to the discharge of water pumped as part of mining or mineral processing operations, and propose water quality criteria for receiving waters.</p> <p>The guidelines set out the requirements for assessment of impacts, dewatering treatment and disposal, receiving water quality criteria and monitoring.</p> |

In setting criteria for water quality impacts, the DoW *Mining and Mineral Processing - Mine dewatering :Water Quality Protection Guidelines No. 11* discusses mine dewatering receiving water quality criteria and notes that the appropriate discharge criteria would be set under the licensing provisions of the *Environmental Protection Act 1986*. However, there is no comment on what those criteria might be. These licensing provisions are administered by DEC and apply to "prescribed premises"; however, no specific published criteria exist for discharges to water as a receiving environment in areas of non-fresh or non-marine waters.

DoW notes that for non-licensed premises, the criteria based on Table 12 would be recommended, "*giving consideration to the natural variability in quality of water resources, the beneficial uses given to water resources and the need to preserve their value.*" Given the lack of DEC specific criteria for such premises in this environment, Table 12 represents appropriate criteria for preliminary assessment of the Proposal.

The criteria set out in Table 12 are replicated in the DoW *Water Quality Protection Note No 51: Industrial wastewater management and disposal*.

Where the criteria in Table 12 may potentially be exceeded as a consequence of a proposal, the beneficial uses of the water would provide guidance to what excursions from the criteria might be acceptable. In the case of the Cloudbreak Expansion Proposal, the beneficial uses of the water primarily relate to stock watering, support of groundwater-dependent ecosystems, and cultural heritage uses.

Table 12: Department of Water Receiving Water Quality Criteria

| Indicator | Criterion |
|------------------------------|--|
| pH | Discharge water should not cause the seasonal background pH of the receiving waterbody to vary by more than ± 0.5 units. |
| Total Dissolved Solids (TDS) | Discharge water should not cause the seasonal background TDS of the receiving waterbody to vary by more than 10%. |
| Dissolved oxygen (DO) | Discharge water DO concentration should not cause the seasonal background DO concentration of the receiving waterbody to decrease by more than 10%. |
| Suspended solids/turbidity | Discharge water should not cause the suspended solids/turbidity seasonal background concentration of the receiving waterbody to increase by more than 10%. |
| Floatable matter | Discharge water should not be the cause of visible floating oil, foam, grease, scum, litter or other objectionable matter being present in the receiving waterbody. |
| Settleable matter | Discharge water should not cause the deposition of settleable matter that may adversely affect the visual, recreational and ecological values of the receiving waterbody. |
| Odours and colours | Discharge water should not produce discernible variation in odour or colour in the receiving waterbody. |
| Temperature | Discharge water should not cause the receiving water temperature to vary by more than 2°C from its seasonal background temperature. |
| Toxicants | The level of toxicants discharged (e.g. cyanide, heavy metals) should not cause the seasonal background concentration of toxicants in the receiving waterbody to increase by more than 10%. |
| Radionuclides | Radionuclides in the discharge water should not cause seasonal background radionuclide concentrations in the receiving waterbody to increase by more than 10%. |
| Nutrients | Discharge water should not add nutrient substances or other growth stimulants (e.g. phosphorus, nitrogen) in quantities sufficient to cause excessive or nuisance algal growth in the receiving waterbody. |

Source: Department of Water "Water Quality Protection Guidelines for Mining and Mineral Processing – Mine dewatering" Guideline No. 11, 2000.

6.2 POTENTIAL SOURCES OF IMPACT

The main value of groundwater in the area is in supporting the ecology of the Fortescue Marsh. Activities or aspects of the Proposal that may potentially affect groundwater include the following:

- dewatering of mine pits will lower groundwater levels
- injection of dewatering product may increase groundwater levels
- injection of dewatering water may cause changes in groundwater salinity.

The potential impacts of groundwater drawdown resulting from dewatering of the ore body aquifer include:

- decrease in the water available to groundwater-dependent ecosystems (including subterranean fauna)
- changes in groundwater level have the potential to reduce the duration of surface water on the Fortescue Marsh and the presence of Yintas
- loss of water supply to station supply bores in the vicinity of the mine
- removal of water in subterranean voids leading to the formation of sinkholes.
- potential oxidisation of Potentially Acid Forming (PAF) material resulting in acid mine drainage.

The potential impacts of groundwater mounding resulting from injection activities may include:

- saturation of the root-zone of vegetation communities sensitive to waterlogging
- mobilisation of salt into the root-zone of vegetation communities sensitive to salinity
- surface discharge of groundwater if the aquifer at the injection zone is unable to receive the total quantity of water being injected
- changes in groundwater quality as a result of injection of higher salinity water into fresh water zones of the aquifer.

The potential effects of groundwater drawdown and mounding on vegetation (including phreatophytic vegetation, Samphire and Mulga), subterranean fauna and the Fortescue Marsh are discussed in Sections 8.5.2, 9.5.2 and 10.5.2 respectively.

6.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

6.3.1 Cloudbreak Hydrogeology

Characterisation of the hydrogeology of Cloudbreak has been based on field investigations undertaken since 2005, including an extensive drilling and testing program and assessment of hydrological properties conducted during 2008/09. The field investigations resulted in development of a conceptual hydrogeological model of the Cloudbreak area intended to represent the understanding of the natural groundwater regime and to enable the potential effect of the Proposal on that regime (Fortescue 2010a) to be assessed.

The Cloudbreak area and Fortescue Marsh are underlain by the fractured rock aquifers of the Roy Hill Shales (Figure 18) (Fortescue 2010a). Above this lies the Marra Mamba Formation, a semi-continuous aquifer of relatively high permeability² and storativity³. The ore body at Cloudbreak is located wholly within the Nammuldi Member of the Marra Mamba Formation. The Marra Mamba Formation aquifer is unconfined⁴ to partially confined in the north and partially confined to confined in the south. Hydraulic properties of the Marra Mamba Formation vary both laterally and vertically. The high permeability aquifer zones are elongated along the east-west strike of the Nammuldi Member.

The Marra Mamba Formation is overlain by the Wittenoom Formation (predominately Wittenoom Dolomite) in the Fortescue Marsh area and Tertiary sediments in the upslope areas⁴ (Figure 18). The Wittenoom Dolomite forms the bedrock below the Tertiary sequence in the Fortescue Valley (Fortescue 2010a). Lithological logging indicates that where unweathered, it has poor inter-granular permeability. Local permeable zones associated with faulting may have developed within this formation; however, weathering has resulted in a clay-dominated zone with low permeability forming the upper profile.

The relatively flat Fortescue Plain is located to the south of the mine and extends either side of the Fortescue Marsh. The Fortescue Plain is underlain by a sequence of layered Quaternary and Tertiary alluvial, colluvial and lacustrine sediments that may be up to 100 m deep, known as Tertiary Detritals (Figure 18). Layers within the Tertiary Detritals have varying properties and include mixtures of gravels, sands, silts and clays. The lower sequence of the Tertiary Detritals is referred to as the Oakover Formation, formed of calcrete (calcium carbonate) (Fortescue 2010a). The Tertiary Detritals at the surface typically comprise unconsolidated silt, sand and gravel around ephemeral creek lines on the slopes, whereas finer-grained sediments including clays predominate across the adjacent flood plains and marsh (Fortescue 2010a).

² Permeability is the measure of the ability of a material (such as rocks) to transmit fluids.

³ Storativity is a measure of the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

⁴ An unconfined aquifer is overlain by permeable layers and the watertable represents the aquifer level. Confined aquifers are below low permeability layers and may be under pressure so that the water level in a bore may be higher than the watertable.

The Tertiary Detritals group includes aquifer and aquitard⁵ subunits or layers. Subsurface aquifers within the Tertiary Detritals are semi-confined to unconfined and have developed within more porous sediments, such as clayey gravels and within the calcretes (i.e. the Oakover Formation) (Fortescue 2010a). The potential for a comparatively less permeable cemented layer below the surface of the marsh has been identified (Fortescue 2010a). The presence of such a layer would reduce the connection between soil moisture and changes to the deeper groundwater aquifer and if it does occur, could minimise the effect of any groundwater level changes on water availability to vegetation in the marsh. However, as the presence and extent of this layer is subject to study and further investigation, the groundwater modelling and impact assessment has been based on the conservative assumption that this layer is not present.

Groundwater Levels and Trends

Groundwater abstraction has occurred at Cloudbreak since 2006 for mining purposes (Appendix E). Prior to August 2008, small amounts were abstracted for dust suppression purposes. Dewatering commenced in mid 2008 resulting in significant increase in abstraction to approximately 15 GL/yr. The OPF came into operation at this time also and mine water usage increased to approximately 1.7 GL/yr. The primary disposal method for disposal of excess groundwater was injection into compatible aquifers, approximately 7 GL/yr was returned to the aquifer system by this method. Since this time, abstraction has increased to approximately 25 GL/a, with regulatory approval. This approval includes reinjection of 20 GL/a. ReInjection has primarily occurred into the Oakover Formation.

Groundwater levels at Cloudbreak vary from the mine site (where the watertable is approximately 409 to 415 metres above Australian Height Datum (mAHD) to the Fortescue Marsh margin (approximately 405 mAHD) (Fortescue 2010a).

Observed groundwater levels in the Cloudbreak area have been falling in response to the lack of rain since the last flooding of the Fortescue Marsh in 2006, falling approximately 1.5 to 2 m between 2007 and 2010 (Fortescue 2010a). Further up the slope, groundwater level variation has been approximately 1 m (Fortescue 2010a). Potential natural long-term groundwater trends under various climatic conditions (dry, average and wet) were modelled and indicate that groundwater levels on the margin of the Fortescue Marsh in the Proposal area can be expected to vary between the surface and 4 m below ground level (Fortescue 2010a). The rate of fall in water levels is highest when groundwater levels are high because evaporation rates from the watertable are higher as it is closer to the ground surface (Fortescue 2010a).

⁵ A zone or geological formation of low hydraulic conductivity that prevents water flow between two aquifers. An aquitard may act as a confining layer.

Groundwater Quality

Cloudbreak groundwater chemistry data shows groundwater in the resource area is generally brackish and becomes increasingly saline towards the Fortescue Marsh and with depth (Fortescue 2010a). Groundwater in the Cloudbreak region ranges from marginally brackish (>500 mg/L Total Dissolved Solids [TDS]⁶) in recharge areas to hypersaline in areas closer to the Fortescue Marsh and in fractured rock zones below the Marra Mamba Formation (>100 000 mg/L TDS) (Fortescue 2010a). Evaporation from the soil profile and surface water in the Fortescue Marsh results in concentration of salts, which has resulted in the aquifer under the marsh becoming hypersaline over time. Salinity in the upper aquifer beneath the marsh is greater than 50 000 mg/L (Fortescue 2010a). Hypersaline groundwater has migrated downwards due to its high relative density (Fortescue 2010a) and formed a wedge below the lower salinity aquifers near the edge of the marsh.

It is thought that density gradients due to salinity differences are an important driving force for groundwater flow in the area. The density contrast between saline groundwater and fresh groundwater leads to a wedge-shaped transitional zone beneath the fresh groundwater in the aquifers flanking the Chichester Range. Within the Marra Mamba Formation, the saline transition zone has been recorded to be in direct hydraulic connection with the overlying brackish layers and this saline interface may move in response to recharge events as well as groundwater drawdown or injection (Fortescue 2010a).

Groundwater Recharge

Aquifers are recharged by direct infiltration of rainfall at outcrop regions of the Marra Mamba Formation and Tertiary Detritals, however, rainfall recharge is low in the Cloudbreak area, reflecting the generally low rainfall of the region (Fortescue 2010a).

Groundwater recharge also occurs during large flood events in the Fortescue Marsh, generally when rainfall is greater than 100 mm in a month (Fortescue 2010a). Following a flood event, it is considered that a portion of the ponded surface water in the Fortescue Marsh will infiltrate (Fortescue 2010a); although this may be slow due to the presence of an impervious layer immediately underlying the bed of the marsh.

Groundwater Discharge

Groundwater discharge occurs due to evaporation of water from the marsh and vegetation transpiration.

⁶ For reference, seawater is approximately 30 000 to 35 000 mg/L TDS

Topography-driven groundwater flow in the shallow tertiary aquifer system is likely to discharge towards the Fortescue valley floor via generally low-permeability sediments and is removed from the system by evaporation and evapotranspiration processes (Fortescue 2010a). Evaporation is the dominant discharge process in the area and although groundwater levels may be above surface after rainfall, surface water generally does not persist longer than 3 to 6 months, indicating that groundwater levels are usually below the surface. The presence of hypersaline water in the discharge zone (beneath the Fortescue Valley) also impedes groundwater discharge, as the saline groundwater creates an opposing density-driven flow potential. The aquifers beneath the Fortescue Marsh become increasingly confined towards the marsh's centre and only limited discharge may occur via slow leakage through overlying tertiary sediments and subsequent evapotranspiration processes at the surface (Fortescue 2010a).

Groundwater Use and Values

The Guidelines for Protection of Groundwater Quality in Australia (ARMCANZ/ANZECC 1995) provide a framework to protect beneficial uses and values of groundwater throughout Australia. The key values for groundwater in the Cloudbreak area relevant under this framework are ecosystem protection, agricultural waters for stock watering and use for industrial purposes (mine process water) by Fortescue.

Groundwater with a salinity of less than 6000 mg/L (brackish water) is considered to have a beneficial use as it is suitable for stock watering (Fortescue 2010b). Groundwater also supports groundwater-dependent vegetation such as Coolibah and River Red Gum in creek lines. Groundwater may also support Samphire communities in and around the Fortescue Marsh (Section 8.3.2).

6.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

The primary option to avoid impacts would be to prevent further mining below the watertable. However, this would mean early closure of the Cloudbreak mine and not accessing the majority of the available ore. This would:

- limit utilisation of the existing infrastructure at the Cloudbreak site, including ore processing facilities, roads, rail and pits
- require mining in other locations, with associated impacts to the environment, to provide iron ore resources.

This is not considered to be a viable option.

Abstraction of groundwater for mining purposes (dewatering and mine water supply) requires consideration of the management of excess water abstracted. Fortescue has considered options for managing excess water in line with the Department of Water hierarchy of water management methods, being (in order of preference) (DoW 2009a):

- 1) Efficient on-site use - used for fit-for-purpose activities (such as processing and dust suppression).
- 2) Transfer to meet other demand, including other proponents in the area and public water supply.
- 3) Injection back into the aquifer at designated sites.
- 4) Controlled release to the environment where the excess water release is allowed to flow (either through a pipe or overland) into a designated water course or wetland.

Fortescue will supply all processing and dust suppression needs at Cloudbreak with the abstracted water in accordance with the preferred water management method above. There are no other demands for water in the area, as other mines in the area are also below watertable with excess available water. The remaining abstracted water will be injected into local aquifers as per management option 3 above, for the conservation and protection of water sources and sensitive environments such as the Fortescue Marsh. Controlled release to the surface will only be used during system failures or in exceptional circumstances when major maintenance is being undertaken on the system, as discussed in Section 7.5.4.

6.5 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

Cloudbreak currently operates a water management system that comprises approximately 70 dewatering bores, 80 injection bores, 200 km of pipelines, multiple settlement dams, transfer ponds, and supply points. Under the current situation, approximately 25 GL/yr of water is abstracted, of which up to 20 GL/yr is reinjected and 7 GL/yr used for ore processing and dust suppression. Brackish and saline water are kept separate, with saline dewater injected into a saline area near the Marsh, and brackish water injected into the Hillside East and Hillside West injection zones within the recharge zone (Figure 11). Plate 2 shows an example of an injection bore.



Plate 2: Brackish Injection Bore

The method of injecting saline and brackish water separately will be continued and expanded as part of this Proposal. The Proposal includes abstraction of up to 100 GL/yr and injection of up to approximately 85 GL/yr with actual rates varying during the Life of Mine and average rates of abstraction and injection being much lower. The maximum net abstraction, being the amount abstracted minus the amount injected, will be 15 GL/yr.

Contingency Planning

Groundwater injection schemes require contingency planning in the event that the desired recharge rate cannot be achieved in a specific area due to bore clogging or unexpectedly low hydraulic conductivities. The injection systems are designed with higher installed bore injection capacity than the assessed aquifer receival capacity, so the primary contingency is provided by additional bores. The saline injection borefield extends beyond the dewatering zone, providing a robust and flexible system for return of water to the aquifer.

The water management system includes several transfer and settlement ponds that provide contingency for short-term loss of injection capacity. The saline injection system is designed with a pond to the south of each mining area. The saline system does not require transfer ponds under normal operating conditions as injection is directly to the south of mining, and the primary purpose of the saline ponds is contingency storage. Five saline ponds could provide approximately six days contingency storage for dewatering excess of 25 GL/a. The contingency storage capacity of the water management system as a whole will progressively increase over time as mining moves to new areas, releasing brackish transfer and settlement ponds from operation and thereby increasing their contingency storage capacity. All major transfer and settlement ponds will be lined and suitable for evaporation of either saline or brackish water.

For brackish water there is a further contingency option provided in the approved Operating Strategy to discharge water to creeks, if required. Discharge may only occur for limited periods (less than 21 days) during one of the following:

- maintenance/repairs of injection pipelines or bores
- injection infrastructure being taken offline to allow addition of further injection bores
- pump failure of transfer ponds
- planning and construction delays.

Re-use, injection, in-pit disposal, a reduction (or cessation) of dewatering rates and temporary storage will be used in preference to discharge to creek lines. A maximum contingency discharge rate of 35 ML/day to creek lines is permitted by DoW and DEC.

If bores clog, they will be redeveloped to remove clogging through a borefield maintenance program and experience to date has been that the need for redevelopment is infrequent once pipes have been flushed clear of construction debris. The likelihood of geochemical clogging in saline injection bores was assessed by geochemical modelling and found to be low (Appendix E). This is supported by the performance of the saline injection undertaken to date for current mining, in which no notable clogging has been observed (Appendix E).

6.5.1 Development of Numerical Model

The numerical model of the hydrogeology developed for the Proposal, which includes Fortescue Marsh hydrology, is a predictive tool with limitations due to a lack of drilling and bore information available for the marsh (a consequence of limited access). The model input parameters used with respect to the marsh have relied on assumptions regarding the marsh environment. Despite the relatively low level of ground-truthed data in the marsh area, improvements in the understanding of the hydrogeology of the area have been made using other approaches. These include (Fortescue 2010a):

- preliminary information assembled under research managed by the University of Western Australia through an Australian Research Council (ARC) Linkage project
- the acquisition and interpretation of high-precision LIDAR surface elevation data across the marsh, which has been used to develop a high precision Digital Elevation Model
- the use of historical LANDSAT imagery to assess the system response to flooding events
- the assessment of the spatial distribution of groundwater salinity using a SkyTEM airborne conductivity survey
- calibration of the model against monitoring data from the existing dewatering activities.

The boundaries of the model are considered appropriate for the modelling of the Fortescue Marsh. The southern boundary of the model is approximately 14 km south of the southern extent of the marsh at the western end, and 23 to 26 km south of the marsh at the eastern end. As Fortescue's operations are on the northern side of the marsh, this model extent is considered appropriate for assessment of groundwater level change at the marsh.

The model provides a good basis for predicting groundwater level change and to identify areas of ground level change within the Fortescue Marsh. The changes in groundwater level are cumulative with natural groundwater level fluctuations. A decrease in groundwater levels due to mining would therefore have a greater impact during a dry period than a wet period. For this reason, changes in groundwater levels have been investigated under average, dry and wet scenarios.

The report on the modelling undertaken by Fortescue is provided in Appendix E. The model was peer reviewed by HydroConcept, who considered it to provide a robust and meaningful representation of the hydrogeology of Cloudbreak (HydroConcept 2010) (Appendix F).

6.5.2 Changes in Quantity

The potential hydrogeological effects of the Cloudbreak water management strategy was assessed through numerical modelling of the groundwater system under three climate scenarios (average, dry and wet). A series of simulated years of rainfall were developed based on historic rainfall statistics for the Newman metrological station. The simulated years were then used to develop the three scenarios. The scenarios were as follows:

- the average scenario represents the median rainfall expected over a 14 year period, and includes nine months where rainfall is greater than the 100 mm/month expected to cause flooding events in the Fortescue Marsh
- the dry scenario represents the rainfall expected to be exceeded in 95% of 14 year intervals and includes two months where rainfall exceeds 100 mm/month
- the wet scenario represents the rainfall expected to be exceeded in 5% of 14 year intervals and includes 19 months where rainfall exceeds 100 mm/month.

Over the Life of Mine (14 years) the total abstraction under an average climate scenario is estimated to be 811 GL at a mean rate of 58 GL/yr (Figure 19, Table 5). The abstraction rate ranges between 38 and 91 GL/yr under an average climate scenario (Figure 19, Table 5). A total of 664 GL (mean rate of 47 GL/yr) will be injected to the groundwater system (Figure 19, Table 5). The difference between these volumes is referred to as net abstraction will be 147 GL (11 GL/yr). This water will be utilised for mine operations including ore processing and dust suppression. Approximately 80% of the abstracted water will be returned to the aquifer by injection, with 20% used for operations.

The Water Management Strategy will not result in a significant change to the quantity of groundwater in the Cloudbreak area.

6.5.3 Changes in Groundwater Levels

The abstraction and injection of water will result in localised changes in groundwater levels, as conceptually shown in Figure 5. Dewatering is centred on the area being mined at a given point in time and will move as mining progresses. The drawdown effects will consequently be concentrated in the area being mined and are generally located higher in the landscape where depths to groundwater are greater. The volume and location of dewatering changes as the area being mined moves to the west.

The impact of mining on groundwater levels under an average rainfall scenario is shown in Figure 20 through Figure 25. These figures show the impact of mining on groundwater in specific years, which were selected because they represent the largest impacts on groundwater when mining occurs in different sections of the Cloudbreak footprint.

Figures showing the impact in each year of mining can be found in Appendix E. The red contours show the height and spatial extent of mounding, with positive values representing mounding and negative values showing drawdown. The blue contours show the depth to groundwater under an average climate scenario with mining occurring. Depth to groundwater without mining can be determined by subtracting the mounding (red) contour value from the depth to groundwater with mining (blue) contour.

At the centre of mining activities, dewatering may result in lowering groundwater levels by up to 70 m (Figure 23). However, these extreme changes are highly localised adjacent to mine pit areas and occur in areas within the clearing footprint for mining and infrastructure. However, small drawdowns of 1 to 5 m will extend over larger areas (Figure 21) and may affect vegetation health where prolonged drawdown occurs in areas that naturally have shallow watertables (5 m or less below ground level, DoW 2010a). Drawdown of approximately 1 m is modelled to occur at limited locations along the edge of the Fortescue Marsh in Years 7 to 10 and Year 13 (Figure 21, Figure 22, Figure 24).

Localised mounding is predicted to occur as a result of injection of water at:

- the two brackish injection areas, Hillside East and Hillside West, located in the range areas (Figure 21)
- the saline injection area that runs parallel to the marsh in the south of the Proposal area (Figure 23, Figure 25).

In the brackish injection areas, injection may result in raising groundwater levels by up to 6 m at the centre of the injection zone under an average climate scenario. In the saline injection areas, injection may result in a rise of groundwater level of up to 3 m under an average climate scenario. Mounding greater than 1 m is not expected within the Fortescue Marsh.

The modelling indicates that mounding will not cause groundwater levels to reach the surface at any location under the average, wet or dry climate scenarios modelled (Fortescue 2010a).

The magnitude of groundwater level changes predicted by the model in the Fortescue Marsh is less than the magnitude of natural fluctuations in groundwater levels that occur at the Marsh. As the changes are of a similar magnitude, it is not considered that a localised model of the Marsh is required at this stage. However, to ensure that the impacts of changes in groundwater levels on the Fortescue Marsh are understood and minimised, Fortescue has commenced a model of the unsaturated zone of the Fortescue Marsh Samphire communities in the HYDRUS software package. The unsaturated zone is the zone above the water table where soil pores are not fully saturated, although some water is present. The model will test the hypothesis that the water requirements for Samphire are provided by surface water inputs from rainfall and runoff onto the Marsh.

The HYDRUS model is in a preliminary phase and includes parameter estimates largely obtained from the literature. The suitability of these parameters will be evaluated in 2011 using findings from the planned marsh hydrogeological drilling program.

Fortescue is also undertaking further work to investigate the relationship between groundwater levels and plant available water in the Fortescue Marsh, as described in Section 6.7.2.

Areas of Potential Impact to Vegetation

Changes in groundwater level may affect the health of vegetation overlying the area of change. In the Cloudbreak area, groundwater drawdown may potentially affect vegetation health if:

- 1) Groundwater levels rise to within 2 m of the surface where this was not previously the case.
- 2) Groundwater levels fall where the depth to groundwater where levels without dewatering was less than 5 m.

Groundwater levels rising to within 2 m of the surface is used as an impact trigger for water potentially entering the root zone of Mulga (*Acacia aneura*), which has a shallow root system and is sensitive to waterlogging (Fortescue 2009c). Areas where mounding results in groundwater levels rising to within 2 m of the surface, where this was not previously the case, have therefore been highlighted in this impact assessment as areas where vegetation health may be affected by mounding.

In areas where the depth to groundwater is less than 5 m, vegetation is more likely to be dependent on groundwater for some of its water requirements. This is illustrated by studies that show phreatophytic (groundwater dependent) species such as *Eucalyptus camaldulensis* occur in areas in the Pilbara with watertables between zero and eight metres below ground level (DoW 2010a). Areas where drawdown occurs where the original water level was less than 5 m from the surface have been highlighted in this impact assessment as areas where vegetation health may be affected.

Predicted Groundwater Level Changes (Average Climate Scenario)

This section describes where changes in groundwater may affect vegetation based on the above criteria under an average climate scenario. A discussion of the nature and extent of this potential impact is discussed in Section 8.5.2. The average climate scenario is discussed as this describes the spatial extent and movement of groundwater level changes as mining progresses. Variability under different modelled climate scenarios is shown in the predicted water level hydrographs is shown in Figure 31 to Figure 39.

Areas and extents of impacts quoted in this section are for areas outside the maximum mine disturbance area. The areas quoted experience a change in groundwater levels greater than 1 m, based on the modelled average rainfall scenario. It is assumed that areas within the maximum mine disturbance area will be impacted by mining and/or associated infrastructure.

Years 1 to 3

During the first three years of mining, impacts from drawdown and mounding are not expected to occur (Figure 20).

Years 4 to 10

During years 4 to 10, increased mounding in the Hillside West area due to an increase in injection in the Hillside West area causes groundwater level rise to within 2 m of the surface (Figure 21, Figure 22) with up to 16 ha affected. As mining moves further west, additional small areas of drawdown occur at the edge of the marsh (Figure 21, Figure 22).

Years 11 and 12

In Years 11 and 12, mining commences in the Hillside West area. The Hillside West area has shallow groundwater levels and mine dewatering causes drawdown within the Proposal area. Injection is intensified along the edge of the marsh, leading to groundwater rising to within 2 m of the surface at scattered locations within the saline injection area, with a total of 66 ha potentially affected in Year 11 (Figure 23).

Year 13

The mining in the Hillside West area expands in Year 13, resulting in more extensive drawdown in that area. This includes localised drawdown at the edge of the marsh of approximately 1 m (Figure 24).

Year 14

In the final year of mining, injection in the saline injection area results in more extensive areas of groundwater rise in the saline injection area, particularly at the western end of the site (Figure 25). A total of 528 ha of area will experience rises to within 2 m of the surface. Drawdown within the 5 m contour occurs near Hillside West.

Total areas of potential groundwater impact during mining

A total of 607 ha outside the maximum mining disturbance area may be affected by greater than 1 m of mounding at some stage during the life of the Proposal and results in groundwater levels reaching 2 m of the surface. No mounding greater than 1 m occurs in the Fortescue Marsh.

A total of 2709 ha outside the maximum mining disturbance area with a depth to groundwater levels initially less than 5 m may be affected by drawdown greater than 1 m during the life of the Proposal. Most drawdown occurs for periods of three years or less. A total of 150 ha of the marsh may be affected by drawdown greater than 1 m for a period of less than three non-consecutive years.

Post-closure

Following mine closure, mounding and drawdown will slowly dissipate in both magnitude and extent (Figure 26 to Figure 30). Mounding of greater than 1 m will continue for between five and ten years post closure with mounding impacts being less than 1 m and not resulting in a depth to groundwater of less than 2 m after closure (Figure 26 and Figure 27) (Fortescue 2010a).

The impacts of drawdown persist for longer as the drawdown has a greater magnitude, therefore taking longer to dissipate (i.e. up to 50 m). The post-closure drawdowns are also exacerbated in the first few years as injection ceases. During mining, the injection of saline water adjacent to the Fortescue Marsh largely mitigates the propagation of drawdown towards the marsh. Some drawdown is predicted to occur for at least 40 years post-closure although the depth of drawdown will gradually decrease (Figure 30).

In the first year after mining, drawdown occurs in the marsh in two locations in the west of the Proposal Area. Approximately 2628 ha where groundwater would be within 5 m of the surface without mining, may be impacted by drawdown at this stage. Within five years of closure, potential drawdown effects at the edge of the marsh cease (Fortescue 2010a). By ten years post-closure, the impact of drawdown is less than 2 m at all locations (Figure 27). The altered groundwater levels will be considered in closure planning for this area. As the presence of drawdown is long term, it is likely that the vegetation communities in this area will adapt to the lower groundwater levels, favouring species more tolerant of dry conditions. As the groundwater levels slowly increase, the communities will adapt to increased water availability.

Impacts under Dry and Wet Scenarios

A comparison of the difference in impacts between average, dry and wet scenarios is shown in the predicted hydrographs at nine locations spread throughout the area potentially affected (Figure 31 to Figure 39). These locations are shown in Figure 25, with monitoring bores located at seven of the sites. The simulated water levels with and without the Proposal for average, dry and wet scenarios over the life of the Proposal and the periods of mounding or drawdown that could result in significant impacts under particular climatic patterns (i.e. drawdown under a dry year or mounding under a wet year) is shown in Figure 31 to Figure 39. Vegetation health may be affected when groundwater levels are outside their normal range.

Because of the moving mining and injection front, there is a significant difference in the spatial and temporal behaviour of groundwater levels. For example, groundwater levels at the location Artificial_West (Figure 32) will exhibit mounding from Years 7 to 11 (blue shading) and drawdown from Years 12 to 14 (yellow shading). CBX02_WT (Figure 31) will exhibit mounding between Years 5, 6, 8, 11 to 12 and 14. Drawdown periods (shown in yellow on the figures) are less than three years at any one location.

Four areas of potential effects were identified:

- western area, located near Hillside West being CBX02_WT (Figure 31) and Artificial_West (Figure 32)
- central bores, being CBX_04S (Figure 33), CBX07_S (Figure 34) and CBX10a_WT (Figure 35)
- eastern bores, being CBX13_WT (Figure 36) and Artificial_Middle (Figure 37)
- marsh bores, being A2 (Figure 38) and B2 (Figure 39).

The bores CBX02_WT, Artificial_West, CBX04_S and CBX10a_WT are within the Proposal area (Figure 25). The other bores are located outside the Proposal area.

Western Bores

Artificial West and CBX02_WT both show effects due to rainfall and mining.

In the case of Artificial West, the differences in water levels with and without the Proposal are more pronounced, particularly in later years when mounding and drawdown are predicted to occur in this area. Periods with potential impacts include:

- mounding between Years 7 and 11 of between 0.5 to 1.5 m which may result in water levels reaching less than 0.5 m from the surface under a wet rainfall period, or within 1 m of the surface under an average rainfall period
- drawdown under all scenarios between Years 12 and 14, with a maximum drawdown of 1.5 m may result in groundwater level falling to more than 4 m below the surface under all scenarios (Figure 32), which may potentially impact vegetation.

Mounding is considered to be a potential impact, especially if it occurs under a wet rainfall scenario. Under a wet rainfall scenario, mounding could rise to within 1 m of the surface for a number of years. This rise would be outside the normal water level range.

Figure 31 (CBX02_WT) shows:

- that during Years 5, 6, 8, 11, 12 and 14 there is a potential for mounding to cause water levels to rise by an average of 0.8 m (1.5 m in the case of Year 14), which could raise groundwater levels above the normal range if this occurs during a wet or average rainfall period (Figure 31)
- drawdown in Year 10, with the potential to lower groundwater levels by approximately 0.8 m which may result in water levels above the normal range if this coincides with a high rainfall period. (Figure 31).

It appears unlikely that groundwater will rise to within 2 m of the surface during mining at CBX02_WT. It is considered unlikely that impacts will occur in this area.

The magnitude and period of the mounding, coupled with shallow depths to groundwater implies there may be impacts due to mounding in this area, as shown in Figure 22.

Central Bores

Bores CBX_04S (Figure 33) and CBX07_S (Figure 34) show drawdown greater than 0.5 m in Years 7 to 10 and 11 to 13, with a maximum magnitude of 1.5 m. Impacts are possible during an average or dry climate period. In Year 13, there is expected to be a period of one year of mounding of up to 1 m. The mounding is not considered to be significant as groundwater levels do not rise outside the range experienced under normal climatic conditions. However, the drawdown may cause groundwater levels to fall below 5 m from the surface at CBX07_S for about three years, which may potentially affect groundwater-dependent vegetation in the area.

Bore CBX10a_WT (Figure 35) shows mounding throughout the life of the Proposal, apart from Years 5 and 7. Mounding impacts may be greater than 2 m, but are generally less than 1.5 m. As the groundwater levels at this point do not rise to within 2 m of the surface, it is considered unlikely that there will be an impact due to mounding at this location.

Eastern Bores

Bore CBX13_WT (Figure 36) shows drawdown in Years 2 to 4 and Year 7 of approximately 1 m which may result in impacts if it coincides with a dry to average rainfall period. Mounding of approximately 1 m occurs from Years 10 to 14 which may result in impacts in a wet rainfall period. Groundwater levels will not rise to within 2 m of the surface at this location. Drawdown in Years 3 and 7 may affect water availability to vegetation under a dry scenario, as groundwater will fall to approximately 0.5 m below the normal range. The groundwater in this area is normally within 5 m of the surface and this change may impact groundwater-dependent vegetation in the area.

At Artificial_Middle (Figure 37), mounding occurs between Years 5 and 14. This may result in impact if it coincides with a wet rainfall period. Mounding at this location is considered unlikely to cause impacts as the water level does not rise to within 2 m of the surface.

Marsh Bores

Modelling of groundwater levels in the area of the Fortescue Marsh represents the deep aquifer water levels underlying the marsh. Based on a limited set of drilling observations the Tertiary Detritals may contain relatively low permeability (cemented) layers creating a separation between unconfined and deeper aquifers. This layer may prevent the infiltration of surface water into groundwater and the rise of groundwater into the marsh. As a conservative approach, the presence of hardpan layers in the Tertiary Detritals was not included in the numerical modelling used to predict areas of groundwater drawdown and mounding over the life of the project. The presence and extent of these layers is a subject of ongoing investigations by Fortescue.

Modelling of water levels in the marsh shows that the main driver of groundwater levels in the marsh is the large rainfall events (generally greater than 100 mm/month) that cause periods of elevated groundwater level (Figure 38, Figure 39) and potential inundation in the marsh. Evaporation is also an important hydrological process when the marsh is flooded. This is the case with or without the Proposal.

The impacts of the Proposal on bore A2 show drawdown of between 0.5 and 0.8 m between Years 7 and 9 (Figure 38). This may cause groundwater levels to fall below their normal range if this occurs during a low rainfall period. Such a change could affect groundwater-dependent vegetation in the area.

Bore B2 shows mounding in Years 4 to 6 of approximately 0.5 m and drawdown in Year 13 of approximately 0.5 m. This may cause groundwater levels to drop below their normal range if this occurs during a low rainfall period. Such a change could affect groundwater-dependent vegetation in the area.

Impact on Station Bores

Station bores (Figure 20) have the potential to be affected by drawdown and may become dry and unable to be used to supply water for stock. Where mounding occurs, bore supply will not be adversely affected. Five station bores are present within the Proposal area and may be affected by drawdown, depending on the rainfall scenario.

Where station bores are predicted to be affected by drawdown the following options will be investigated for implementation:

- establish contingency plan in consultation with station manager/lease owners should station bore supply be affected by dewatering drawdown, potential actions to be implemented include:
 - modifying well construction (deepen well)
 - establishing an alternative water supply (i.e. install another well)
 - supplementing water supply at affected well sites

Any potential impact on station bores is considered to be manageable.

6.5.4 Impacts on Surface Water Residence Time in Fortescue Marsh

Groundwater drawdown at the edge of the Fortescue marsh could increase infiltration of surface water when it occurs, potentially decreasing the period of inundation in a flood event. However, due to the high evaporation rates in the Pilbara, it is likely that evaporation will remain the key process in removing water from the marsh. The Fortescue Marsh is adapted to a highly variable rainfall regime in terms of magnitude and frequency and is not inundated on an annual basis. Periods of surface water inundation may vary between less than one month and six months (Fortescue 2010a). Given the natural variability of the system and the localised and short term effects of drawdown at the edge of the marsh, no significant effect on the surface water regime of the Fortescue Marsh is expected as a result of groundwater abstraction.

6.5.5 Impacts on Groundwater Quality

Potential for Changes in Groundwater Salinity

The predicted maximum salinity of the bulk pit water is saline at 9000 mg/L (Fortescue 2010a). Injection of large volumes of saline water into areas with fresh or brackish water quality (i.e. less than 6000 mg/L) has the potential to increase the salinity of groundwater in these areas. This is considered a concern as increasing the salinity above 6000 mg/L limits the potential use of the water for stock watering and other beneficial uses.

To investigate this potential impact, Fortescue (2010a) undertook two dimensional modelling of the impacts of injection of saline water on water salinity. The results of this assessment indicate that the shallow watertable zone may be marginally influenced by the injection of more saline water but will generally be maintained within the brackish range (Fortescue 2010a). Fortescue has also set a goal for water management that the salinity of groundwater with high beneficial use (defined as watertable aquifer waters with salinity less than 6000 mg/L and not near a mining or transitional saline zone), will be maintained below 6000 mg/L (Fortescue 2010b). If salinity begins to increase in areas where this is considered undesirable, Fortescue may alter the injection program to prevent further impact. It is considered that these measures are adequate to ensure that the salinity of groundwater will be maintained, and no significant impact on groundwater salinity is consequently expected.

Potential for Changes in Surficial Groundwater Chemistry

Groundwater will be injected into deep naturally saline aquifers of the Marra Mamba ore body and the Oakover calcrete. Mounding that may occur at the water table would be due to pressurisation of the aquifer at depth forcing the water table upward. Injected saline water will enter the saline aquifer at depths well below the water table and, given the calcrete aquifer has much higher permeability than the overlying tertiary detritals, the flow will be lateral rather than upward. The chemical composition of water at the water table near the Fortescue Marsh is therefore not expected to be changed by the injection process. For these reasons the mechanism of watertable rise will not result in salt being transported to the surface unconfined aquifer.

The water management program has been designed to minimise the duration of mounding and drawdown at any single location, which will prevent the opportunity for significant salt accumulation across much of the Proposal area. Where mounding occurs in areas with relatively shallow watertables, the duration of mounding will generally be in the order of one year. Under these conditions salt accumulation is not expected to significantly exceed naturally occurring levels.

Potential for Acid Mine Drainage

Acid mine drainage (AMD) forms where rocks or soils containing sulphides are excavated and/or exposed to air, leading to oxidation of sulphides and formation of acid. Groundwater infiltration and surface runoff from waste landforms containing these acidified materials has the potential to cause environmental harm. Investigations by Fortescue indicate that the ore bearing Marra Mamba Formation does not contain elevated levels of sulphides and is not considered to be potentially acid forming (PAF) (GCA 2005).

The Roy Hill Shale which underlies the ore body contains sulphides and is considered to be potentially acid forming (GCA 2005). Between 10 and 20 m of unmineralised Marra Mamba Formation generally occurs between the ore body and the Roy Hill Shale.

For acid drainage to be generated from Roy Hill Shale by dewatering at Cloudbreak, the PAF material would need to be exposed by dewatering long enough for the in-situ rock to drain and the contained sulphide materials to be oxidised. Dewatering will not target the Roy Hill Shale and the extent of dewatering will generally not extend to the depth of the Roy Hill Shale. Dewatering near the base of mining, where dewatering is at risk of intersecting the Roy Hill Shale, is expected to occur for a period of three months or less in each pit. Based on these operational and material characteristics, the risk of acid mine generation from dewatering of Roy Hill Shale is considered to be very low. Should AMD occur, the volume would be small for the reasons outlined above.

Following dewatering, the recently dewatered area will be a groundwater sink, drawing in groundwater for some time until normal groundwater levels in the area recover. Once groundwater levels have recovered, normal groundwater patterns (i.e. towards the marsh) will return. During the period in which the area is acting as a sink, any small volumes of AMD affected water that may occur is unlikely to be transported from the mining area and could be readily diluted by the recovery inflow during this period, prior to the return of normal groundwater flow conditions.

Should AMD occur, affected water may be collected in the dewatering system, and this may present a risk to groundwater dependent ecosystems if injected, or to other ecosystems if used for mining purposes or released through a contingency discharge. Although the likelihood and potential quantity are small, a monitoring and management strategy for this situation will be developed.

Potential for Metal and Metalloid Contamination of Mine Drainage

Drainage from waste rock from mining may potentially contain metals and metalloids such as selenium, arsenic, bismuth and antimony. This may occur under acid, neutral or alkaline conditions. These elements are toxic in high concentrations and may cause environmental problems if allowed to leach. The risk of leaching of metals and metalloids at Cloudbreak is considered to be low because:

- 1) There is only slight enrichment – the concentrations of enriched minor elements fall within the range typically recorded for lithotypes at iron-ore mines in the Pilbara where there are negligible occurrences of sulphide-minerals (i.e. there are only small amounts of these elements) (Graham Campbell and Associates, 2005).
- 2) Where they occur, enriched elements of potential concern are immobile – the mineralogy of the rock types at Cloudbreak is such that metal and metalloid species are fixed within the rock matrix (i.e. not in forms that are soluble or otherwise bio-available)
- 3) The rocks are already deeply weathered – the rocks that will be disturbed have been subject to eons of weathering/leaching and it is unlikely that these deeply weathered materials will leach further.

Fortescue therefore considers that further assessment of leachate risks for metals and metalloids are not required.

Potential for Acid Sulphate Soils

Potential acid sulphate soils (ASS) are soils that are rich in iron sulphides that occur in anoxic⁷ conditions, below the watertable (DEC 2009c). These soils are generally associated with current or historical wetlands (DEC 2009c).

The marsh is an area of extensive low-lying, episodically inundated flats underlain by a shallow water table. Inland wetlands with these characteristics have the potential to contain potential ASS in soils below the permanent groundwater level (DEC 2009c). Dewatering activities that lower the water table beyond the natural fluctuation range could expose potential ASS to oxidation and subsequent acidification (DEC 2009c).

Based on numerical modelling outputs, dewatering will be confined to the northern fringe of the Fortescue Marsh over the life of the mine. The magnitude of dewatering beneath the marsh is predicted to be approximately 1 m at limited locations along the edge of the Fortescue Marsh in Years 7 to 10 and Year 13. The threat of dewatering activities oxidising potential ASS in the marsh is considered to be low as the level of drawdown is likely to be within the natural fluctuation range of the watertable beneath the marsh under most climatic scenarios, and where it occurs is unlikely to create sufficient desiccation of subsoil layers to allow oxygen ingress.

The occurrence and extent of ASS in the Fortescue Marsh has not been investigated in any historical field studies. A limited number of soil profile samples from the marsh have been collected as part of recent hydrogeological investigations by Fortescue and analysis of these samples for ASS is in progress. Fortescue intends to undertake an extensive soil profile sampling program to better characterise the properties of soils and subsoils along the northern fringe of the marsh, within the potential influence of mine pit dewatering activities.

Potential for sinkhole formation

Sinkholes are considered unlikely to be formed as a result of the Proposal. Sinkholes are reported to have occurred around the world as a result of dewatering, where lowering of groundwater levels drains geological voids and removes the buoyant support of water (EPA 2010). Sinkholes are generally associated with karstic geology (a type of terrain developed on soluble rock landforms with underground drainage) or ferricrete.

⁷ Anoxic – without oxygen

Karst typically occurs on limestone and dolomite with competent, fractured rock characteristics and high intact unconfined compressive strength. Weaker limestone and chalk lack the strength to span large cavities which may lead to sinkhole formation. Sinkholes may also form within calcrete and ferricrete. Sinkholes within calcrete occur as a result of dissolution of the carbonaceous rock in acidic conditions that form in the air water interface at the watertable, whereas the formation of sinkholes in ferricrete is less well understood. The Proposal area is not underlain by carbonaceous rocks in the vicinity of the watertable and the risk that larger sinkholes associated with this rock type will form is consequently likely to be very low. If sinkholes form on any calcrete or ferricrete areas as a result of the Proposal they are likely to be small in size and have little environmental impact.

Dolomite of the Wittenoom Formation is an extensive regional geological unit that overlies the Marra Mamba formation stratigraphically. It has been weathered from the profile in the Proposal area. Ferricrete is not known to occur in the Proposal area and the conditions for generation of ferricrete are not present.

Calcrete of the Oakover Formation south of the mining areas may be alternately exposed to depressurisation and mounding by dewatering and injection. The calcrete occurs well below the water table and will not be dewatered; therefore dissolution due to acidic conditions at the water table will not occur. The risk of sinkhole generation is considered very low. If sinkholes form above any calcrete areas as a result of the Proposal they are likely to be small in size and have little environmental impact.

6.6 CUMULATIVE IMPACTS

The predicted extent of drawdown and mounding from the Proposal has been examined in the context of predictions regarding the Fortescue owned Christmas Creek operation, immediately to the east of Cloudbreak, as well as the following projects, where drawdown predictions are publicly-available through respective PERs (Fortescue 2010a):

- Roy Hill (proponent, Hancock Prospecting, located east of Christmas Creek)
- Marillana (proponent Brockman Resources, located on the southern side of the Fortescue Marsh) (Figure 40).

Cumulative impacts would occur if the impact from one mine exacerbated the impact from the other through intersection of the drawdown and/or mounding zones of each mine. There is no overlap of the drawdown and/or mounding zones of the Cloudbreak Proposal with those of either Roy Hill or Marillana (Figure 40).

Modelling undertaken by Fortescue for this Proposal included Christmas Creek injection simulations from the Hillside East injection area. This reflects adoption by Fortescue of a combined approach to water management of its operations in the Chichester Range to optimise Cloudbreak and Christmas Creek water management interactions. Figure 40 shows the impact in 2015, as planning and modelling for Christmas Creek currently does not extend beyond this period. However, it is likely that operations at Christmas Creek will extend beyond this period. Operations at Christmas Creek beyond 2015 will be the subject of a separate environmental approval, and the cumulative impact of these operations will be assessed as part of that approval.

Other than the shared impact from the Hillside East area, the extent of mounding and drawdown from the Proposal does not interact with any other area affected by the Christmas Creek operation.

6.7 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

Dewatering of groundwater will be subject to a licence issued by the DoW under the RIWI Act that specifies the annual dewatering volume and includes conditions for monitoring. As part of the licensing process, an Operating Strategy detailing the monitoring and adaptive management of the dewatering program is required by DoW. An Operating Strategy has been prepared by Fortescue for the management of mine dewatering and disposal at Cloudbreak (Fortescue 2009a). Operations will be consistent with this and the Fortescue *Chichester Operations Groundwater and Bore Management Plan* (Fortescue 2009b).

6.7.1 Management Actions

Management of potential impacts on groundwater from this Proposal are also addressed in the Groundwater Management Plan in the Environmental Management Plan (EMP) (Appendix A) and includes the following key management actions:

- 1) Manage saline and brackish dewatering and injection separately to protect aquifer water quality.
- 2) Progressive dewatering only in active mining areas to minimise dewatering requirements.
- 3) Monitor water levels and quality (including pH and salinity) prior to and during mining and post-closure (for three years on a six monthly basis), to address potential water quality issues including acidification of potential ASS. The monitoring results will be reviewed after 3 years and the need for any ongoing monitoring determined. Regulatory agencies will be consulted as a component of the review process.
- 4) Develop trigger criteria for water levels and modify operations should trigger criteria be breached.

- 5) Develop trigger criteria for water quality and undertake an investigation program should these criteria be breached.
- 6) Modify injection regime if required to mitigate potential effects of groundwater drawdown or mounding.
- 7) Establish a contingency plan in consultation with station manager/lease owners should station bore supply be affected by dewatering drawdown.
- 8) Develop a detection plan for sinkholes, should dolomite, calcrete and/or ferricrete with extensive voids, be encountered.

An adaptive management approach to groundwater management is being developed by Fortescue to monitor and respond to the actual water level changes as a result of dewatering and injection. This approach is described in the Groundwater Management Plan in Appendix A.

In addition, Fortescue will develop a monitoring and contingency strategy for potential Acid Mine Drainage.

6.7.2 Proposed Future Investigations

Fortescue is also planning (and in some cases has already commenced) a series of investigations related to groundwater impacts. These investigations will include:

- investigation of the geology and hydrogeology of the Fortescue Marsh
- investigation of Samphire use of groundwater and response to salinity changes and drying regimes
- investigation of the response of Mulga to drought, waterlogging and salinity stresses.

The findings of these investigations will inform mining operations in order to provide for ongoing vegetation protection and management. Fortescue will maintain an ongoing dialogue with regulatory authorities with respect to the implementation of these investigations and their outputs, which will be used to refine the EMP provided in Appendix A.

6.8 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

After mitigation measures as described in Appendix A, the Expansion Proposal and the cumulative effects of the current Proposal are expected to result in the following outcomes in relation to groundwater:

- 1) An estimated average rate of abstraction of 58 GL/yr, of which an estimated 47 GL/yr will be injected back into the aquifer and 11 GL/yr will be used for processing and dust suppression.

- 2) A total of 607 ha outside the maximum disturbance footprint associated with mining may be affected by greater than 1 m of mounding over the life of the Proposal that results in groundwater levels reaching 2 m of the surface. No mounding greater than 1 m occurs in the Fortescue Marsh.
- 3) A total of 2709 ha outside the maximum disturbance footprint with a depth to groundwater levels initially less than 5 m may be affected by drawdown greater than 1 m over the life of the Proposal. Most drawdown occurs for periods of three years or less. A total of 150 ha of the marsh may be affected by drawdown greater than 1 m for a period of less than three non-consecutive years.
- 4) Mounding and drawdown will slowly dissipate post-closure. Groundwater mounding will continue for between five and ten years post closure. Limited areas of drawdown will occur for at least 40 years post closure.
- 5) No impact is expected in terms of residence time of surface water in the Fortescue Marsh.
- 6) Impacts to groundwater salinity are expected to be minimal due to the geographically separated injection of saline and brackish water designed to match the quality of the receiving waters.
- 7) Any potential impact to station supply bores will be managed through well modification or substitution with an appropriate water source if water supply is affected.
- 8) Acidification of any potential ASS may occur in marsh areas if drawdown occurs during dry climate periods. The potential for acidification will be prevented through the manipulation of the injection regime to maintain water levels.
- 9) Acid mine drainage is not expected to occur as dewatering will not target the Roy Hill Shale member below the ore body and generally the extent of drawdown will not extend into the Roy Hill Shale. However, a monitoring and contingency strategy will be developed to address this risk.
- 10) No impact is expected in terms of acid mine drainage or sinkhole formation.

These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Proposal will not be significantly affected. The key mitigation measure is the separation of saline and brackish water and managed injection that minimises mounding and drawdown effects and maintains a net abstraction of less than 15 GL/yr. The impact of mounding and drawdown upon vegetation is discussed in Section 8.5.2. Fortescue expects that the EPA objective for this factor will be met.

7. SURFACE WATER IMPACT ASSESSMENT

7.1 RELEVANT ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

The EPA applies the following objective in assessing proposals that may affect surface water:

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

7.1.1 Water Resource Policies and Guidances

National

In 1996, the Australian and New Zealand Environment and Conservation Council (ANZECC) together with the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) developed the National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996). These national principles aim to improve the approach to water resource allocation and management and to incorporate the water requirements of the environment in the water allocation process. The overriding goal of the principles is to provide water for the environment to sustain and, where necessary, restore the ecological processes and biodiversity of water-dependent ecosystems.

A set of water quality guidelines for the protection of marine and freshwater ecosystems has also been released under the auspices of the National Water Quality Management Strategy (ANZECC/ARMCANZ 2000). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and applied to five geographical regions across Australia and New Zealand.

A series of guidelines on national water quality management have also been released by the Natural Resource Management Ministerial Council (NRMMC) and, in some cases, in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State

The Government of Western Australia developed the State Water Quality Management Strategy in 2001 to supplement the National Water Quality Management Strategy with the objective 'to achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development'.

The State Water Quality Management Strategy requires that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions require implementation of the Water Conservation Plan to an agreed schedule.

In 2000, the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP) developed a series of Water Quality Protection Notes and Guidelines for mining and mineral processing. These guidelines address a range of issues including installation of mine site groundwater monitoring wells, mine site water quality monitoring, mine site stormwater management and acid mine drainage. These guidelines are outlined in Table 11.

7.2 POTENTIAL SOURCES OF IMPACT

The main environmental value of Surface Water in the Cloudbreak area is supporting the ecology of the Fortescue Marsh. Activities or aspects of the Proposal that may potentially affect surface water include:

- physical presence of infrastructure may cause disruption to channel and sheet flow surface water regimes through the diversion, ponding or capture of surface water flows
- injection of dewater may potentially cause surface expression of groundwater if there is too much being injected (i.e. the aquifer at the injection zone being unable to receive the total quantity of dewater being injected)
- surface water discharge as a contingency if injection infrastructure fails may cause surface water quality impacts and create new flow paths and erosion risk
- drainage from mine waste facilities may affect surface water quality through:
 - an increase in surface water turbidity
 - acidification of mine waste if it occurs
- storage and use of hydrocarbons have the potential to affect surface water quality through the discharge of potentially contaminated stormwater from the mine area
- earthworks and clearing may cause deterioration in water quality as a result of erosion and sedimentation.

The potential effects of changes to surface water flow on vegetation (including phreatophytic vegetation, Samphire and Mulga) and the Fortescue Marsh are discussed in Sections 8.5.2 and 10.5.2 respectively.

7.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

The Proposal area is located in the Upper Fortescue River catchment which drains in a southerly direction from the Chichester Range to the Fortescue Marsh. The Fortescue Marsh is an extensive, ephemeral wetland bounded by the Chichester Range to the north and the Hamersley Range to the south, occupying an area of approximately 1000 km² (100 000 ha) when in flood (Worley Parsons 2011). The Fortescue Marsh is within the internally draining upper catchment of the Fortescue River system.

Flooding of the Fortescue Marsh is generally associated with large rainfall events (>100 mm/month) over the 26 000 km² catchment, usually due to cyclonic events (Worley Parsons 2011). Broad scale flooding occurs on a frequency of about one year in ten, with inundation persisting for three to six months (SEWPAC, 2010a). The Fortescue Marsh is not believed to flow into the lower Fortescue River (SEWPAC, 2010a). During smaller rainfall and runoff events, isolated pools form on the Fortescue Marsh at the main drainage inlets. Surface water runoff to the Fortescue Marsh is typically of low salinity but high turbidity (SEWPAC, 2010a).

The Fortescue Marsh and some semi-permanent water pools or “yintas” along the northern shoreline have been identified as having cultural significance (Plate 3). The yintas are located at low points in the marsh topography and are thought to be associated with seasonal surface water flows. Each of the yintas is associated with large catchments draining the Chichester Ranges. There are two yintas that have part of their catchments within the Proposal area, Yinta 1, which receives flow from Gorman Creek, and Yinta 2 (Figure 41).

Water stored in the Fortescue Marsh slowly dissipates through the processes of seepage, evaporation and evapotranspiration (Worley Parsons 2011). As the surface water evaporates, the salinity increases. Over time this process has led to the aquifer below the marsh becoming hypersaline.



Plate 3: Yinta on the Fortescue Marsh

7.3.1 Surface Water Flow Processes

Surface water flow in and around the Proposal area takes several different forms, covering different areas (Worley Parsons 2011). From an environmental perspective, the most important forms are:

- channel flow – convergent flow to large creek channels and adjacent floodplains
- sheet flow – overland flow in a broad shallow front.

Channel Flow

Channel flow zones are associated with large catchments that predominantly drain the steep upland areas, rather than the flatter terrain closer to the Fortescue Marsh. This surface flow has large convergent flows, with high velocities in large, well defined channels (Plate 4). Small, more frequent flows are generally confined to the channel. Breakouts into the adjacent floodplains occur during larger and less frequent flood events (Worley Parsons 2011). The main channels are usually devoid of vegetation. Vegetation on the adjacent floodplains includes *Eucalyptus victrix* (Coolibah) -*Eucalyptus camaldulensis* (River Red Gum) open woodlands and Scrub to Low Open Woodland dominated by *Acacia* species (ENV 2011). These communities are maintained by periodic inundation and/or roots that access superficial freshwater lenses that form from infiltration of smaller rainfall events (Worley Parsons 2011).



Plate 4: Goman Creek

Sheet Flow

Sheet flow occurs where overland flow moves down-slope while maintaining a broad shallow front. Sheet flow occurs where there is no convergence of flows in relatively flat areas, meaning that sheet flow zones are maintained over large areas (Worley Parsons 2011). Sheet flow occurs over extensive areas within and to the south of the Proposal area. These flat areas occur where the terrain has been formed by remnant alluvial fans (Worley Parsons 2011). Sheet flow is unlikely to occur during small rainfall events as it only occurs when the intensity or volume of rainfall exceeds the local capacity for infiltration. Hence

Sheet flow processes are important for the banded Mulga (*Acacia aneura*) communities that are common in the mid to lower slopes of the Chichester Range, including within the Cloudbreak area. Mulga in these areas occur in bands, where relatively dense groves of Mulga in low lying areas are interspersed with slightly elevated inter-grove areas that contain grasses or less dense areas of Mulga (Worley Parsons 2011).

Water infiltration rates are generally higher in grove areas where sheet runoff from inter-grove areas collects in the groves and is concentrated and infiltrates (Tongway and Ludwig 1990, Dunkerley 2002, reported in UWA 2010).

Surface Water Quality

Surface water runoff entering the marsh is generally of low salinity and turbidity, though turbidity increases after flooding (Aquaterra 2005). During flooding events, salts deposited from previous drying episodes are redissolved and the water entering the marsh becomes moderately saline (Fortescue 2009a). As the water evaporates, the salts are further concentrated and become hypersaline and deposition occurs, leaving traces of surface salts (EPA 2006a).

7.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

The scope to consider alternative locations for this Proposal to avoid or minimise impact is limited as the location of the mine is dictated by the extent of resource. Surface water drainage paths at Cloudbreak generally run in a north-south direction, towards the Fortescue Marsh and the entire proposed Cloudbreak mine is almost 40 km long with an east-west alignment. As such, drainage has been a key consideration in mine planning. There is some flexibility with locations of linear infrastructure and waste landforms and minimising disturbance to surface water regimes within these constraints has been incorporated into the mine planning by ensuring that final waste landforms are generally outside of major creek line flood areas.

The most significant means of avoiding surface water impact in the Proposal is the dewatering and injection system. This system will ensure that under normal circumstances, all water not required for mining will be injected back into the aquifer rather than discharged to the surface. Discharge to the surface will only occur as a contingency measure.

Contingency Discharge (or “controlled surface water discharge”) is a licensed water disposal method, instigated for operational ‘contingency’ reasons (including lack of injection capacity due to construction delays). Discharge volumes are reported to DEC in accordance with Fortescue’s regulatory requirements. Surface water discharge as a means of discharging excess water from dewatering abstraction was undertaken at Cloudbreak between December 2008 and September 2009, when between 200 000 and 400 000 kL/month was discharged. A total of 20 000 kL was also discharged in December 2009.

During September 2009, bore construction and infrastructure installation on the Hillside West Injection line enabled greater injection capacity, eliminating the need to discharge down creeks. Small volumes of fresh water were discharged during the months of December 2009, February 2010 and March 2010 to facilitate pipe scouring after such installations, with records kept outlining volumes, quality and location.

Open cut mining changes landforms in order to extract the target ore and manage the waste rock or overburden. Pits, stockpiles and waste landforms will alter the local surface water regime by diverting or capturing water that would otherwise be transported downstream. Mining at Cloudbreak uses progressive backfilling to reduce the pit and stockpile areas that are active at any given time. This reduces the impact of mining upon the surface water regime of the area as the landforms can be stabilised and rehabilitated as the mining face progresses. All major creek lines that require diversion within the Cloudbreak mine will be re-established as part of the progressive rehabilitation work.

7.5 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

7.5.1 Physical Presence of Infrastructure

Mine pits and waste landforms affect surface water flows by potentially diverting upstream flows and capturing rainfall within mining areas; reducing the catchment area for downstream flows. This can result in areas of shadowing that receive less flow than previously because surface flow processes have been interrupted or diverted. Shadowing can affect both channel flow and sheet flow processes. Mine pits and waste landforms can also prevent water flowing downstream, causing previously dry areas to become inundated (ponding).

The impact of mine pits and waste landforms on the surface hydrology of the site has been modelled by Worley Parsons (2011). The impact has been modelled for the 16 stages of the mine, which represent periods of activity in different parts of the mine. Each stage is expected to last approximately 10 months. The relationship between stages and approximate years of mining is shown in Table 13. Prior to Stage 7 (July 2015), it is expected that mining should not occur outside the existing approved footprint.

Table 13: Development stages and approximate start and end dates

| Development Stage | Start Date | End Date |
|-------------------|----------------|----------------|
| Stage 1 | July 2010 | April 2011 |
| Stage 2 | April 2011 | February 2012 |
| Stage 3 | February 2012 | December 2012 |
| Stage 4 | December 2012 | October 2013 |
| Stage 5 | October 2013 | September 2014 |
| Stage 6 | September 2014 | July 2015 |
| Stage 7 | July 2015 | July 2016 |
| Stage 8 | July 2016 | May 2017 |
| Stages 9 and 10 | May 2017 | February 2019 |
| Stages 11 and 12 | February 2019 | October 2020 |
| Stages 13 and 14 | October 2020 | March 2023 |
| Stages 15 and 16 | March 2023 | March 2024 |
| Post-closure | March 2024 on | |

Water Management within Mining Areas

During operation, the mine pits and waste landforms are designed to drain internally (except in major flood events) and act as closed catchments which do not pass runoff onto downstream areas. Rainfall onto pit areas is generally managed through the dewatering infrastructure and diverted via sumps into settlement or transfer ponds, before injection into the groundwater system.

Rainfall onto waste landforms infiltrates due to the waste landform design. The top of waste landforms are typically finished off as a level surface and surrounded by windrows to capture surface runoff. Some waste material is placed in unlevelled piles, creating an uneven surface. For paddock dumped waste, water is generally absorbed into the uneven and uncompacted surface material. In both cases, little or no surface runoff occurs from the waste landforms, particularly during low flow events. In larger flow events, pits and waste landforms may absorb water and act as blockages to flow, causing upstream ponding and downstream water shadows to form (Worley Parsons 2011).

Mine areas are designed to be internally draining during operation to minimise potential impacts to water quality downstream from turbidity and potential contamination. However, the effect of this is to effectively remove the mine area from the catchment area of the downstream creek lines and sheet flow areas. This effect persists after mining as waste landforms continue to have higher infiltration rates than the original landform.

Water Diversion

Runoff from upstream is diverted around the waste landforms and mine pits. However, all surface water diversions will still flow into the Fortescue Marsh. Any diversion increases the risk of erosion and sedimentation through concentrating flows and increasing flow velocity. This risk is taken into account when designing diversion structures. In areas where sheet flow occurs, there is a risk that the diversions will shadow some areas from the flow and increase flows to others changing the surface water hydrology and potentially the vegetation.

Impacts of the development due to the processes described above have been assessed based on the proposed engineering approach that incorporates the following steps to minimise impacts:

- installation of perimeter drains around the outside of pits and waste landforms to divert flows around pits and waste landforms
- installation of engineering culverts or floodways where required on haul roads and access roads
- burying of pipelines beneath major creek lines
- provision of rock aprons at the outlet of perimeter drains, culverts and floodways, to disperse flows and reduce erosion.

Infrastructure such as haul roads, pipelines, buildings, waste dumps, and tailings facilities will be placed in the drainage shadows created by the mine pits, where viable to do so, in order to minimise the overall impact of reduced sheet flow.

Changes to Surface Water Flow Volumes

The main receiving water bodies downstream of the Proposal are major creek lines and yintas in smaller rainfall events and the broader Fortescue Marsh in larger flood events. The catchment areas of these waterbodies may be reduced during and following mining due to:

- pit areas being internally draining during mining and not allowing surface water to overflow from the pit
- high infiltration rates in porous waste dumps resulting in surface water infiltrating rather than flowing.

Water that infiltrates rather than forming runoff will enter the groundwater system within the marsh catchment.

Reductions in catchment area are not expected to have a significant impact on the water balance of the marsh. As the Proposal area is completely within the catchment area of the marsh, flow diversions will still flow into the marsh and the potential impact is limited to the increased infiltration in the mine areas. The Proposal will result in an estimated maximum of 16.5 km² (16 500 ha) of catchment reduction (mine footprint) in Stage 12, and 10.9 km² (10 900 ha) in the post-closure scenario (Appendix F). This is not considered to be significant, as this is less than 0.1% of the total catchment area (26 000 km² or 2 600 000 ha) of the marsh (Appendix F). The change in catchment area resulting from this Proposal is not considered to be large enough to significantly alter the volume of surface water entering the marsh.

There will be some reduction in catchment areas for the yintas and the major creek lines that supply them. Yinta 1, with a catchment area of 57 700 ha, has an estimated maximum catchment reduction of 410 ha or 7% in Stage 8 and 140 ha or 2% in the post-closure scenario (Appendix F). Yinta 2, with a catchment area of 63 400 ha, has an estimated maximum catchment reduction of 1900 ha or 3% in Stage 5 and 40 ha or 0.6% in the post-closure scenario (Appendix F). Protection of the yintas is a key consideration for mine planning and therefore, the major creek lines that flow into these systems will be diverted in the mine area but flow will be directed back into the same creek line at the southern end of the mine area; thus protecting the yintas from a potential further loss in catchment area. As the short term reduction during mining is less than 10% and the long term reduction post-closure is 2% or less for the yintas, there is not expected to be any significant long term effect on the water inflows to the yintas.

Impacts on Channel Flow and Erosion

Erosion generally occurs in larger flood events, when velocities are higher. Erosion occurs under natural flooding regimes, however, the disturbance to landform associated with mining increases this risk. To investigate this risk, the areas impacted by the 1 in 100 year flood event⁸ were modelled for the pre-mining and post-closure scenarios as well as during the mining period, to look at where flows would be constrained by infrastructure and where there are predicted to be changes in the areas inundated (Worley Parsons 2011). Results of the modelling can be found in Appendix G. Locations of creek lines and catchments are shown in Figure 41.

Mining alters the areas inundated in large flood events by shadow effects and through infrastructure constraining the areas subject to flooding and causing expansion of flooding in another direction and increased depth and velocity of flows. Inundation can also occur if flows are blocked and ponding occurs behind infrastructure.

Flow Velocities and Erosion

The estimated cross sectional velocities for 1 in 2 year and 1 in 100 year floods were modelled at selected sections of each creek line and compared to pre-development conditions by Worley Parsons (Appendix G).

For the 100 year ARI flood, the model typically showed an increase in flow velocity because pits and dumps encroach on the floodplains, reducing the overall flow path width resulting in a velocity increase. The biggest impacts were shown in Stages 10 and 11 (approximately 2018 to 2020) where velocities doubled in two catchments (Worley Parsons 2011). The remaining Stages have similar impacts with increases in flows in later years. Post-development velocities in the 1 in 100 year event are generally similar to pre-development velocities, with variations usually less than 20%, but up to 45% (Worley Parsons 2011).

For the 2 year ARI flood, the estimated impact was often a decrease in velocity (Worley Parsons 2011). This is considered to be the result of flows being pushed out of the main channels, into the flatter floodplain area where high velocities cannot be achieved due to surface roughness (Worley Parsons 2011).

Some erosion would generally be expected to occur in 1 in 2 and 1 in 100 year events in the Pilbara area because of the lack of stabilising vegetation and high flow velocities in channels in major events. This is shown by the high turbidity of surface flows. The post development changes in velocity in the 1 in 2 and 1 in 100 year events are generally localised and are considered unlikely to cause significant increases in erosion. However, greater than normal erosion may occur during events greater than the 1 in 2 year event if these occur between the beginning of 2018 and mid 2024.

⁸ The largest flood event expected in a 100 year period.

Areas subject to inundation

Prior to the proposed mining, approximately 7.5 ha are estimated to be inundated in the 1 in 2 year event (Appendix G) (Worley Parsons 2011). This increases to a maximum of 8.1 ha in Stages 10 and 11, with 0.7 ha of formerly dry areas becoming wet and 0.1 ha of formerly wet areas becoming dry (Worley Parsons 2011). In the post-closure scenario, approximately 7.1 ha is inundated in the 1 in 2 year event, with 7 ha of this being inundated prior to mining, 0.5 ha of formerly dry areas becoming wet and less than 0.1 ha of formerly wet areas becoming dry (Worley Parsons 2011). As the areas involved are small, these changes are not considered to be a significant impact.

Prior to mining, the total area subject to inundation in the 1 in 100 year flood event due to channel flow was estimated at 2300 ha predominantly adjacent to major creek lines to the north of the flatter sheet flow areas (Figure 42) (Worley Parsons 2011). Prior to Stage 7, the mine footprint will be within the existing approved disturbance areas and there is a limited change in the area of inundation, with approximately 7 ha of area formerly inundated in the 1 in 100 year flood event being cut off (Figure 43) (Worley Parsons 2011). From Stage 10 (approximately mid-2018) onwards, the impacts vary with typically around 250 to 300 ha of previously inundated areas becoming dry and up to 80 ha of previously dry areas becoming inundated (Figure 44, Figure 45). The long term impact of the waste landforms is seen in the post-closure stage when 170 ha of formerly inundated areas become dry and around 45 ha of previously dry areas become inundated (Figure 46) (Worley Parsons 2011). It is noted that the majority of this effect occurs within the proposed disturbance footprint.

All buildings and processing infrastructure will be kept out of the 1 in 100 year flood zone or will be appropriately bunded to minimise flood risks. Chemicals and hydrocarbons will not be stored in the 1 in 100 year flood zone.

Impacts on Sheet Flow

The impact of the presence of mine pits and waste landforms on sheet flow areas in the 1 in 100 year flood event was mapped for each stage of the Proposal. This includes mapping of areas of potential ponding and shadowing, as described on page 79.

For the first seven stages (approximately six years), the mined area is predominantly within the approved project area, and therefore the impact is the same as for the approved project. The majority of the additional impacts take place after Stage 5, when most new pits are outside the existing approved disturbance area (Figure 47). Between Stages 5 and 12 (Year 3 and Year 10), approximately 300 to 400 ha of shadowing occurs outside the approved footprint (Figure 48) (Worley Parsons 2011). Up to 130 ha of area outside the approved footprint becomes susceptible to ponding during Stages 9 to 11, with ponding less than 40 ha for the rest of the project life. Stage 14 shows the maximum extent of shadowing, with 800 ha being shadowed outside the approved footprint and 65 ha subject to ponding outside the approved disturbance area (Figure 49) (Worley Parsons 2011). The majority of these changes will occur within the total mine clearing footprint.

Following closure, a total of 300 ha outside the approved footprint is expected to be impacted by shadowing and 20 ha subject to ponding (Figure 50) (Worley Parsons 2011).

The potential effect of this shadowing on vegetation is addressed in Section 8.5.3.

Table 14: Sheet Flow Area outside the Approved Footprint Impacted by Shadowing and Susceptible to Ponding in the 1 in 100 year event

| Development Stage | Estimated Shadow Zone (ha) | Estimated Area Susceptible to Ponding (ha) |
|-------------------|----------------------------|--|
| Stage 1 | 0 | 0 |
| Stage 2 | 20 | 2 |
| Stage 3 | 148 | 2 |
| Stage 4 | 250 | 6 |
| Stage 5 | 293 | 6 |
| Stage 6 | 257 | 6 |
| Stage 7 | 298 | 8 |
| Stage 8 | 254 | 38 |
| Stage 10 | 337 | 130 |
| Stage 12 | 400 | 38 |
| Stage 14 | 797 | 65 |
| Stage 16 | 394 | 32 |
| Post-Closure | 298 | 20 |

The above impact assessment does not include the potential impact on sheet flow of linear infrastructure such as roads and pipelines on sheet flow. The injection infrastructure extends beyond the mine footprint to the east and west and therefore has an additional potential impact on surface water flows. The impact of linear infrastructure on sheet flow will be minimised by constructing minor roads (e.g. pipeline access roads) at or near the natural surface elevation to minimise surface flow interruption. Surface flows will be allowed to flow over the minor roads in preference to the construction of culverts that would artificially concentrate flows.

An estimated additional 108 km of pipeline will be required for this Proposal with the majority of this infrastructure installed east-west, perpendicular to surface water flows. As the pipelines are temporary and will be moved during mining and removed at closure, the pipelines are laid on the ground surface (Plate 5). This method has the potential to interrupt surface water flows, so the pipelines will either be buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding.



Plate 5: Dewatering injection pipelines

7.5.2 Water Quality Impacts from Mine Infrastructure

The project has considered water quality risks associated with:

- sedimentation
- nutrients
- heavy metals and metalloids
- waste water and discharge
- pesticides
- hydrocarbon contaminants.

As the expansion of the mine will not result in a long-term increase in workforce numbers, a change in waste water production and disposal is not expected due to this Proposal.

Nutrients and pesticides are considered unlikely to be a risk in the context of the mine as fertilisers and pesticides will not be used at the mine site, and wastewater production will not increase as a result of the Proposal.

Hydrocarbon contamination is considered to be a minor issue, and will be managed through bunding of hydrocarbon storage and workshop areas, and treatment of stormwater from this area prior to release. This issue is further discussed in Section 7.5.5 and Appendix A. As nutrient and hydrocarbon contamination of waters are considered unlikely to occur, it is unlikely that the Proposal will reduce dissolved oxygen concentrations in receiving waters due to pollution or algal blooms resulting from increased nutrient concentrations.

The only potential source of heavy metals and metalloids to surface water or groundwater in the area is potential leaching due to Acid Mine Drainage. Acid Mine Drainage and the potential for metalloid contamination of drainage is discussed in Section 6.5.5. It is considered that there is a very low risk of either Acid Mine Drainage or metalloid contamination occurring at Cloudbreak.

Turbidity and Sedimentation

Waste landforms are formed from loose overburden and other waste material that is not suitable for ore processing. The waste material is unconsolidated and in low rainfall events creates little runoff due to high infiltration rates. In high rainfall events the unconsolidated material is susceptible to erosion which in turn affects the water quality of downstream flows and potentially leads to sedimentation.

The potential for erosion from waste landforms is mitigated through:

- containing all waste landforms within windrows which will absorb and prevent runoff downstream
- use of perimeter drains designed to minimise erosion to divert upstream flows away from the waste landforms
- flattening the top of waste landforms to encourage infiltration and minimise runoff
- installing berms to minimise channel flow off waste landforms
- stabilising and rehabilitating waste landforms as soon as they are complete.

Water quality currently entering the Fortescue Marsh is generally highly turbid (SEWPAC 2010a). High turbidity and sediment loads are common in runoff in the Fortescue Valley due to the silty nature of the floodplain soils, paucity of vegetation and intensity of rainfall associated with tropical thunderstorms and cyclonic events. It is consequently expected that the Proposal will not impact on water turbidity entering the marsh. Progressive closure will aim to recreate the same level of soil stability as was the case prior to mining, and therefore no long term change to erosion risk is expected.

It is considered that the project will not significantly impact on the values of surface water in terms of water quality in Fortescue Marsh for environmental or stock watering purposes.

7.5.3 Potential Impacts due to Injection of Excess Dewatering Water

If the quantity of water being injected is greater than the aquifer can manage, waterlogging and the potential creation of new surface flow paths and erosion may result. If the water is saline, this may also cause surface salinity. Surface expressions of injected dewater are not expected. Each injection bore will be monitored and managed so that water levels are not brought above the surface. Each bore will be controlled by telemetry to automatically monitor water levels and avoid exceeding pre-determined criteria. Bores are also regularly monitored manually. Injection is managed so that saline water is injected into the deeper aquifer to minimise the risk of salinisation of the shallow aquifer. As a result of this management system, it is not expected that surface water expression of injected water will occur.

The dewatering and injection system is further addressed in Section 6.5, which discusses groundwater management.

7.5.4 Surface Flow as a Contingency for Dewater Injection System

Surface flow will only be used as a method of discharge for water if adequate injection capacity is not available due to a system failure or maintenance requirements. If uncontrolled, this process could lead to the creation of new flow paths and erosion. In line with the *Dewatering Discharge Contingency Procedure* (Fortescue 2009b), discharge of water will only occur at designated creek line discharge points. This procedure allows for discharge of up to 35 ML/day of fresh or brackish dewater for periods of up to 21 days under limited circumstances (Fortescue 2009b). Monitoring of water quality and turbidity is required during the process (Fortescue 2009b). The potential impact of any discharge is considered to be limited and can be managed adequately through this process.

7.5.5 Potential Impacts due to Chemical Storage

The storage of chemicals, including hydrocarbons, and their use has the inherent potential for leaks or spills to occur and affect surface water quality. The spill prevention and response measures that will be implemented to minimise the risk of chemical spills and leaks is outlined in the EMP (Appendix A).

7.5.6 Potential Impacts due to Clearing and Earthworks

Clearing and disturbance for water conveyance infrastructure may lead to erosion of exposed soils, which may in turn lead to deterioration in water quality from increased turbidity. This risk is potentially greatest where clearing and earthworks occur on steep slopes with erosive soils. The Proposal area is gently undulating, and soils are generally stony so the likelihood of significant impacts to surface water quality from this aspect is considered to be low. Management measures will be undertaken to limit clearing in erosion prone areas and rehabilitation will occur progressively throughout the Proposal area.

7.6 CUMULATIVE IMPACTS

The main cumulative effect of mining in the Fortescue Marsh catchment in terms of surface water is the potential reduction of runoff into the marsh.

The predicted extent of changes to surface water catchments from the Proposal has been examined in the context of predictions regarding the neighbouring Fortescue Christmas Creek operation as well as the following projects, where predicted changes in catchment areas or discharges are publicly available through environmental approvals documents:

- Roy Hill (proponent, Hancock Prospecting, located east of Christmas Creek)
- Marillana (proponent Brockman Resources, located on the southern side of the Fortescue Marsh).

All four mines are within the catchment of Fortescue Marsh. Marillana is further from the marsh than the other mines, but is within the catchment of Weeli Wolli Creek, that flows into the Marsh (EPA 2005).

In terms of total catchment area reduction, the maximum area of disturbance at Cloudbreak is estimated at 18 100 ha. The respective losses of catchment for mine voids and waste landforms for the other mines are:

- Christmas Creek – 10 100 ha (Fortescue 2010a)
- Roy Hill – 12 000 ha (Environ 2009)
- Marillana – 3100 ha (EPA 2005).

The total area of catchment lost is therefore estimated at 43 300 ha, or approximately 2% of the total marsh catchment area. This is not considered to be a significant proportion of the total catchment area and is not expected to have a significant impact on water inflows to the marsh.

The northern boundary of the marsh is approximately 100 km long. Creek lines in this area provide water for yintas and other small water bodies along the boundary of the marsh. The length of the area to be mined at Cloudbreak parallel to the marsh is approximately 40 km. This is an addition to a parallel length of 15 km for Christmas Creek (Fortescue 2010a) and approximately 20 km for Roy Hill along the northern and eastern boundary (Environ 2009). While these mines are at least 1 km from the marsh, this means that flows through approximately 75 km or three quarters of the northern boundary of the marsh flow through mine areas. There is no cumulative effect on any yinta or creek line as each has its own catchment that is only affected by a single mine. However, the extent of mining may have a small cumulative effect on the water quality and quantity of inflows into the northern areas of the marsh. This potential for cumulative impacts will be mitigated in the Cloudbreak mine through ensuring that surface water flows are not unnecessarily diverted and that catchment boundaries and water quality are preserved during and following mining.

7.7 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

Fortescue has previously prepared a management plan for surface water management at Cloudbreak (Fortescue 2010b). The management of surface water at Cloudbreak is based on the principle of maintaining flows and water quality between the Chichester Range and the Fortescue Marsh along the current major flow paths. Modifications to major flow paths will be required for periods of up to a few years to allow for mining, but flow paths will be predominantly reinstated in the long term.

Management of potential impacts on surface water from this Proposal are also addressed in Surface Water Management Plan in the EMP (Appendix A) and includes the following key management actions:

- 1) Divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible.
- 1) Separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release into injection.
- 2) Minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion and berms and perimeter drains to prevent stormwater entering waste landform areas.
- 3) Locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation.
- 4) Ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding.
- 5) Disposal of water via surface water flow paths will only occur during emergencies and when maintenance is required.

- 6) Ensure that chemical storage is undertaken in a manner that limits potential surface water contamination.
- 7) Manage clearing and earthworks to minimise erosion.
- 8) At closure, the twelve major creek lines defined by Worley Parsons (2011) will be re-established in their original alignments and rehabilitated.

7.8 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

Through the mitigation measures outlined above and described in detail described in Appendix A, the Proposal and the approved project are expected to result in the following outcomes in relation to surface water:

- 1) No significant impact on water quality and quantity of water entering Fortescue Marsh.
- 2) Increases in velocity of peak flows in major creek lines during the later stages of mining, with velocities generally returning to close to the pre-development values following closure.
- 3) A post-closure effect of 170 ha of areas formerly inundated in the 1 in 100 year event may become dry and around 45 ha of previously dry areas become inundated (Figure 46) (Worley Parsons 2011). The change in the areas inundated in the 1 in 2 year event is less than 1 ha.
- 4) A post-closure effect of 300 ha of sheet flow area outside the approved footprint may be affected by shadowing and 20 ha subject to ponding.
- 5) Temporary decrease of up to 7% in catchment areas for the yintas and long term post-closure reduction of 2% or less.
- 6) All surface flow from potentially contaminated areas contained.
- 7) Possible increase in turbidity during high flow events, although flows in the area are already highly turbid.
- 8) At closure, the twelve major drainage lines defined by Worley Parsons (2011) will be re-established as close as practicable to their original alignments and levels and rehabilitated.

These impacts are considered to be acceptable as the key environmental values surrounding the Proposal will not be significantly affected. The key mitigation measure is the progressive stabilisation and rehabilitation of final landforms, including the re-establishment of the major drainage lines at closure. More information on closure management is provided in Section 13. It is expected that the EPA objective for this factor will be met.

8. VEGETATION AND FLORA IMPACT ASSESSMENT

8.1 RELEVANT ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

8.1.1 EPA Objective for Vegetation and Flora

The EPA applies the following objective to the assessment of proposals that may affect vegetation and flora:

- To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

8.1.2 Policies and Guidances

National Strategy for Conservation of Australian Biodiversity

The State and Australian Governments have endorsed the National Strategy for Conservation of Australian Biodiversity and the National Strategy for Ecologically Sustainable Development that protects biodiversity. The strategies address the conservation of Australia's biological diversity by defining guiding principles.

National Strategy for the Conservation of Australia's Biological Diversity

The principles of this Strategy are:

- biological diversity is best conserved in situ
- although all levels of government have clear responsibility, the cooperation of conservation groups, resource users, indigenous peoples, and the community in general is critical to the conservation of biological diversity
- it is vital to anticipate, prevent and attack at source the causes of significant reduction or loss of biological diversity
- processes for, and decisions about, the allocation and use of Australia's resources should be efficient, equitable and transparent
- lack of full knowledge should not be an excuse for postponing action to conserve biological diversity
- the conservation of Australia's biological diversity is affected by international activities and requires actions extending beyond Australia's national jurisdiction
- Australians operating beyond our national jurisdiction should respect the principles of conservation and ecologically sustainable use of biological diversity and act in accordance with any relevant national or international laws

- central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems
- the close, traditional association of Australia's indigenous peoples with components of biological diversity should be recognised, as should the desirability of sharing equitably benefits arising from the innovative use of traditional knowledge of biological diversity.

National Strategy for Ecologically Sustainable Development

The principles of this Strategy are:

- decision-making processes should effectively integrate both short-term and long-term economic, environmental, social and equity considerations
- where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- the global dimension of environmental impacts of actions and policies should be recognised and considered
- the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised
- the need to maintain and enhance international competitiveness in an environmentally-sound manner should be recognised
- cost-effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms
- decisions and actions should provide for broad community involvement on issues which affect them.

EPA Position Statement No. 2

EPA Position Statement No. 2, "*Environmental Protection of Native Vegetation in Western Australia*" (EPA 2000), provides an overview of the EPA position on the clearing of native vegetation in Western Australia. Principles and related objectives and actions have been adopted from the above mentioned national strategies in the formation of this Position Statement. In assessing a proposal, the EPA consideration of biological diversity will include the following basic elements:

- comparison of development scenarios or options of biodiversity at the species and ecosystems level
- no known species of plant or animal is caused to become extinct as a consequence of the development and the risks to threatened species are considered to be acceptable

- no association or community of indigenous plants or animals ceases to exist as a result of the proposal
- there is a comprehensive, adequate and secure representation of scarce or endangered habitats within the project area and/or in areas which are biologically comparable to the project area, protected in secure reserves
- if the project is large (in the order of 10 ha – 100 ha or more, depending on where in the State) the project area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity are secure and protected
- the on-site and off-site impacts of the project are identified and the proponent demonstrates that these impacts can be managed.

EPA Position Statement No. 3

EPA Position Statement No. 3, “*Terrestrial Biological Surveys as an Element of Biodiversity Protection*” (EPA 2002b), discusses the principles which the EPA would apply when assessing proposals which may affect biodiversity values in Western Australia. The outcomes sought by this Position Statement are intended to:

- promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and therefore the need to develop and implement best-practice in terrestrial biological surveys
- enable greater certainty for proponents in the EIA process by defining the principles the EPA will use when assessing proposals which may impact on biodiversity values.

EPA Guidance Statement No. 51

EPA Guidance Statement No. 51, “*Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*” (EPA 2004c), provides guidance on standards and protocols for terrestrial flora and vegetation surveys, particularly those undertaken for the environmental impact assessment of proposals.

Significance of Vegetation

Vegetation is considered significant by the EPA (2008) for a range of reasons including:

- scarcity
- unusual species
- novel combination of species
- a role as a refuge
- a role as a key habitat for threatened species, or large populations representing a significant proportion of the local or regional total population of a species

- being representative of the range of a unit
- a restricted distribution.

Threatened Ecological Communities (TECs), as listed by DEC and under the EPBC Act are of high significance.

In addition, DEC maintains a list of Priority Ecological Communities (PECs) which identifies those communities that need further investigation before possible nomination for TEC status.

Significant Flora

The preservation and conservation of flora is covered primarily by the following statutes:

- *Wildlife Conservation Act 1950* (WC Act)
- *Conservation and Land Management Act 1984*
- *Environmental Protection Act 1986* (EP Act)
- *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government) (EPBC Act).

The WC Act protects all native flora in Western Australia. Flora considered to be rare are gazetted as Declared Rare Flora (DRF) under Section 23F of the WC Act. Under the WC Act it is illegal to remove or damage DRF without approval. DRF are specifically scheduled for protection under the WC Act and are species that have been adequately searched for, and are deemed to be either rare, in danger of extinction, or otherwise in need of special protection.

Priority species are those listed by DEC as potentially threatened but for which there is insufficient evidence to properly evaluate their conservation significance. They range from Priority 1 to Priority 4 species, and are as follows:

- **Priority 1:** Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat
- **Priority 2:** Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat
- **Priority 3:** Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat
- **Priority 4:** Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Note that of the above classifications, only DRF has statutory standing. The Priority flora classifications are employed by the DEC to manage and classify their database of species considered potentially to be at risk, but these categories have no legislative status for protection in addition to the native vegetation clearing legislation.

Species may also be protected as Matters of NES under the EPBC Act.

8.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the Proposal may affect vegetation and flora values:

- **vegetation clearing** for mine pits, waste dumps, tailings facilities, infrastructure corridors, product stockpiles and processing facilities will lead to the direct disturbance of vegetation communities and may potentially affect Priority flora species
- **dewatering** of mine pits will lower watertables and potentially stress or cause death of groundwater-dependent vegetation communities
- **injection of excess groundwater** may result in groundwater mounding and potentially stress or kill vegetation communities due to waterlogging and/or salt accumulation in the vegetation root zone
- **disruption of surface hydrology** may affect vegetation communities that rely on surface water flows.

Potential impacts from dust emissions, spread of weeds through vehicle movement and earthworks, and fire risk are not expected to be any greater than that already assessed for the approved Cloudbreak Mine, hence are not addressed further in this document. These aspects are currently managed under the existing Operation Environmental Management Plan (Fortescue 2008).

8.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

8.3.1 Studies Undertaken

Collectively, four floristic assessments have been conducted within and surrounding the Proposal area between 2004 and 2007. All the studies were undertaken in accordance with the methodology and approaches of EPA Position Statement No. 3 (EPA 2002a) and EPA Guidance Statement No. 51 (EPA 2004c). The studies are:

- Biota 2004, Fortescue Metals Group Stage B Rail Corridor, Christmas Creek, Mt Lewin, Mt Nicholas and Mindy Mindy Mine Areas, Prepared for Fortescue Metals Group Ltd, December 2004
- Matiske Consulting Pty Ltd (Matiske) 2005a, Flora and Vegetation on the Cloudbreak and White Knight Leases, Prepared for Fortescue Metals Group Ltd, June 2005
- Matiske 2005b, Review of Vegetation Condition on the Cloudbreak Lease Area, Prepared for Fortescue Metals Group Ltd, June 2005
- Matiske 2007, Flora and Vegetation near Fortescue Marsh, Prepared for Fortescue Metals Group Ltd, June 2007.

In addition, ENV (2011) undertook a flora and vegetation assessment of the Cloudbreak iron ore mine area, which consolidated information from previous surveys along with additional field survey work to verify and expand previous vegetation mapping. Approximately 1200 ha of the 150 000 ha of vegetation mapping was not assessed during the field survey and was extrapolated from the adjacent vegetation mapping based on aerial photograph interpretation. The ENV (2011) survey was undertaken in accordance with the methodology and approaches of EPA Position Statement No. 3 (EPA 2002b) and EPA Guidance Statement No. 51 (EPA 2004c) as much as practicable given seasonal conditions and logistical constraints. The full ENV (2011) report is included in Appendix B.

8.3.2 Vegetation

Beard (1975) Vegetation Mapping

The Proposal area is located in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia (Beard 1975). Beard (1975) broadly mapped the Proposal area as four vegetation associations (Table 15).

Table 15: Vegetation Associations in the Proposal Area as Mapped by Beard (1975)

| Beard code | Association (Shepherd <i>et al</i> 2002) | Vegetation description |
|-------------------|--|--|
| a1Lp | 29 | Sparse Low Mulga Woodland, discontinuous in scattered groups. |
| e16Lr.t3Hi / a1Li | 562 | Mosaic of low Mulga woodland in valleys, and open low Snappy Gum tree steppe and Hummock grasslands of Limestone Spinifex. |
| K3Ci | 676 | Succulent steppe, Samphire. |
| a2Sr t1,3Hi | 173 | Hummock grasslands, shrub steppe; Kanji over Soft Spinifex & Limestone Spinifex on basalt. |

Vegetation Communities

Mapping of vegetation communities of the Proposal and wider area have been completed for Fortescue by Biota (2004), Mattiske (2205a, 2007) and ENV (2011) over a total of approximately 150 000 ha of vegetation. Vegetation descriptions have been based on structure and species composition, as defined by quadrat (50 m square) and relevé (undefined area) data, and field observations.

Thirty-five vegetation communities have been mapped in the Cloudbreak, Christmas Creek and wider area (Biota 2004, 2005a, 2007, ENV 2011). Of these, 21 vegetation communities have been mapped in the Cloudbreak Survey Area (Table 16; Figure 51 to Figure 53).

Table 16: Vegetation Communities within the Cloudbreak Survey Area

| Vegetation Community | Description |
|---|--|
| Creek line and drainage lines – Coolibah and River Red Gum dominated | |
| 1 | Open Woodland of <i>Eucalyptus victrix</i> , <i>E. camaldulensis</i> with pockets of <i>Acacia coriacea</i> subsp. <i>pendens</i> over <i>Grevillea wickhamii</i> subsp. <i>aprica</i> , <i>Petalostylis labicheoides</i> and <i>A. tumida</i> over <i>Triodia longiceps</i> , <i>Chrysopogon fallax</i> , <i>Themeda triandra</i> and <i>Aristida</i> species. |
| Creek line and drainage lines – Mulga dominated | |
| 2 | Low Woodland to Low Open Forest of <i>Acacia aneura</i> var. <i>aneura</i> , <i>A. citrinoviridis</i> , <i>A. pruinocarpa</i> over <i>A. tetragonophylla</i> and <i>Psyrax latifolia</i> over <i>Chrysopogon fallax</i> , <i>Stemodia viscosa</i> , <i>Blumea tenella</i> , <i>Themeda triandra</i> and species of <i>Triodia</i> and <i>Aristida</i> . |
| Creek line and drainage lines – other <i>Acacia</i> dominated | |
| 8 | Closed Scrub to Tall Shrubland of <i>Acacia pruinocarpa</i> , <i>A. tumida</i> , <i>A. ancistrocarpa</i> , <i>A. maitlandii</i> , <i>A. kempeana</i> , <i>A. tetragonophylla</i> with occasional <i>Eucalyptus gamophylla</i> and <i>Corymbia deserticola</i> over <i>Triodia epactia</i> , <i>Themeda triandra</i> and <i>Aristida</i> species. |
| 9 | Closed Scrub to Shrubland of <i>Acacia ancistrocarpa</i> , <i>A. maitlandii</i> , <i>A. kempeana</i> , <i>A. monticola</i> with occasional <i>Eucalyptus gamophylla</i> and <i>Corymbia deserticola</i> over <i>Senna</i> species, <i>Triodia basedowii</i> and <i>Aristida</i> species. |
| Flats and broad plains containing Mulga | |
| 3 | Low Woodland to Low Open Forest of <i>Acacia aneura</i> var. <i>aneura</i> , <i>A. pruinocarpa</i> , <i>A. tetragonophylla</i> , <i>A. tenuissima</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i> , <i>Psyrax latifolia</i> over <i>Dodonaea petiolaris</i> and species of <i>Triodia</i> and <i>Aristida</i> . |
| 4 | Low Open Woodland of <i>Acacia aneura</i> var. <i>aneura</i> , <i>A. pruinocarpa</i> , <i>A. xiphophylla</i> , <i>A. victoriae</i> over <i>A. tetragonophylla</i> , <i>Psyrax latifolia</i> and <i>Psyrax suaveolens</i> over <i>Ptilotus obovatus</i> and species of <i>Maireana</i> and <i>Sclerolaena</i> . |
| 10 | Low Open Woodland of <i>Acacia xiphophylla</i> , <i>Acacia victoriae</i> , <i>Acacia aneura</i> var. <i>aneura</i> over <i>Acacia tetragonophylla</i> , <i>Ptilotus obovatus</i> , <i>Senna</i> species and species of <i>Maireana</i> and <i>Sclerolaena</i> . |
| Flats and broad plains without Mulga | |
| 15 | Low Open Woodland of <i>Acacia victoriae</i> , <i>A. xiphophylla</i> over <i>Ptilotus obovatus</i> , <i>Senna</i> species and species of <i>Maireana</i> and <i>Sclerolaena</i> . |
| Ranges, hills and hillslopes | |
| 7 | Hummock Grassland of <i>Triodia basedowii</i> with emergent patches of <i>Eucalyptus gamophylla</i> , <i>E. leucophloia</i> , <i>Corymbia deserticola</i> over <i>Acacia ancistrocarpa</i> , <i>A. sclerosperma</i> subsp. <i>sclerosperma</i> , <i>A. kempeana</i> , <i>A. arida</i> , <i>Grevillea berryana</i> , <i>G. wickhamii</i> subsp. <i>aprica</i> , <i>Calytrix carinata</i> over <i>Goodenia stobbsiana</i> and mixed Poaceae species. |
| 16 | Hummock Grassland of <i>Triodia basedowii</i> with pockets of <i>Triodia epactia</i> and <i>T. lanigera</i> with emergent patches of <i>Eucalyptus leucophloia</i> , <i>Corymbia deserticola</i> over <i>Acacia ancistrocarpa</i> , <i>A. hilliana</i> , <i>A. acradenia</i> , <i>A. pyriformis</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> over <i>Goodenia stobbsiana</i> and mixed <i>Senna</i> species. |
| 17 | Hummock Grassland of <i>Triodia basedowii</i> with areas of <i>T. epactia</i> and <i>T. lanigera</i> with emergent patches of <i>Eucalyptus leucophloia</i> , <i>Corymbia deserticola</i> over <i>Acacia ancistrocarpa</i> , <i>A. pyriformis</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> over <i>Goodenia stobbsiana</i> and mixed <i>Senna</i> and <i>Ptilotus</i> species. |
| 18 | Hummock Grassland of <i>Triodia angusta</i> with emergent patches of <i>Eucalyptus leucophloia</i> over <i>Acacia ancistrocarpa</i> , <i>A. pyriformis</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> over <i>Goodenia stobbsiana</i> and mixed <i>Senna</i> and <i>Ptilotus</i> species. |
| Fringes of Samphire flats containing Samphire | |
| 12 | Low Halophytic Shrubland of <i>Tecticornia auriculata</i> and <i>T. indica</i> subsp. <i>leiostachya</i> with associated <i>Maireana</i> species and <i>Atriplex flabelliformis</i> with <i>Muehlenbeckia florulenta</i> with patches of <i>Acacia victoriae</i> and <i>A. sclerosperma</i> subsp. <i>sclerosperma</i> . |
| 13 | Low Halophytic Shrubland of <i>Tecticornia auriculata</i> , <i>T. indica</i> subsp. <i>leiostachya</i> , <i>T. halocnemoides</i> subsp. <i>tenuis</i> with patches of <i>Frankenia</i> species. |
| 22 | Low Shrubland of <i>Tecticornia indica</i> subsp. <i>bidens</i> and <i>Nicotiana occidentalis</i> over grasses with occasional stands of <i>Sesbania cannabina</i> and <i>Cullen cinereum</i> . |

| Vegetation Community | Description |
|---|---|
| 25 | Low Shrubland of <i>Tecticornia auriculata</i> , <i>T. indica</i> subsp. <i>bidens</i> and <i>Frankenia ambita</i> over <i>Eragrostis dielsii</i> . |
| 26 | Low Shrubland of <i>Muellerolimon salicorniaceum</i> and <i>Tecticornia indica</i> subsp. <i>bidens</i> . |
| Fringes of Samphire flats without Samphire | |
| 11 | Hummock Grassland of <i>Triodia angusta</i> with patches of <i>Acacia victoriae</i> , <i>A. aneura</i> var. <i>aneura</i> , <i>A. xiphophylla</i> over <i>Atriplex codonocarpa</i> , <i>Eremophila cuneifolia</i> and mixed Chenopodiaceae species. |
| 14 | Hummock Grassland of <i>Triodia angusta</i> with patches of <i>Acacia victoriae</i> over <i>Atriplex codonocarpa</i> and mixed Chenopodiaceae and Poaceae species. |
| 20 | Scrub of <i>Acacia sericophylla</i> over <i>Muellerolimon salicorniaceum</i> , <i>Nicotiana occidentalis</i> and <i>Mimulus gracilis</i> . |
| 27 | Low Shrubland of <i>Maireana carnososa</i> , <i>Atriplex codonocarpa</i> and <i>Sclerolaena cuneata</i> over <i>Eragrostis dielsii</i> and <i>Trianthema turgidifolia</i> . |

Vegetation Condition

The Proposal area contains the approved footprint, which currently comprises large cleared areas that have been developed for mine pits and associated mine infrastructure. Vegetation within the Proposal area is also intersected in several areas by existing roads and pipeline infrastructure associated with the existing Cloudbreak Mine.

The condition of the vegetation in the Cloudbreak Survey Area ranged from Good to Excellent, under the Trudgen (1991) vegetation condition scale (ENV 2011). The majority of the vegetation in the fringe of Samphire Flats, Creek and Drainage line and Ranges, Hills and Hill slope vegetation types was categorised as Excellent, whilst the majority of vegetation on Broad Flats and Plains was categorised as Good due to grazing pressures.

Fire age within and surrounding the Proposal area was mostly observed to be Very Old (eight to twelve years since last fire) (ENV 2011). Thus indicating fire is not a significant disturbance in the Proposal area and results of the field surveys are likely to have been more robust.

Threatened Ecological Communities and Priority Ecological Communities

No vegetation communities recorded in flora and vegetation assessments conducted in the Proposal area are representative of any TEC listed under the EPBC Act or by the DEC (2010).

The Fortescue Marsh has recently been classified as a Priority 1⁹ Priority Ecological Community (PEC) and comprises an area from east of Mulga Downs to Marillana and Roy Hill Stations. The Fortescue Marsh PEC is characterised by the presence of endemic and new to science *Eremophila* and *Tecticornia* species occurring on the fringe of the Fortescue Marsh (ENV 2011). The Fortescue Marsh is also listed on the Australian Heritage Commission Register of the National Estate as an 'Indicative Place' and as a 'Nationally Important Wetland' in the Directory of Important Wetlands in Australia (Environment Australia 2001).

The Samphire (*Tecticornia* species.) vegetation communities 13, 22, 25 and 26 that are recorded within the Fortescue Marsh are part of the PEC and are also significant due to the presence of varying endemic and new to science species including *Eremophila spongiorcarpa* (Priority 1) (Figure 51 to Figure 53). In addition, the Samphire communities are considered by Fisher *et al.* (2004) in '*Review of Total Grazing Pressure Management and Issues in Biodiversity Conservation in Rangelands*', to be unique because they are locally restricted to the marsh (ENV 2011).

The condition of Fortescue Marsh is currently under threat from grazing and trampling by cattle and other introduced fauna (Kendrick 2001).

Other Significant Vegetation Communities

Mulga

Mulga (*Acacia aneura*) is abundant in the low open woodlands and shrublands on Flats and Broad Plains within the Proposal area. Vegetation communities containing Mulga are a dominant vegetation type of semi-arid and arid Australia and occupy almost 20% (1 500 000 km²) of the Australian continent (Johnson and Burrows 1994); however, the Mulga within the Proposal area is considered significant by the DEC as it:

- is the northern extent of Mulga in Western Australia
- is highly morphologically¹⁰ variable
- appears to play an important role in water and nutrient capture and is important to ecosystem function
- supports a range of Priority flora such as *Phyllanthus aridus*, *Eremophila youngii* subsp. *lepidota*, *Goodenia nuda*
- is highly susceptible to disturbance from fire, grazing and development of infrastructure.

⁹ Priority 1: Poorly known ecological communities. Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

¹⁰ Morphologically refers to the structure and form of an organism, excluding its functions.

Mulga vegetation communities 3, 4 and 10 that have been mapped in the Proposal area and the surrounding area occur in groves, interspersed with bare, less densely vegetated (tussock grasslands) inter-grove areas. These vegetation communities comprise 74 651 ha or approximately 50% of the total area mapped within the Cloudbreak and Christmas Creek Survey Areas.

Mulga is considered to be generally shallow-rooted (likely less than 2 m depth) and to utilise water from shallow surface soils (Ecoscape 2009). Currently it is generally accepted that groved Mulga communities have a strong reliance on sheet flow to replenish soil water in the groves (ENV 2011).

Groundwater-Dependent Vegetation

Open woodlands of *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus victrix* (Coolibah) were mapped on the creek lines that occur in the Proposal area. River Red Gum and Coolibah are considered to have a partial dependence on groundwater (partially phreatophytic) to meet their physiological moisture requirements through the use of deep, aggressive root systems (Fisher *et al* 2010). River Red Gum and Coolibah vegetation (vegetation community 1) covers approximately 2367 ha (1.6%) of the Cloudbreak and Christmas Creek survey areas.

A characteristic of River Red Gum is the rapid development of an extensive, dense and deep taproot system that extends down towards zones of higher water supply. The root system of a mature River Red Gum extends at least 10 m in the horizontal direction and greater than 20 m vertically. River Red Gums can alternate between different sources of water (i.e. ground or surface water) depending on which is the most energetically favourable at the time. River Red Gum is generally (including most occurrences in the Cloudbreak area) associated with riparian systems and is typically found where the depth to groundwater varies between 1 m and 3 m (Ecoscape 2009).

Coolibah is considered a vadophyte, a species that primarily utilises water held in the vadose zone (the unsaturated zone above the watertable) and is not necessarily dependent on the watertable. Coolibah is considered tolerant to long periods without flooding or ready availability of water (Muir Environmental 1995) and has a dimorphic root system¹¹, with extensive, dense, superficial lateral roots that spread beyond the width of the canopy and one or several long tap roots (Florentine 1999; Adams *et al*. 2005).

River Red Gum and Coolibah grow in areas subject to highly varying groundwater levels, which may vary by more than 10 m due to rainfall conditions (Ecoscape 2009).

¹¹ Dimorphic root system refers to Coolibah having two types of roots: extensive dense superficial root system spreading beyond the width of the canopy and one or several tap roots, which are known not to be well developed (Adams *et al* 2005).

8.3.3 Flora

A total of 230 taxa from 47 families and 159 genera have been previously recorded during surveys of the Cloudbreak area (Biota 2004, Mattiske 2005a and 2007, ENV 2011). The plant families most frequently recorded from the surveys were Fabaceae (82 taxa), Poaceae (68 taxa) and Malvaceae (42 taxa). The most frequently recorded genera were *Acacia* (44 taxa), *Ptilotus* (14 taxa) and *Senna* and *Sida* (13 taxa).

Flora of Conservation Significance

No Threatened species pursuant to the EPBC Act were located within the Proposal area. In addition, no plant taxa gazetted as DRF pursuant to the WC Act have been located within the Proposal area (Biota 2004, Mattiske 2005a, 2007, ENV 2011).

Seven Priority Flora have been recorded within the Proposal area (Biota 2004, Mattiske 2005a, 2007, ENV 2011; Table 17; Figure 54).

Table 17: Priority Flora Recorded in Proposal Area

| Taxa | Conservation Status | Vegetation Communities Recorded |
|---|---------------------|---------------------------------|
| <i>Eremophila spongiorcarpa</i> | Priority 1 | 2, 22, 26 |
| <i>Gymnanthera cunninghamii</i> | Priority 3 | 17 |
| <i>Phyllanthus aridus</i> | Priority 3 | 1, 2, 3, 4, 8, 9, 17 |
| <i>Rostellularia adscendens</i> var. <i>latifolia</i> | Priority 3 | 4 |
| <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) | Priority 3 | 9 |
| <i>Eremophila youngii</i> subsp. <i>lepidota</i> | Priority 4 | 10, 22, 26 |
| <i>Goodenia nuda</i> | Priority 4 | 1, 2, 3, 4, 8, 9, 10, 17 |

***Eremophila spongiorcarpa* (Priority 1)**

Eremophila spongiorcarpa is a compact, succulent-leaved shrub, to 1 m with white flowers in May and September. It is known to occur on weakly saline alluvial plains on the margins of marshes. It is known from 16 records from the Western Australian Herbarium (WAH) (2010) has been recorded in five locations within or adjacent to the Proposal area in vegetation communities 2, 22, and 26.

***Gymnanthera cunninghamii* (Priority 3)**

Gymnanthera cunninghamii is an erect shrub to 2 m with cream to yellow flowers. It is known from 15 records from WAH (2010). This species has been recorded once in hummock grassland (vegetation community 17).

***Phyllanthus aridus* (Priority 3)**

Phyllanthus aridus is an erect, much-branched shrub to 0.25 m with cream to green flowers. It is known from 23 records from the WAH (2010). This species has been recorded throughout the Proposal area (60 records) in a range of vegetation communities including hummock grassland, creek and drainage lines, and flats and plains (vegetation communities 1, 2, 3, 4, 8, 9 and 17).

***Rostellularia adscendens* var. *latifolia* (Priority 3)**

Rostellularia adscendens var. *latifolia* is a prostrate shrub to 0.3 m with blue, purple and violet flowers from April to May. It is known from 12 records from the (2010). On the basis of these records it appears that this species is relatively widespread locally in a range of habitats from alluvial fringes of creek lines to rocky hillslopes (red ironstone to volcanic soils) (Matiske 2005a). This species has been recorded once in Mulga woodland on flats and plains (vegetation community 4).

***Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3)**

Themeda sp. Hamersley Station (M.E. Trudgen 11431) is a perennial grass restricted to the Pilbara Bioregion, and is found in red clay in clay pans or on grass plains. It may form tussocks or take on an herbaceous habit between 90 and 180 cm in height (Matiske 2005a). It is known from 13 records from the WAH (2010). This species has been recorded once in creek lines and drainage lines (vegetation community 9).

***Eremophila youngii* subsp. *lepidota* (Priority 4)**

Eremophila youngii subsp. *lepidota* is a dense spreading shrub to 3 m with purple, red and pink flowers from January to March and June to September. It is known from 25 records from the WAH (2010) from the Pilbara, Gascoyne and Carnarvon Bioregions. Herbarium records appear to indicate the species is associated with a range of habitats including well-drained stony sandy loam, semi-saline floodplains, mudflats and clayflats, and the following species *Acacia pruinocarpa*, *Senna artemisioides* subsp. *oligophylla*, *Hakea preissii*, and halophytes (Matiske 2005a). *E. youngii* subsp. *lepidota* has been recorded in two locations in Mulga woodland on the flats and plains, and on the fringes of the Fortescue Marsh (vegetation communities 10, 22 and 26).

***Goodenia nuda* (Priority 4)**

Goodenia nuda is an erect to ascending herb to 0.5 m with yellow flowers. It is known from 42 records from the WAH (2010). This species has been recorded throughout the Proposal area and its surrounds (66 records in survey area) in a range of vegetation communities including hummock grassland, creek and drainage lines, flats and plains (vegetation communities 1, 2, 3, 4, 8, 9, 10 and 17).

Other Priority Flora

An additional 11 species listed as Priority Flora have not been recorded within the Proposal area, but may occur in the vicinity of the Proposal area. This list is based on the DEC database search (DEC 2010c) and recent survey results from the adjoining survey area of Christmas Creek and Fortescue Marsh:

- *Eremophila pilosa* (Priority 1) (Biota 2004b)
- *Helichrysum oligochaetum* (Priority 1) (Biota 2004b)
- *Myriocephalus scalpellus* (Priority 1) (Biota 2004b)
- *Peplidium* sp. Fortescue Marsh (S. van Leeuwen 4865)(Priority 1) (DEC 2010c)
- *Nicotiana heterantha* (Priority 1) (Matiske 2007)
- *Tecticornia* sp. Christmas Creek (K.A. Shepherd & T. Colmer et al. KS 1063) (Priority1) (ENV 2011)
- *Tecticornia* sp. Fortescue Marsh (K.A. Shepherd et al. KS 1055) (Priority 1) (ENV 2011)
- *Stylidium weeliwolli* (Priority 2) (DEC 2010c)
- *Atriplex flabelliformis* (Priority 3) (ENV 2011)
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) (ENV 2011)
- *Tecticornia* sp. Roy Hill (H. Pringle 62) (Priority 3) (ENV 2011).

Nicotiana heterantha is a decumbent, short-lived annual or perennial herb, to 0.5 m high, forming low, spreading colonies. It flowers white, cream March to June or September and is found on black clay and in seasonally wet flats. *N. heterantha* was recorded during Matiske (2007) Fortescue Marsh survey outside of the Proposal area. The closest location is 1.2 km south-west of the Proposal area.

Range extensions

The following species were listed by Matiske (2005a) as range extensions:

- *Acacia aneura* var. *conifer*
- *Eremophila platycalyx* subsp. *platycalyx* (ms)
- *Fimbristylis leucocolea*
- *Frankenia irregularis*
- *Maireana luehmannii*
- *Melaleuca leiocarpa*
- *Portulaca cyclophylla*
- *Psydrax rigidula* (ms).

However, new understanding of a number of these species ecological distributions suggest that three of these species are unlikely to be range extensions, these being *Eremophila platycalyx* subsp. *platycalyx* (ms), *Maireana luehmannii* and *Portulaca cyclophylla* (pers. comm. ENV 2011). The remaining five species may represent mis-identifications; however, their taxonomic status could not be validated in the ENV (2011) survey because the original specimens were not lodged at the WAH.

No further species were considered significant by current scientific knowledge by ENV (2011).

8.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

Alternative locations to avoid or minimise impact is somewhat limited as the location of the mine is dictated by the extent of the resource. However, locations of linear infrastructure and waste landforms are flexible to some extent and avoidance of significant flora species or vegetation communities is part of the mine planning process. A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process, areas of vegetation which may comprise high value flora and vegetation may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the proposed 2015 pastoral lease exclusion zone.

The dewatering and injection system has also been designed to minimise impacts to significant vegetation within the Fortescue Marsh by minimising the propagation of drawdown or mounding into the marsh habitats (Section 6).

The Proposal is based on open cut mining due to the comparatively shallow nature of the resource. Open cut mining requires areas to be cleared in order to extract the ore and manage the waste rock or overburden. This style of mining may be undertaken in a number of ways that includes developing a large shallow open pit with large adjacent overburden stockpiles; or progressive development of the pit, where a starter pit is opened (with overburden from the starter pit placed in a smaller overburden stockpile), and the open pit is then progressively backfilled with overburden and rehabilitated as the mining face progresses. The latter method has been selected to reduce the size of the areas required for overburden storage and consequently the amount of vegetation clearing required. This method also allows progressive rehabilitation which will aim to re-establish vegetation values on the final landform.

8.5 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

8.5.1 Vegetation Clearing

Vegetation will be progressively removed from sections of the Proposal area, during construction of mining infrastructure and during mining. Up to 12 600 ha of vegetation will be disturbed for the Proposal. The total area cleared for the Cloudbreak Project (i.e. the Proposal combined with the already approved clearing) will be 18 100 ha.

The maximum disturbance amounts for each vegetation community (Table 18) have been calculated by assessing the amount of each vegetation that exists within a broad mining area (maximum mine disturbance area) of 17 000 ha and broad injection infrastructure corridors of 40 m width (actual clearing width 20 m) within which the clearing of up to 12 600 ha will occur (Figure 55). Thus Table 18 outlines the maximum amount of clearing of each vegetation community regardless of the configuration of the final footprint. The combined survey areas surrounding the Cloudbreak and Christmas Creek mines have been used to provide an indication of the local extent of each vegetation community. For the purpose of impact assessment, vegetation communities have also been grouped in accordance with their conservation significance into broad vegetation types (Table 18).

The majority of disturbance for the Proposal will occur within Mulga woodland on flats and broad plains (approximately 9000 ha occurs within the maximum mine disturbance area) and hummock grassland on ranges, hills and hill slopes (5600 ha) (Table 18, Figure 55). Both of these vegetation types occur extensively throughout the Pilbara; however, Mulga is locally significant as it is the most northern extent of this habitat type. The majority of vegetation clearing will result in less than 40% loss of each broad vegetation type locally with the exception of vegetation community 15 that will have up to 67% of its local extent removed. The vegetation community is not locally significant and is likely to be widespread throughout the region.

Vegetation of Conservation Significance

Fortescue Marsh

Up to 4 ha of Samphire vegetation associated with Fortescue Marsh (vegetation communities 12, 13, 22, 25, 26) may be cleared for installation of injection infrastructure. Approximately 31 500 ha of Samphire vegetation exists within the local area and as such clearing will only result in a maximum of 0.01% of this local extent being cleared, which is not considered to be significant.

Mulga

As Mulga woodland is the most common vegetation within the local area, clearing of this vegetation type is unavoidable. Up to 10 500 ha or 11% of Mulga vegetation mapped (includes mulga on flats and broad plains and Mulga along creeks and drainage lines) in the local area may be cleared as a result of the Proposal. However, as stated earlier Mulga is widespread throughout the Pilbara and the regional extent of Mulga is not expected to be significantly affected by the Proposal (refer to regional impacts below).

Groundwater-Dependent Vegetation

Up to 473 ha or 20% of the local extent of Coolibah and River Red Gum vegetation along creek lines and drainage lines may be directly affected by the Proposal. Clearing of this vegetation is likely to be unavoidable as it transects the Proposal area north to south in several areas (Figure 55). This impact is not expected to significantly affect the regional representation of this vegetation community as it is widespread throughout the Pilbara along creek and drainage lines.

Regional Impacts on Vegetation

The regional impacts to the Beard (1975) vegetation associations have been assessed using the extent of vegetation associations determined by Shepherd *et al* (2002) and Comprehensive Adequate Representation (CAR) remaining extent calculations maintained by the Department of Agriculture (latest update in 2010) (Table 19). It should be noted that there is likely some inaccuracy in the calculation of extent remaining as these have only been determined a scale of 1:250 000 and likely do not include all areas cleared for mining throughout the Pilbara. However, this data is the best available to determine regional impacts.

The EPA, in Position Statement 2 (EPA 2000), outlined several key criteria that should be applied to clearing of remnant vegetation, particularly in agricultural areas:

- 1) The “threshold level” below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at a level of 30% of the pre-clearing extent of the vegetation type.
- 2) A level of 10% of the original extent is regarded as being a level representing “endangered”.
- 3) Clearing which would put the threat level into the class below should be avoided.

Only one vegetation association affected by the Proposal has less than 100% pre-European extent remaining (vegetation association 29 with 95% remaining). The Proposal will result in the removal of a maximum of 0.01% of the pre-European extent of this vegetation and as such the remaining extent will not be significantly affected. Of the three other vegetation associations, only one association will be affected by more than 1% of its pre-European extent (vegetation association 562), with up to 6% of the pre-European extent being cleared. As data indicates that 100% of its pre-European extent remains, the Proposal will not compromise the vegetation association by taking it below the “threshold level” of 30% its pre-clearing extent (EPA 2000).

Table 18: Maximum Disturbance to Vegetation Communities within the Proposal Area

| Group | Total Area Mapped (ha) | Proportional Representation of Community in Area Surveyed (%) | Extent within Maximum Disturbance Area (ha) | % of Mapped Vegetation Community within Maximum Disturbance Area | Cumulative Extent with Approved Footprint (ha) | Cumulative % of Mapped Vegetation Community |
|--|------------------------|---|---|--|--|---|
| 1 Creek lines and drainage lines – Coolibah/River Red Gum dominated | 2367 | 1.6 | 473 | 20.0 | 565 | 23.9 |
| 2 Creek lines and drainage lines – Mulga dominated | 15402 | 10.3 | 1482 | 9.6 | 1993 | 12.9 |
| Creek lines and Drainage lines – other Acacia dominated | 3290 | 2.2 | 1070 | 32.5 | 1280 | 38.8 |
| 8 | 2060 | 1.4 | 425 | 20.6 | 523 | 25.4 |
| 9 | 1230 | 0.8 | 645 | 52.4 | 757 | 61.5 |
| Flats and broad plains containing Mulga | 74651 | 49.9 | 8983 | 12.0 | 12156 | 16.3 |
| 3 | 34501 | 23.1 | 4085 | 11.8 | 6585 | 19.1 |
| 4 | 21871 | 14.6 | 2304 | 10.5 | 2680 | 12.2 |
| 10 | 18279 | 12.2 | 2595 | 14.2 | 2891 | 15.8 |
| 15 Flats and broad plains without Mulga | 231 | 0.2 | 154 | 66.60 | 155 | 67.0 |
| Ranges, hills and hillslopes | 21183 | 14.2 | 5647 | 26.7 | 6313 | 28.5 |
| 7 | 1403 | 0.9 | 179 | 12.8 | 179 | 12.8 |
| 16 | 2517 | 1.7 | 1528 | 60.1 | 1675 | 66.5 |
| 17 | 17260 | 11.5 | 3940 | 22.8 | 4458 | 25.8 |
| 18 | 3 | 0.002 | 1 | 33.3 | 1 | 33.3 |
| Fringes of Samphire Flats containing Samphire | 31478 | 21.0 | 4 | 0.01 | 4 | 0.01 |
| 12 | 485 | 0.3 | 4 | 0.8 | 4 | 0.8 |
| 13 | 5837 | 3.9 | 0 | 0 | 0 | 0 |
| 22 | 7588 | 5.1 | 0 | 0 | 0 | 0 |
| 25 | 184 | 0.1 | 0 | 0 | 0 | 0 |
| 26 | 17384 | 11.6 | 0 | 0 | 0 | 0 |

| Group | Total Area Mapped (ha) | Proportional Representation of Community in Area Surveyed (%) | Extent within Maximum Disturbance Area (ha) | % of Mapped Vegetation Community within Maximum Disturbance Area | Cumulative Extent with Approved Footprint (ha) | Cumulative % of Mapped Vegetation Community |
|---|------------------------|---|---|--|--|---|
| Fringes of Samphire Flats without Samphire | 947 | 0.6 | 4 | 0.4 | 4 | 0.4 |
| 11 | 828 | 0.5 | 4 | 0.5 | 4 | 0.5 |
| 14 | 62 | 0.04 | 0 | 0 | 0 | 0 |
| 20 | 5 | 0.003 | 0 | 0 | 0 | 0 |
| 27 | 52 | 0.03 | 0 | 0 | 0 | 0 |

Table 19: Impacts on Beard (1975) Vegetation Associations (based on Shepherd *et al* [2002] and CAR [2010])

| Beard code | Association | Vegetation Description | Pre-European Extent (ha) | % Remaining | Extent within Maximum Disturbance area (ha) | % Extent of Association within Maximum Disturbance Area | Cumulative Extent with Approved Footprint (ha) | Cumulative % of Vegetation Association |
|-------------------|-------------|--|--------------------------|-------------|---|---|--|--|
| a1Lp | 29 | Sparse Low Mulga Woodland, discontinuous in scattered groups. | 7 914 567 | 100 | 11 257 | 0.10 | 15 791 | 0.20 |
| e16Lr.t3Hi / a1Li | 562 | Mosaic of low Mulga woodland in valleys, and open low Snappy gum tree steppe and Hummock grasslands of Limestone Spinifex. | 103 662 | 100 | 6424 | 6.00 | 7378 | 7.00 |
| K3Ci | 676 | Succulent steppe, Samphire. | 2 078 885 | 95 | 200 | 0.01 | 200 | 0.01 |
| a2Sr t1,3Hi | 173 | Hummock grasslands, shrub steppe; Kanji over Soft Spinifex & Limestone Spinifex on basalt. | 1 755 315 | 100 | 7 | 0.00 | 7 | 0.00 |

Impacts to Flora of Conservation Significance

No DRF will be affected by the Proposal as none have been recorded or are expected to occur within the Proposal area.

The seven Priority flora recorded in the vicinity of the Proposal area may be affected by the Proposal. These species have been found in association with certain vegetation communities and are likely to occur elsewhere in the region where these vegetation communities occur (Table 17). Disturbance to the known occurrences of the Priority flora populations will mostly be avoided as they occur outside the maximum mine disturbance area, with the exception of *Goodenia nuda* and *Phyllanthus aridus* which occur throughout the Proposal area. However, the impact on these species is unlikely to be significant because both these species appear to be widespread on the landforms that occur across the north side of the Fortescue Marsh (Figure 54), and both species occur elsewhere in the Pilbara. *Goodenia nuda* is particularly widespread in the Pilbara, with over 42 known populations listed on Naturemap (2011); most of which are from outside the Fortescue valley. *Phyllanthus aridus* is known from 35 records on NatureMap (2011); all of which are outside the Fortescue valley. It should be noted that the records of *Phyllanthus aridus* from the original surveys have not been lodged with the Western Australian Herbarium and therefore it was not possible to validate the identification in the 2010 survey. However, *Phyllanthus aridus* is mainly a Kimberley species, so the records from the Proposal area may be mis-identifications.

Less than 30% of the local extent of the vegetation communities that may support each species will be cleared in the Proposal area with the exception of *Themeda sp.* Hamersley Station (M.E. Trudgen 11431), which may have up to 52% of its associated vegetation cleared (Table 20). However, records from the WAH (2010) indicate that this species also occurs in grasslands and this vegetation is widespread throughout the Pilbara.

The Proposal is not expected to result in significant impacts to Priority flora species.

Table 20: Predicted Impact to Vegetation That May Support Priority Flora

| Taxa | Conservation Status | Vegetation Communities | Local Extent of Vegetation (ha) | Maximum Disturbance (ha) | Proportion of Local Extent Affected (%) |
|---|---------------------|--------------------------|---------------------------------|--------------------------|---|
| <i>Eremophila spongiocarpa</i> | P1 | 2, 22, 26 | 40 374 | 1 482 | 4 |
| <i>Gymnanthera cunninghamii</i> | P3 | 17 | 17 905 | 3 940 | 22 |
| <i>Phyllanthus aridus</i> | P3 | 1, 2, 3, 4, 8, 9, 17 | 95 347 | 13 354 | 14 |
| <i>Rostellularia adscendens</i> var. <i>latifolia</i> | P3 | 4 | 21 871 | 2 304 | 10 |
| <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) | P3 | 9 | 1 240 | 645 | 52 |
| <i>Eremophila youngii</i> subsp. <i>lepidota</i> | P4 | 10, 22, 26 | 43 251 | 2 595 | 6 |
| <i>Goodenia nuda</i> | P4 | 1, 2, 3, 4, 8, 9, 10, 17 | 113 627 | 15 948 | 14 |

8.5.2 Groundwater Drawdown and Mounding

The key potential impacts of groundwater drawdown and mounding are drawdown on vegetation that may be groundwater-dependent (River Red Gum and Samphire) and mounding on vegetation that may be intolerant of waterlogging (Mulga).

For the purpose of impact assessment, indirect impacts on vegetation from drawdown and mounding have only been quantified outside the maximum mine disturbance area, as any potential indirect impacts to vegetation communities within the maximum mine disturbance area have already been counted as a direct impact.

Mulga

Mulga has a shallow root distribution with root zones generally within 2 m of the surface (Ecoscape 2009). They therefore predominantly utilise water from shallow surface soils, intercepted from rainfall and runoff (UWA 2010). As such, Mulga are not considered groundwater-dependent and are not expected to be adversely affected by groundwater drawdown from the Proposal.

However, Mulga are sensitive to waterlogging and salinity and may potentially be affected by groundwater mounding if groundwater levels rise to within 2 m of ground surface (where pre-mining groundwater level fluctuations did not) resulting in prolonged saturation of their root zone.

Mulga's tolerance is largely dependent on their position in the landscape (Ecoscape 2009). For the purpose of this impact assessment, areas where groundwater is predicted to rise to within 2 m of ground surface and where levels are currently below 2 m have been identified as potential impact areas.

Mulga vegetation in close proximity to the Fortescue Marsh that are subject to mounding are not expected to be adversely affected, as groundwater levels are naturally closer to the surface in these areas. This is because the soils in close proximity to the Fortescue Marsh are more prone to saturation and Mulga likely to exhibit a greater tolerance to waterlogging of their root system (van Leeuwin S 2009, pers. comm).

Based on groundwater modelling (Section 6), approximately 380 ha of Mulga vegetation outside of the maximum mine disturbance area will be subject to groundwater mounding to within 2 m of the surface (Figure 56) at some stage during mining. Of this area (380 ha), approximately 18 ha are associated with creek and drainage lines. Mulga in creek lines and drainage lines are likely to be tolerant of periods of water logging of their root zone given their low topographical position in the landscape and being subject to periods of inundation following significant rainfall and creek line flow events (Ecoscape 2009).

The remaining 362 ha of Mulga is considered unlikely to be tolerant of their root systems being saturated for an extended period of time. Only 14 ha of which, will be affected by mounding for two or more consecutive years. This extended period of mounding is more likely to adversely impact the health and/or survival of Mulga vegetation in this area. This 14 ha equates to approximately 0.02% of the total Mulga communities mapped in the local area, which does not significantly add to the proportion of Mulga being directly affected by the Proposal (11%).

Salinity together with waterlogging can cause severe damage to plants that are not adapted to those conditions. Mulga is considered to have only a low to medium tolerance of saline conditions based on current knowledge (UWA 2010). No studies have been conducted on the salinity tolerance of Mulga in the Pilbara. However, based on naturally occurring groundwater salinity increases near the marsh where the groundwater table is shallow, the salt tolerance of vegetation in the Proposal area can be expected to increase with proximity to the Fortescue Marsh.

The mounding predicted to occur across the Proposal area will largely be transient (in the order of 1 year (Figure 56) and as the brackish injected groundwater that may cause mounding in areas of Mulga will not exceed 6000 mg/L, it is not expected to cause significant salt redistribution and accumulation within the vegetation root zone.

Samphires

Samphires are particularly tolerant of salinity and waterlogging (Astron 2011). Samphires have been observed to survive extended periods of inundation and waterlogging with tolerance varying between species (Astron 2011). The Fortescue Marsh is an episodically inundated marsh that is dry most of the time but with very regular phases of inundation and waterlogging that may persist for months (Astron 2011). As such, groundwater mounding is not expected to have an impact on this vegetation.

In contrast, groundwater drawdown may potentially affect Samphire communities as they specifically occur in areas with naturally shallow groundwater levels and may be groundwater-dependent. The level of groundwater dependence of the Samphire is unknown and could plausibly range between 'little or no dependence' to 'a high level of dependence'. The key unknowns relating to groundwater dependence are:

- the depth to groundwater beneath different marsh vegetation communities
- connectivity between groundwater and surface soil evaporation processes
- the soil water storage capacity of the unsaturated profile (which is recharged by rainfall and may also receive lateral water inputs)
- the root architecture of the marsh vegetation, in particular the depth of root penetration.

Studies of soil moisture conditions and depth to groundwater from elsewhere in Australia indicate that some Samphire species could be groundwater dependent (Astron 2011). Preliminary studies of soil moisture present in zones occupied by *Tecticornia auriculata*, *T. indica* and *T. medusa* at the Fortescue Marsh indicate that it is unlikely that the plants would only access moisture contained in the top 0.5 m of the soil, although the depth of the Samphire root systems and the watertable is unknown at these locations (Astron 2011). Fortescue is supporting work by the University of Western Australia (UWA) to undertake further investigations to the Fortescue Marsh Samphire. Fortescue is also developing an unsaturated zone model of representative soil profiles of the marsh. The potential for groundwater use by Samphire is one of the key aspects of this work.

To assess the potential effect of groundwater drawdown on Samphire communities, it has been assumed that there is some level of groundwater dependency of all Samphire vegetation that occurs where natural groundwater levels are generally less than 5 mbgl prior to mining. Figure 57 shows where these areas intersect areas of predicted groundwater drawdown of greater than 1 m from the Proposal.

Approximately 767 ha of Samphire vegetation on the fringes of the Fortescue Marsh may be affected by groundwater drawdown at some stage during the life of the mine. The duration of drawdown on this 767 ha will vary, as follows:

- 754 ha will only be subject to drawdown for a single year
- approximately 13 ha of Samphire may be affected by groundwater drawdown for two or more consecutive years.

If the drawdown periods coincide with a year where there is average or above rainfall, the Samphire would be likely to survive drawdown as they are drought tolerant and can utilise low levels of soils moisture from rainfall.

However, the 13 ha of Samphire that may be affected by groundwater drawdown for two or more consecutive years have increased risk, especially if the drawdown coincides with dry years. This 13 ha of Samphire comprises approximately 0.04% of the local extent of mapped Samphire in the region by Fortescue. Therefore the Proposal is not expected to result in significant additional impact to Samphire vegetation communities of the Fortescue Marsh as a result of dewatering activities.

Other Potentially Groundwater-Dependent Vegetation

Based on groundwater modelling and vegetation mapping, Coolibah and River Red Gum dominated communities will not be affected by groundwater drawdown or mounding outside of the proposed maximum disturbance area (Figure 56 and Figure 57).

8.5.3 Alteration to Surface Water Regime

Mine pits and waste landforms may affect surface water flows by potentially diverting upstream flows and capturing rainfall within mining areas; thereby reducing the catchment area for downstream flows. This can result in areas of shadowing that receive less flow because surface flow processes have been interrupted or diverted. Shadowing can affect both channel flow and sheet flow processes.

The change in catchment area resulting from increased infiltration within the Proposal mining areas (i.e. the total catchment area will remain the same, however less runoff will be generated from the mining areas) is not considered to be large enough to significantly alter the volume of surface water entering the marsh and hence changes to the distribution and composition of vegetation within the marsh is not expected. Alteration to surface water flow into the Fortescue Marsh is discussed in detail in Section 7.5.1.

Sheet Flow Shadow

Sheet flow occurs where overland water flow moves down slope across a broad shallow front (Section 7.3.1). Sheet flow areas do not promote convergence of flows and are relatively flat, meaning that sheet flow zones are maintained over large areas (Worley Parsons 2011). Sheet flow processes are considered important for the groved Mulga communities that are common in the mid-slopes of the Chichester Range.

The impact of mine pits and waste landforms on sheet flow areas during the 1 in 100 year rainfall event was determined for the life of the mine (Figure 58).

Approximately 330 ha of Mulga vegetation outside the maximum mine disturbance area may be affected by sheet flow shadow from mine pits and waste landforms. Of this area, 108 ha will only be in shadow for one year. Data suggests that Mulga can maintain very low water use during extended drought to survive (UWA 2010). It is therefore assumed that surface water shadowing for one year will not be sufficient to affect the survival of Mulga communities as lack of sheet flow may occur for periods of months to a year, as part of the natural rainfall variation in the Pilbara (UWA 2010). However, Mulga communities may be at risk if they are subject to longer periods (two or more years) without sheet flow recharge to surface soils. Up to 222 ha of Mulga outside the maximum mine disturbance area may be within sheet flow shadow zones for two or more years (Figure 58). This equates to approximately 0.2% of the total Mulga communities mapped in the local area, which does not significantly add to the proportion of Mulga being directly affected by the Proposal (11% to a total of 11.2%). The same 222 ha of Mulga outside the maximum mine disturbance area is expected to be affected by permanent shadowing post-closure (Figure 58).

Fortescue propose to monitor tree health in areas subject to 'sheet-flow shadow for less than two consecutive years' throughout the life of the mine. The most appropriate vegetation health and condition parameters for both Mulga and Samphire will be finalised in consultation with DEC. Should changes to the health of Mulga be detected, appropriate mitigation, such as surface irrigation, will be undertaken. Mulga responds rapidly to rainfall, which suggests that Mulgas may also respond rapidly to irrigation, if mitigation of reduced surface flows due to the Proposal is required (UWA 2010). The mitigation plan would be developed in consultation with DEC and OEPA.

Sheet Flow Ponding

Sheet flow areas that may be subject to ponding in the 1 in 100 year event due to the presence of mine pits and waste landforms were also mapped (Figure 59). Large scale ponding is expected only to occur following high intensity, high volume rainfall events such as cyclonic activity, which occur on an annual or less frequent basis. The 1 in 100 year event can be considered to be a 'worst case' scenario for ponding. Ponded water will slowly infiltrate at a rate dependent on soil properties.

Most of the ponding zones are within the approved footprint or the maximum mine disturbance area; however, approximately 26 ha of vegetation outside these areas may be susceptible to ponding. The vegetation within these zones consists of:

- 2.8 ha of Coolibah and River Red Gum dominated creek lines and drainage lines
- 6.7 ha of Acacia (not including Mulga) dominated creek lines and drainage lines
- 15.1 ha of Mulga woodland on flats and broad plains
- 1.3 ha of hummock grassland ranges and hill slopes.

Of these vegetation types, Mulga and hummock grasslands are likely to be most sensitive to ponding. Creek line vegetation, such as Coolibahs, is likely to be comparatively tolerant of ponding. These areas may be susceptible to ponding for a maximum of two years, and therefore depending on the rainfall may not actually be affected by the Proposal as the region may not experience high rainfall within the period of susceptibility.

Following closure, approximately 20 ha outside the maximum mine disturbance area are expected to be subject to ponding due to post-mining landforms. This may result in some change in vegetation to types more tolerant of ponding.

Channel Flow

Several creek lines and drainage lines intersect the Proposal area (Figure 55) and their flow may be affected by the presence of mine pits, landforms and other infrastructure. Major creek lines will be diverted around mine infrastructure into adjacent or downstream defined surface water flow pathways. Most impacts to creek line vegetation will be within the proposed maximum disturbance area, however there may be some vegetation associated with minor drainage lines that may have a reduced flow during the life of the mine. Vegetation affected will mostly consist of Mulga as this occurs on the dominant creek line south of the Proposal area. Impacts to Mulga vegetation from alteration of channel flow is not expected to significantly add to the proportion of Mulga being directly affected by the Proposal.

8.5.4 Summary of predicted direct and indirect impacts

Table 21 provides a summary of the predicted maximum direct and indirect impacts to each of the broad vegetation types within the Proposal area.

Table 21 Maximum Direct and Indirect Disturbance to Vegetation Communities

| Group | Vegetation Community | Total Area Mapped (ha) | Maximum Direct Disturbance (ha) | Maximum Indirect Disturbance from groundwater drawdown/ mounding (ha) | Maximum Indirect Disturbance from surface water changes (ha) | Maximum Total Disturbance (ha) | % of Mapped Vegetation Community |
|---|----------------------|------------------------|---------------------------------|---|--|--------------------------------|----------------------------------|
| Creek lines and drainage lines – Coolibah/River Red Gum dominated | 1 | 2367 | 473 | - | 2.8 | 476 | 20.1 |
| Creek lines and drainage lines – Mulga dominated | 2 | 15402 | 1482 | - | 4.5 | 1487 | 9.7 |
| Creek lines and Drainage lines – other Acacia dominated | 8, 9 | 3300 | 1070 | - | 6.7 | 1077 | 32.6 |
| Flats and broad plains containing Mulga | 3, 4, 10 | 74652 | 8983 | 14 | 232 | 9215 | 12.3 |
| Flats and broad plains without Mulga | 15 | 231 | 154 | - | - | 154 | 66.7 |
| Ranges, hills and hillslopes | 7, 16, 17, 18 | 22128 | 5647 | - | 1.3 | 5648 | 25.5 |
| Fringes of Samphire Flats containing Samphire | 12, 13, 22, 25, 26 | 31478 | 4 | 13 | - | 17 | 0.05 |
| Fringes of Samphire Flats without Samphire | 11, 14, 20, 27 | 947 | 4 | - | - | 4 | 0.4 |

8.6 CUMULATIVE IMPACTS

The main potential cumulative impact on vegetation and flora is the combined effect of clearing of conservation significant vegetation communities from Cloudbreak, Christmas Creek Mine and Roy Hill Mine (Table 22, Table 23 and Table 24). Cumulative impacts have been calculated from the following projects:

- Roy Hill Mine— Stages 1 and 2
- Christmas Creek Mine – approved project and Water Management Scheme Proposal
- Cloudbreak Mine – approved project and this Proposal
- Fortescue Port Hedland to Christmas Creek Rail Duplication Proposal.

Of the nearby projects, the Christmas Creek mine will affect up to 4120 ha of Mulga communities (FMG 2005) and Roy Hill will affect up to 4145 ha of Mulga communities (Roy Hill 2009). The addition of the potential area of disturbance to Mulga from this Proposal and the approved Cloudbreak Project will result in an overall cumulative impact of 20% of the mapped extent of Mulga in the Fortescue and Roy Hill areas (Table 22). Only 0.31 ha of Acacia dominated vegetation is proposed to be cleared for the duplication of sections of Fortescue's Port Hedland to Christmas Creek rail line (Fortescue 2011). This is not considered to be a significant impact in this context and has not been included in Table 22.

Table 22: Potential Cumulative Direct Impact Calculations for Mulga

| Mine | Area (ha) | Percentage Impact (%) |
|---|---------------|-----------------------|
| Mulga mapped for Roy Hill | 17 679 | |
| Mulga mapped for Fortescue | 90 054 | |
| Total representation of Mulga | 107 733 | 100 |
| Maximum Cloudbreak loss of Mulga | 14 165 | 13 |
| Roy Hill loss of Mulga | 4145 | 4 |
| Christmas Creek loss of Mulga | 4120 | 4 |
| Potential cumulative loss including Proposal | 22 430 | 21 |
| Remaining extent of Mulga | 85 303 | 79 |

Samphire communities will not be affected by the Roy Hill project, however cumulative impacts may result from Cloudbreak and Christmas Creek. The Christmas Creek Water Management Scheme Proposal has very conservatively based the impact assessment of clearing up to 600 ha of Samphire for the Proposal (only some of which will occur). The total cumulative impact equates to only 2% of the mapped extent of Samphires and hence is not considered significant. No Samphire is proposed to be cleared for Fortescue's rail duplication (Fortescue 2011).

Table 23: Potential Cumulative Direct Impact Calculations for Samphire

| Mine | Area (ha) | Percentage Impact (%) |
|---|---------------|-----------------------|
| Samphire mapped for Roy Hill | 0 | |
| Samphire mapped for Fortescue | 31 478 | |
| Total representation of Samphire | 31 478 | 100 |
| Maximum Cloudbreak loss of Samphire | 4 | 0.01 |
| Roy Hill loss of Samphire | 0 | 0 |
| Christmas Creek loss of Samphire | 600* | 2 |
| Potential cumulative loss including Proposal | 604 | 2 |
| Remaining extent of Samphire | 30 874 | 98 |

*Due to the fact that the location of areas to be cleared for the Christmas Creek Water Management Scheme has yet to be determined, the maximum possible impact of clearing 600 ha (the total amount of clearing for the Proposal) has been used to assess the potential impact on Samphires.

The largest cumulative impact appears to be to groundwater dependent vegetation (Table 24) with an overall cumulative impact of over 30% of the mapped extent of groundwater-dependent vegetation. However, once again, a very conservative estimate of 600 ha of clearing of this vegetation type has been used for the Christmas Creek Water Management Scheme Proposal and actual clearing for this Proposal will be a lot less. Approximately 36 ha of riparian vegetation will be affected by the rail duplication, however this area will be spread over the entire length of the works and only a small proportion of this clearing is expected to be within the vicinity of the Proposal.

Table 24: Potential Cumulative Direct Impact Calculations for Groundwater Dependent Vegetation

| Mine | Area (ha) | Percentage Impact (%) |
|---|-------------|-----------------------|
| Groundwater-dependent vegetation mapped for Roy Hill | 2587 | |
| Groundwater-dependent vegetation mapped for Fortescue | 2367 | |
| Total representation of groundwater-dependent vegetation | 4954 | 100 |
| Maximum Cloudbreak loss of groundwater-dependent vegetation | 565 | 11.4 |
| Roy Hill loss of groundwater-dependent vegetation | 437 | 8.8 |
| Christmas Creek loss of Groundwater dependent vegetation | 601* | 12.1 |
| Potential cumulative loss including Proposal | 1474 | 32.3 |
| Remaining extent of groundwater-dependent vegetation | 3480 | 69.6 |

*Due to the fact that the location of areas to be cleared for the Christmas Creek Water Management Scheme has yet to be determined, the maximum possible impact of clearing 600 ha (the total amount of clearing for the Proposal) has been used to assess the potential impact on groundwater-dependent vegetation. This total also includes 1 ha of disturbance from original Christmas Creek Project.

8.7 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

8.7.1 Ground Disturbance

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the proposed 2015 pastoral lease exclusion zone.

8.7.2 Adaptive Management of Groundwater

Potential impacts to significant vegetation communities, such as Mulga and Samphire communities, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in the EMP (Appendix A). The adaptive management approach is based on responding to information provided through implementation of a monitoring program and response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management approach outlined in Appendix A.

The proposed contingency measures are hierarchical, ordered by response to impacts of increasing severity as follows:

- 1) The primary contingency measures involve adjustment of dewatering wellfield configurations and dewatering rates or adjustment of the location and injection rates of the injection wellfields.
- 2) Localised mitigation of temporary groundwater level changes through case specific contingencies such as surface irrigation.
- 3) Temporary reduction in dewatering or injection rates while further investigations into potentially unacceptable and unexpected occurrence are undertaken.
- 4) Permanent reduction in dewatering or injection rates where determined to be appropriate in consultation with the DoW.
- 5) Cease dewatering or injection and investigate alternatives.

8.7.3 Environmental Management Plan

In addition, impacts to vegetation and flora will be managed under the Biodiversity Plan in the EMP (Appendix A). Key management measures include:

- road and other access alignments and borrow pit areas are to be constructed to avoid DRF and Priority flora as far as practicable
- all DRF locations (if found) are to be demarcated on the ground with appropriate fencing, signage and flagging
- where clearing of DRF cannot be avoided:
 - assess the local/regional conservation significance of the species prior to clearing
 - consult with DEC regarding the proposed clearing
 - translocation of individuals to nearby similar vegetation associations will be attempted if practicable, dependent on research advice from consultant botanists and the DEC
 - seed and other propagules of DRF planned for clearing will be collected and used for revegetation where practicable
- collect seed from areas to be cleared within the Proposal area; for use in future rehabilitation
- clearing to be undertaken progressively

8.7.4 Proposed Future Investigations

Fortescue is also planning (and in some cases has already commenced) a series of investigations into the water use dynamics of Samphire and Mulga vegetation. These investigations will include:

- investigation of Samphire use of groundwater and response to salinity changes and drying regimes
- investigation of the response of Mulga to drought, waterlogging and salinity stresses.

The findings of these investigations will inform mining operations in order to provide for ongoing vegetation protection and management. Fortescue will maintain an ongoing dialogue with regulatory authorities with respect to the implementation of these investigations and their outputs, which will be used to refine the EMP provided in Appendix A.

8.8 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to vegetation and flora:

- 1) Approximately 12 600 ha of vegetation will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance within a 23 000 ha area combined with the approved project) with the majority of this occurring in Mulga woodland on flats and broad plains and Spinifex on ranges and hillslopes.
- 2) Up to 10 500 ha of Mulga vegetation will be directly affected by the Proposal with an additional 250 ha potentially indirectly affected by an altered surface water regime and groundwater mounding.
- 3) Up to 4 ha of Samphire vegetation communities (associated with the Priority 1 PEC) will be directly affected by the Proposal with an additional 13 ha potentially indirectly affected for two or more years through dewatering activities (groundwater drawdown).
- 4) Up to 473 ha of Coolibah and River Red Gum vegetation will be directly affected by the Proposal. No additional indirect impact from dewatering and injection activities (groundwater drawdown and mounding) is expected.
- 5) Clearing for the Proposal and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the “threshold level” of 30% of its pre-clearing extent.
- 6) No DRF will be affected by the Proposal and impacts to Priority flora are not expected to be significant.

9. TERRESTRIAL FAUNA IMPACT ASSESSMENT

9.1 RELEVANT ENVIRONMENT OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

9.1.1 EPA Objectives

The EPA applies the following objectives in assessing proposals that may affect fauna:

- To maintain the abundance, diversity geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.
- To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.

9.1.2 EPA Statements and Guidelines

EPA Position Statement No. 3

EPA Position Statement No. 3 (EPA 2002b) discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in Western Australia. The outcomes sought by this Position Statement are intended to:

- promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and, therefore, the need to develop and implement best practice in terrestrial biological surveys
- enable greater certainty for proponents in the environmental impact assessment process by defining the principles the EPA will use when assessing proposals that may have an effect on biodiversity values.

EPA Guidance Statement No. 56

EPA Guidance Statement No. 56 (EPA 2004a) provides guidance on standards and protocols for terrestrial fauna surveys, particularly those undertaken for the Environmental Impact Assessment of proposals.

EPA Guidance Statement No. 20

EPA Guidance Statement No. 20 (EPA 2009) provides guidance on standards and protocols for surveys for Short Range Endemics (SRE) fauna, particularly those undertaken for the Environmental Impact Assessment of proposals.

9.1.3 State Regulatory Framework

State Protection

The preservation and conservation of fauna is covered by the following Western Australian legislation:

- *Wildlife Conservation Act 1950* (WA) (WC Act)
- *Conservation and Land Management Act 1984*.

In WA, rare or endangered species are protected by the Wildlife Conservation (Specially Protected Fauna) Notice 2008, under the WC Act. Schedules 1 and 4 in this notice are relevant to this assessment, providing a listing of the species protected by this Notice.

Fauna are also listed by DEC as Priority species if they are potentially threatened but for which there is insufficient evidence to properly evaluate their conservation significance. They range from Priority one to Priority four species, and are as follows:

- **Priority 1:** Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat
- **Priority 2:** Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat
- **Priority 3:** Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat
- **Priority 4:** Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Note that the Priority status does not have statutory standing. The Priority fauna classifications are employed by the DEC to manage and classify their database of species considered potentially to be at risk, but these categories have no legislative status for protection in addition to the native vegetation clearing legislation.

9.1.4 International Agreements

Australia is party to the Japan-Australia (JAMBA), Republic of Korea- Australia (ROKAMBA) and China-Australia (CAMBA) Migratory Bird Agreements. Birds listed in these agreements include some that are associated with saline wetlands and therefore are relevant to the Proposal area.

9.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the Proposal that may potentially affect terrestrial fauna values, not considering mitigation efforts, include:

- **vegetation clearing** for development within the mining areas and installation of water conveyance infrastructure will directly remove fauna habitat
- **trenching for burial of some pipelines** may result in the loss/injury of individual fauna
- **physical presence of linear infrastructure** such as roads and pipelines may disrupt fauna linkages
- **redistribution of surface water flows** around the mine and its infrastructure, may alter fauna habitat
- **dewatering and injection activities** may affect groundwater-dependent vegetation and affect the value of significant fauna habitat
- **vehicle movements during construction and operation** may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes
- **presence of artificial water bodies** may result in the impact to native fauna through increases in introduced fauna, entrapment, poisoning or alteration of fauna behaviour.

Other potential impacts from dust emissions, noise emissions, light pollution and feral animals are not expected to be any greater than that already assessed for the approved Cloudbreak Mine and are not addressed in this document. These aspects are currently managed through existing management plans.

9.3 FINDING OF SURVEYS AND INVESTIGATIONS

9.3.1 Studies Undertaken

The following fauna studies include assessment of at least a portion of the Cloudbreak Survey Area ¹² (Figure 60) and have been used to inform this impact assessment:

- 1) Bamford Consulting Ecologists (Bamford 2005a) conducted a Level 2 terrestrial vertebrate fauna survey of the Proposal area (excluding some injection areas) (Figure 60). The survey objective was to identify species of conservation significance and their habitats. The studies were completed in accordance with EPA Position Statement No. 3 (EPA 2002b) and EPA Guidance Statement No. 56 (EPA 2004a).

¹² The Cloudbreak Survey Area is the area covered by the Ecologia (2011a) survey (Figure 60). This is also the extent of fauna habitat mapping for Cloudbreak.

- 2) Biota Environmental Sciences [Biota] (2005) conducted a Level 2 terrestrial vertebrate fauna survey and habitat mapping of the Fortescue Stage B rail corridor and proposed mines at Cloudbreak, Christmas Creek, Mindy Mindy, Mt Lewin and Mt Nicholas to support the PER for this project.
- 3) Level 1 fauna assessments of a trial mine pit site and the airstrip, camp and access road (ATA 2006a and 2006b) were undertaken in accordance with the EPA Position Statement No. 3 (EPA 2002b). The assessments consisted of a desktop study and reconnaissance survey to verify the desktop survey and to delineate fauna values present in the area (Figure 60).
- 4) Annual Night Parrot surveys have been conducted by Bamford Consulting Ecologists (2005b, 2006, 2007a, 2007b, 2009, 2010a and 2011) in accordance with the existing commitment by Fortescue to determine whether the Night Parrot occurs within Fortescue Marsh and surrounds.
- 5) A desktop terrestrial fauna study was undertaken by Ecologia (2010a). The purpose of this study was to consolidate previous survey information to provide sufficient information to the EPA to assess the impact of the Proposal on vertebrate fauna of the area. This study utilised the aforementioned fauna surveys as well as Ecologia internal databases, NatureMap, Birddata and EPBC protected matters database. Aerial photography and vegetation surveys previously conducted in the area (Biota 2004; Mattiske 2005a, 2005b, 2007) were also used in this assessment to predict fauna habitats within the Proposal area and 70 000 ha of the surrounding area including the edge of the Fortescue Marsh (Figure 60) shows the extent of this mapping).
- 6) Ecologia (2011a) undertook an one-phase Level 2 vertebrate fauna assessment in accordance with the requirements of EPA Guidance Statement No. 56 and Position Statement No. 3 in October 2010.. The total size of the survey area was approximately 581.5 km² encompassing the Cloudbreak tenements and part of the Fortescue Marsh.
- 7) A desktop SRE invertebrate assessment was undertaken by Ecologia (2010b) to consolidate information from previous surveys undertaken at Cloudbreak (including Harvey 2006).
- 8) Ecologia (2011b) undertook a baseline SRE invertebrate fauna survey of the Proposal area in accordance with the requirements documented in EPA's Guidance Statement 20.
- 9) Bennelongia (2011) undertook a desktop subterranean fauna assessment by drawing on previous stygofauna surveys at Cloudbreak (Ecologia 2006, Ecowise 2007, Bennelongia 2007) and surrounding areas and inferring occurrence of troglafauna from results of surveys in nearby areas.

- 10) Bamford Consulting Ecologists (2010b) undertook a Level 1 and Level 2 terrestrial fauna survey for the proposed duplication of sections of the Fortescue railway between Port Hedland and Christmas Creek, including areas near and within the Proposal area. This survey involved visual inspection of areas proposed to be affected by the duplication for habitat and evidence of fauna.

The following description of the Proposal area is adapted from Ecologia (2010a) unless otherwise stated. The methodology and full results of the key surveys listed above are included in Appendix C.

9.3.2 Land Systems

The Cloudbreak survey area contains seven land systems: Newman, McKay, Jamindie, Turee, Cowra, Christmas and Marsh (Table 25; Figure 61).

Table 25: Land Systems of the Cloudbreak Area

| Land System | Description |
|-------------|--|
| Newman | Rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands. |
| McKay | Hills, ridges, plateau remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard Spinifex grasslands. |
| Jamindie | Stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with Spinifex understorey. |
| Turee | Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands. |
| Cowra | Plains fringing the Marsh land system and supporting Snakewood and Mulga shrublands with some halophytic undershrubs. |
| Christmas | Stony alluvial plains supporting Snakewood and Mulga shrublands with sparse tussock grasses. |
| Marsh | Lakebeds and floodplains subject to regular inundation, supporting Samphire shrubland, salt water couch grasslands and halophytic shrubland. |

9.3.3 Terrestrial Fauna Habitats

Six broad fauna habitats present within the Cloudbreak survey area (Ecologia 2010a) (Figure 62, Figure 63):

- low halophytic shrubland
- hummock grassland on fringe of Fortescue Marsh
- low Mulga, Snakewood and other Acacia woodland
- Spinifex covered hills and ranges
- creek lines and wells with Acacia shrubland and/or Eucalypt woodland
- Rocky escarpments.

Other habitats that occur in the surrounding areas are floodplain, Eucalypt woodland, spinifex on calcrete and sandy spinifex plain (Figure 63). These habitats are not present in or adjacent to the Proposal area and will therefore not be directly or indirectly affected by the Proposal.

Table 26: Habitats of the Proposal Area

| Habitat Type | Corresponding Land System | Description | Location in Survey Area |
|---|---|--|---|
| Low halophytic shrubland | Marsh, Cowra | Consists of <i>Tecticornia</i> (formally <i>Halosarcia</i> – Samphire) species with <i>Muellerolimon salicorniaceum</i> and other mixed chenopod species. | Surrounds areas of permanent, semi-permanent and ephemeral water bodies of the Fortescue Marsh. |
| Hummock grassland on the fringe of the Fortescue Marsh | Cowra | Consists of <i>Triodia angusta</i> (Spinifex) with patches of <i>Acacia</i> spp., <i>Eremophila</i> spp., and mixed chenopods. | Surrounds halophytic shrubland of the Fortescue Marsh. |
| Mulga, Snakewood and other <i>Acacia</i> woodland | Jamindie, Cowra, Turee | Consists of open to moderate Mulga (<i>Acacia aneura</i>), Snakewood (<i>Acacia xiphophylla</i>) and other mixed <i>Acacia</i> spp. low woodland over scattered <i>Eremophila</i> , <i>Senna</i> and mixed <i>Acacia</i> shrubs. An understorey of Spinifex is also present in some areas. | Dominant habitat type running across the Proposal area. |
| Spinifex covered hills and ranges | Newman, McKay | Consists of scattered eucalypts and <i>Acacias</i> (e.g., Snappy Gum, <i>Eucalyptus leucophloia</i> , and kanji, <i>Acacia pyrifolia</i>) over Spinifex grassland. The ground is typically a red loam-clay and covered with a layer of small to medium sized pebbles. | This habitat type corresponds to Beard's (1975) tree steppe and the Newman and McKay land systems, running in an east-west strip across the northern edge of the Proposal area. |
| Creek lines and wells with <i>Acacia</i> shrubland and/or Eucalypt woodland | Running north-south through Jamindie, Newman, Cowra | Consists primarily of tall eucalypts bordering the sandy or gravel creekbed, with <i>Acacia</i> shrubs and tussock grass covering the riparian area. | The Proposal area contains numerous small to large sized creek lines, typically running north to south and emptying into the Fortescue Marsh. |
| Rocky escarpments | Newman, McKay | Consists of shallow caves and crevices within rocky spinifex hills. | Located in the north of the Proposal area. |

These habitats occur in three main east-west running strips that broadly reflect the land systems (Figure 61). The halophytic shrubland occurs within the boundary of the Fortescue Marsh, with areas of hummock grassland on the edge of the marsh (Marsh and Cowra land systems), moving into low Mulga woodland on alluvial flats (Jamindie, Cowra and Turee land systems), followed by the Spinifex-covered hills and ranges of the Newman and the McKay land systems. Creek and drainage lines supporting either *Acacia* shrubland or eucalypt woodland, run north-south into the Fortescue Marsh.

Low Halophytic Shrubland

The low halophytic shrubland habitat, which occurs within the Fortescue Marsh may provide suitable habitat for conservation significant species. Areas of dense low halophytic vegetation potentially provide suitable habitat for the Night Parrot. Areas within the marsh with a sandy substrate, located above the high-water mark, may provide potential burrowing habitat for the Bilby and Mulgara (Section 9.3.5). This habitat is also expected to support many waterbird species, including migratory species listed under the CAMBA and JAMBA international agreements.

Hummock Grassland on fringe of Fortescue Marsh

Spinifex of the hummock grassland form large dense hummocks that may provide shelter and protection for a variety of species. The highest diversity and individual captures of mammal species in the survey area were recorded from this habitat type during the Bamford (2005a) survey. Dense, long unburnt areas of Spinifex may provide habitat for the Night Parrot and areas with sandy substrate may provide suitable habitat for the Bilby and Brush-tailed Mulgara (Section 9.3.5).

Low Mulga, Snakewood and other Acacia Woodland

The Mulga woodland habitat may provide habitat for geckos and other small reptiles that inhabit bark and dead trees. Several bird species are also typically associated with Mulga woodlands as it provides foraging and nesting potential amongst Mulga trees. Species of conservation significance that may potentially utilise Mulga woodland habitat include Greater Bilby, Australian Bustard, Bush Stone-curlew and Northern Short-tailed Mouse (Section 9.3.5).

Spinifex Covered Hills and Ranges

A distinct suite of species are known to occur within the Spinifex covered hills and ranges habitat type. The Spinifex provides excellent shelter from heat and protection from predators for many reptile species with the pebble covered foot-slopes providing ideal habitat for the Western Pebble-mound mouse. Large rocks and crevices found within this habitat types provide habitat for larger reptile species and certain mammal species such also the Northern Quoll (Section 9.3.5).

Creek Lines and Wells with Acacia shrubland and/or Eucalypt woodland

Eucalypts and accumulations of leaf litter below the eucalypts along watercourses provide good habitat for several reptile species. River systems and watercourses also often have a higher density and diversity of bird species than other habitats. Many bird species, including Migratory bird species (Section 9.3.5) show preference for this habitat type, in particular foraging and nesting in the eucalypts. Many of the small insectivorous bat species also occur in this habitat type due to the abundance of insects around water bodies. Some species will also roost in hollow eucalypt branches or under bark.

Rocky Escarpments

The large rocks, small caves and crevices present in this habitat type provide habitat for numerous species and several rocky range specialists can be found in this habitat type, including Spiny-tailed Monitor, Black-headed Monitor and Moon Snake. The ridges contain small patches of boulder piles and deep crevices which represent potential habitat for the Northern Quoll and suitable foraging habitat for the Ghost Bat and the Pilbara Leaf-nosed Bat (Section 9.3.5).

9.3.4 Occurrence of Vertebrate Fauna

Desktop studies of potential fauna abundances conducted during previous investigations were refined by Ecologia (2010a), which identified 238 species that either may potentially occur or have previously been recorded in the surveyed area. This total included 165 species of birds, 34 species of native mammals, nine introduced mammals, 96 species of reptiles and five amphibians. Surveys within the Cloudbreak area have recorded 62% of the native mammals, 84% of the birds and 80% of the amphibians potentially occurring (Table 27).

Table 27: Occurrence of Terrestrial Fauna within the Cloudbreak Survey Area (source: Ecologia 2010a)

| Fauna Group | Number of Species Recorded |
|--------------------|-----------------------------------|
| Avifauna | 139 |
| Mammals | 23 (plus 8 introduced mammals) |
| Introduced species | 8 |
| Herpetofauna | 63 |
| Total | 233 |

Mammals

The highest number of mammal species and individuals were recorded on sites where dense *Triodia* hummocks occurred, which appeared to offer excellent habitat for small mammals. The most common mammal trapped during the Bamford (2005a) survey was *Pseudomys desertor* (Desert Mouse). A relatively large number of Little Red Kalutas (*Dasykaluta rosamondae*) and Pilbara Ningau (Ningau *timealeyi*) was captured during the Ecologia (2011a) survey. Red Kangaroos (*Macropus rufus*) were at low densities throughout the site and were absent during night spotlighting surveys.

Two micro-bat species were captured in mist-nets, seven species of bat were identified through recordings of echolocation calls and a single bat species was observed during spotlighting activities during the Bamford (2005a) survey. On the basis of echolocation calls the most abundant micro-bat species within the survey area were *Scotorepens greyii* and *Chalinolobus gouldii*.

Birds

Bird abundances were generally low, most likely reflecting the dry conditions experienced during the main survey period (Bamford 2005a, Ecologia 2011a). Bird life was notably concentrated around sources of permanent water such as Minga, Qwirriawirrie and Moojarri Wells, which were the only locations where species such as Little Corella were observed. These sources of permanent water harboured significant numbers of Cockatiels, Crested Pigeons, Common Bronzewing and Bourke's Parrots. Creek-line habitats also tended to provide attractive habitat for a range of bird species due to the diversity of habitats available including the opportunity for nest hollows in tall eucalypts (Bamford 2005a).

Minga Well is a permanent water source and is likely to be important to local animals, especially during the dry season and times of drought. A total of eight species of conservation significance have been observed at Minga Well, including the Night Parrot which was observed drinking at Minga Well during a period of drought (Bamford 2006).

Herpetofauna

The Ecologia (2011a) survey recorded much a higher number of species than the Bamford (2005a) survey (47 compared to 28 respectively). Several families of reptiles were recorded, consisting of Cheluidae (Plate-shelled Tortoise), Agamidae (dragon lizards), Gekkonidae (geckoes), Pygopodidae (legless lizards), Scincidae (skink lizards), Varanidae (goanna or monitor lizards), Elapidae (elapid snakes), Typhlopidae (blind snakes) and Boidae (pythons). No reptiles of conservation significance were recorded during the Ecologia (2011a) survey, most likely due to a limited amount of suitable habitat.

The Bamford surveys recorded four amphibian species within the survey area, with most belonging to the Hylidae (tree frogs) family. The Ecologia (2011a) survey recorded only one species at Moojarri Well and Minga Well. High temperatures and the lack of rain prior to the survey are likely to have resulted in the low amphibian activity during the latest survey. No conservation significant species of amphibian is likely to occur within the survey area or surrounding areas (Ecologia 2011a).

Introduced Animals

Previous surveys of the Cloudbreak area recorded seven of the nine potentially occurring introduced species, including *Mus musculus* (house mouse) *Felis catus* (feral cat), *Canis lupus* (dog/dingo), *Oryctolagus cuniculus* (European rabbit) *Equus asinus* (donkey), *Equus caballus* (horse) and *Bos taurus* (cow). Although not actually sighted within the survey area, evidence (scats and tracks) of *Camelus dromedaries* (camel) were also recorded.

9.3.5 Vertebrate Species of Conservation Significance

Based on previous surveys, database and literature searches from within 50 km of the Proposal area, there is the potential for 23 species of conservation significance to occur in the area (Table 28). Twelve of these species have been recorded within the survey area (either directly or through secondary evidence).

Table 28: Summary of Potential Presence of Conservation Significant Species

| Species | Status | | Habitat | Likelihood of Occurrence |
|--|----------|-------|---|---|
| | EPBC Act | State | | |
| Night Parrot (<i>Pezoporus occidentalis</i>) | EN | S1 | Triodia hummock grassland or chenopod shrublands. Thick unburnt vegetation most suitable. | Recorded from Minga Well in 2005. Suitable habitat exists adjacent to the Proposal area with suitable habitat at some injection infrastructure locations and the species is considered likely to occur. |
| Northern Quoll (<i>Dasyurus hallucatus</i>) | EN | S1 | Rocky areas, also eucalypt forest and woodland. | Previously recorded near Proposal area in 1980 (NatureMap). Limited areas of rocky breakaways that may provide a small amount of suitable habitat. |
| Greater Bilby (<i>Macrotis lagotis</i>) | VU | S1 | Spinifex hummock grassland and <i>Acacia</i> scrub. | Records of recently active burrows within Proposal area (Bamford 2005a). Areas of suitable habitat present along the Fortescue Marsh and in Mulga woodland. |
| Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>) | VU | S1 | Roosts in caves with high humidity and temperature. | Recorded at Thieves Well. No suitable roosting habitat but may forage within the Proposal area. |
| Pilbara Olive Python (<i>Liasis olivaceus barroni</i>) | VU | S1 | Gorges and escarpments, areas of permanent water. | May be present within the rocky areas in the north of the Proposal area. |
| Fork-tailed Swift (<i>Apus pacificus</i>) | Mig | S3 | Almost entirely aerial, particularly associated with storm fronts. | Will occasionally overfly Proposal area, but will not utilise it directly. |
| White-bellied Sea-eagle (<i>Haliaeetus leucogaster</i>) | Mig | S3 | Coastal and near coastal water bodies. | Recorded at Fortescue Marsh. Uncommon in area, although suitable habitat present along the marsh where water present. Unlikely to be suitable habitat within the Proposal area. |
| Rainbow Bee-eater (<i>Merops ornatus</i>) | Mig | S3 | Open country, most vegetation types, dunes, banks. | Recorded within Proposal area. Suitable habitat for hunting and breeding. |
| Eastern Great Egret (<i>Ardea modesta</i>) | Mig | S3 | Floodwaters, rivers, shallows of wetlands, intertidal mud-flats. | Suitable hunting habitat when surface water present in Fortescue Marsh and some potential habitat along creek lines within the Proposal area. |
| Wood Sandpiper (<i>Tringa glareola</i>) | Mig | S3 | Freshwater swamps, river pools, claypans, salt lakes. | Recorded at the Fortescue Marsh. Suitable habitat present in marsh, especially after rain. Some potential habitat along creek lines within the Proposal area. |

| Species | Status | | Habitat | Likelihood of Occurrence |
|---|----------|------------|---|--|
| | EPBC Act | State | | |
| Common Greenshank (<i>Tringa nebularia</i>) | Mig | S3 | Coastal and inland lakes. | Recorded at the Fortescue Marsh. Suitable habitat present in marsh, especially after rain. Some potential habitat along creek lines within the Proposal area. |
| Red-necked Stint (<i>Calidris ruficollis</i>) | Mig | S3 | Coastal and inland shorelines. | Few records, but suitable habitat present in marsh especially after rain. Some potential habitat along creek lines within the Proposal area. |
| Peregrine Falcon (<i>Falco peregrinus</i>) | | Schedule 4 | Coastal cliffs, riverine gorges and wooded watercourses. | Recorded hunting within Proposal area. Suitable hunting habitat along rivers and gorges. Some potential breeding habitat in rocky areas. |
| Blind Snake (<i>Ramphotyphlops ganeii</i>) | | Priority 1 | Unknown, but possibly associated with moist gorges and gullies. | Species rarely recorded but suitable habitat present in gullies throughout area of Spinifex hillslopes within the northern areas of the Proposal area. |
| <i>Ctenotus nigrilineatus</i> | | Priority 1 | Spinifex at the base of granite outcrops. | May occur as suitable habitat exists in the Proposal area. |
| <i>Ctenotus uber johnstonei</i> | | Priority 2 | Small outcrops on sandy and stony plains. | Likely to occur around small outcrops on sandy and stony plains in the Proposal area. |
| Grey Falcon (<i>Falco hypoleucos</i>) | | Priority 4 | Lightly wooded coastal and riverine plains. | Recorded near Proposal area at Sandy Creek. Wide-ranging species. Some suitable habitat for hunting and breeding along creek lines in the Proposal area. |
| Australian Bustard (<i>Ardeotis australis</i>) | | Priority 4 | Open grasslands, chenopod flats and low heath. | Recorded within Proposal area and surrounds. Suitable habitat present throughout Mulga woodland. |
| Bush Stone-curlew (<i>Burhinus grallarius</i>) | | Priority 4 | Lightly wooded country next to day time shelter of thickets or long grass. | Recorded within the Proposal area. Suitable habitat present along creek lines throughout Mulga woodland. |
| Star Finch (<i>Neochmia ruficauda subclaescens</i>) | | Priority 4 | Vegetation around watercourses, particularly thick reed beds. | Recorded at Minga Well. No other suitable habitat present within Proposal area. |
| Long-tailed Dunnart (<i>Sminthopsis longicauda</i>) | | Priority 4 | Rocky habitat with Spinifex or open habitat with a rocky mantle. | May occur in suitable habitat such as rocky hill-slopes within and around the Proposal area. However, very few records within 100 km of Proposal area. |
| Pebble-mound Mouse (<i>Pseudomys chapmani</i>) | | Priority 4 | Spurs and rocky hills with many small pebbles vegetated by Spinifex. | Numerous active mounds recorded within the Proposal area. Large amount of suitable habitat along Spinifex hill slopes within and surrounding the Proposal area. |
| Northern Short-tailed Mouse (<i>Leggadina lakedownensis</i>) | | Priority 4 | Spinifex and tussock grassland on cracking clays. Also <i>Acacia</i> shrubland, Samphire, woodlands and stony ranges. | Likely to occur within the Proposal area. Recorded at Christmas Creek in tussock grasslands on cracking clay and in other habitats. Similar habitats are present in Proposal area. |

| Species | Status | | Habitat | Likelihood of Occurrence |
|--|----------|------------|---|--|
| | EPBC Act | State | | |
| Brush-tailed Mulgara (<i>Dasymercus blythi</i>) | | Priority 4 | Sandy areas with moderately dense Spinifex with 'runways' between clumps. | May occur within the area. Potential burrows previously observed in Proposal area but no evidence of individuals. Small amount of suitable habitat within the Proposal area. |
| Ghost Bat (<i>Macroderma gigas</i>) | | Priority 4 | Caves, rockpiles and abandoned mines. | Record of individual foraging along edge of Fortescue Marsh. No suitable roosting habitat within Proposal area. |

9.3.6 Occurrence of Short-Range Endemic (SRE) Invertebrates

A DEC and Western Australian Museum (WAM) database search for SRE species in the Pilbara did not identify any Threatened terrestrial invertebrate species.

Three SRE species recorded in the Pilbara were listed as Priority Two by the DEC (Ecologia 2010b):

- *Antipodogomphus hodgkini* (Dragonfly)
- *Nososticta pilbara* (Dragonfly)
- *Dupucharopa millestriata* (Mollusc).

These species are known from areas not under immediate threat of habitat destruction or degradation. They have not been recorded within or near the Proposal area in previous surveys; however, the Fortescue Marsh and surrounding areas may provide potential habitats for these three species (Ecologia 2010b).

A total of 685 invertebrate specimens were collected during the Ecologia (2011b) SRE Invertebrate survey. These individuals represented six orders, 15 families, 22 genera and at least 26 species of invertebrates. One confirmed, one likely and five potential SRE species were recorded during the survey including mygalomorph spiders, millipedes, scorpions and pseudoscorpions (Table 29; Figure 64). An additional six potential SRE species have been previously recorded within or adjacent to the Proposal area according to the WAM database (Ecologia 2010b; Table 29 and Figure 64).

Table 29: Potential SRE species recorded within and adjacent to the Proposal area

| Species | SRE status | Number recorded | Habitat | Source of record |
|------------------------------------|-------------|--|---|---|
| Mygalomorph spiders | | | | |
| <i>Conothele</i> sp | Potential | 3 | Creek line habitat. Hummock grassland habitat on the fringe of Fortescue Marsh. | Ecologia (2011b) survey |
| <i>Aname</i> 'MYG001 group' | Potential | 1 | Hummock grassland habitat on the fringe of Fortescue Marsh. | Ecologia (2011b) survey |
| <i>Aganippe</i> 'Cloudbreak sp. 1' | Potential | unknown | Spinifex Covered Hills and Ranges habitat. | WAM database |
| <i>Missulena</i> "MYG045" | Potential | unknown | Spinifex Covered Hills and Ranges habitat and creek line habitat. | WAM database |
| <i>Cethegus</i> "Cloudbreak sp 1" | Potential | unknown | Creek line habitat. | WAM database |
| <i>Synothele</i> "MYG127" | Potential | unknown | Mulga woodland habitat. | WAM database |
| Scorpions | | | | |
| <i>Urodacus</i> sp | Potential | 1 (Ecologia 2011b) Several (WAM database) | Creek line habitat within Mulga woodland. | Ecologia (2011b) survey WAM database |
| <i>Lychas</i> "scottae" | Potential | 1 | Spinifex Covered Hills and Ranges habitat. | WAM database |
| Pseudoscorpions | | | | |
| <i>Austrohorus</i> sp. | Potential | 1 | Hummock grassland on fringe of Fortescue Marsh habitat. | Ecologia (2011b) survey |
| <i>Beierolpium</i> 'sp. 8/2' | Potential | 12 | Creek line, Snakewood and Mulga Woodland and Hummock Grassland on fringe of Fortescue Marsh habitats. | Ecologia (2011b) survey |
| <i>Linnaeolpium</i> sp. | Likely | 2 | Snakewood and Mulga Woodland habitat. | Ecologia (2011b) survey |
| Millipedes | | | | |
| <i>Antichiropus</i> 'Cloudbreak' | SRE species | 39 | Creek line habitat. | Ecologia (2011b) survey |
| Opilionids | | | | |
| <i>Dampetrus</i> 'Pilbara 1' | Potential | Several | Under rock and leaf litter against a cliff face and edge of a small range. | WAM database |

9.3.7 Occurrence of Subterranean Fauna

Stygofauna

At least six stygofauna surveys have been conducted in the vicinity of the Cloudbreak Proposal area (Bennelongia 2011). These comprise five surveys undertaken for assessments of mines within the Pilbara Iron Ore and Infrastructure Project (Knott and Goater 2007; Ecowise 2007; Bennelongia 2007, 2008b, 2008c) and a large Pilbara-wide survey by DEC (Halse et al. in preparation).

Sixty-nine (69) samples of stygofauna have been collected from 29 bores within the Proposal area and the spatial extent of predicted dewatering impacts during the life of mine. This level of sampling exceeds the level of sampling recommended by the EPA (2007) of 40 samples within an impact area. Results of sampling show that a moderately rich stygofauna community of 21 species of stygofauna belonging to eight higher taxonomic groups occurs within the Proposal area at a capture rate of 0.83 species per sample. Despite sampling effort being high at Cloudbreak, only 48% of the species known from the search area were collected within the Proposal area, suggesting there is species turnover within the search area as aquifer conditions change.

Only two species appear to be restricted to the vicinity of the Proposal area: the copepods *Parapseudoleptomesochra* sp. B1 and *Goniocyclops* sp. B2 (Bennelongia 2011; Figure 65).

Troglofauna

There has been no sampling of troglofauna in the vicinity of the Proposal area. However, two species, the isopods *Philosciidae* sp. B5 and *Troglarmadillo* sp. B15, have been collected just south the maximum mine disturbance area as by-catch during stygofauna sampling (Bennelongia 2011; Figure 66).

Troglofauna surveys in surrounding parts of the Chichester Range have not been extensive, although 18 troglofauna species were collected in the Bonney Creek area and 31 'deep soil' species were collected at the Roy Hill 1 mine site, nine of which are potentially troglofauna. The occurrence of troglofauna elsewhere in the Chichester Range, the collection of some troglofauna around the Proposal area while stygofauna sampling, and the presence of prospective lithologies at Cloudbreak Mine suggest that a modest troglofauna community is likely to be present within the Proposal area (Bennelongia 2011).

9.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

The scope to consider alternative locations for this Proposal to avoid or minimise impact is limited as the location of the mine is dictated by the extent of the resource. However, there is some flexibility with locations of linear infrastructure and waste landforms and avoidance of significant habitat is part of the mine planning process. A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a GDP). Under the permitting process, areas of vegetation which may comprise significant flora and vegetation, including high value habitat such as Mulga and large 'habitat' trees are identified and this may include ground-truthing surveys to assess their value. The GDP process is based on a significance assessment such that where particular values may be present, such as proximate to the Fortescue Marsh, significant fauna, drainage lines, Mulga or where no previous surveys have been conducted, further surveys are conducted prior to clearing. Areas confirmed as having high value are then reassessed for suitability for clearing in consultation with DEC. This includes an analysis of whether viable alternative locations for infrastructure exist.

The dewatering and injection system has also been designed to minimise impacts to significant habitats within the Fortescue Marsh by minimising propagation of drawdown or mounding into the marsh habitats (Section 6).

The Proposal is based on open cut mining due to the comparatively shallow nature of the resource. Open cut mining requires areas to be cleared in order to extract the ore and manage the waste rock or overburden. Fortescue is proposing to mine progressively and then backfill and rehabilitate as the mining face progresses. This method minimises the footprint as there is less area required for overburden storage and consequently the amount of habitat clearing required. This method also allows progressive rehabilitation aimed at re-establishing fauna habitat values on the final landform.

9.5 ASSESSMENT OF LIKELY AND DIRECT IMPACTS

9.5.1 Clearing of Habitat

Almost all native fauna species rely on native vegetation to provide food, shelter and breeding sites. Loss or degradation of native vegetation may reduce the capacity of the habitat to support the range of species it could support in an undisturbed state. The fauna habitat types identified by previous surveys support a range of fauna species, including conservation significant species (Ecologia 2010a).

Vegetation will be progressively removed from sections of the Proposal area during construction of mining infrastructure and during mining. Up to 12 600 ha of vegetation will be disturbed for the Proposal. Maximum disturbance amounts for each habitat type have been calculated by assessing the amount of each habitat type that exists within a broad mine area (maximum mine disturbance area) of 17 000 ha and broad injection infrastructure corridors of 40 m width (actual clearing width 20 m) within which the total clearing of up to 12 600 ha will occur (Figure 62).

Table 30 outlines the maximum amount of clearing of each habitat type regardless of the configuration of the final footprint. The combined survey areas surrounding the Cloudbreak and Christmas Creek mines have been used to provide an indication of the local extent of each habitat.

The majority of disturbance for the Proposal will occur within Mulga, Snakewood and other Acacia woodland (up to 9740 ha) and Spinifex covered hills and ranges (up to 6258 ha) (Figure 62; Table 30). Up to 22% and 26% of these habitats respectively will be cleared in the local area (the combined Cloudbreak and Christmas Creek survey areas). Both of these habitat types occur extensively throughout the Pilbara and are well represented within 30 km of the Proposal area (Figure 63). Mulga vegetation within the Cloudbreak area, however, is considered locally significant as it is the most northern extent of this habitat type (Heidrich A 2010, pers. comm).

Table 30: Maximum Disturbance to Fauna Habitats within the Proposal Area

| Habitat | Extent Within Survey Area | Proposed Maximum Disturbance of each Habitat | | Extent of Maximum Disturbance for Cloudbreak Project (includes approved footprint) | |
|--|---------------------------|--|------|--|------|
| | ha | ha | % | ha | % |
| Low halophytic shrubland | 25 599 | 4 | 0.01 | 4 | 0.01 |
| Hummock grassland on the fringe of the Fortescue Marsh | 875 | 4 | 0.43 | 4 | 0.43 |
| Mulga, Snakewood and other Acacia woodland | 44 504 | 9740 | 22 | 13 173 | 30 |
| Spinifex covered hills and ranges | 23 746 | 6258 | 26 | 7557 | 32 |
| Creek lines and wells | 11 596 | 1844 | 16 | 2586 | 22 |
| Rocky escarpments | 32 | 27 | 83 | 27 | 83 |

A short pipeline (approximately 4 km) crosses both the halophytic shrubland and hummock grassland habitat types on the fringe of the Fortescue Marsh. These areas provide potential habitat for several conservation significant species, including Night Parrot, Bilby and Brush-tailed Mulgara. Vegetation clearing of up to 4 ha in this area may result in a small loss of these habitats, equating to 0.01% of the local extent of halophytic shrubland and 0.4% of fringing hummock grassland. These small areas of clearing are not significant when considered against the amount of similar habitat within the local area and are highly unlikely to significantly affect fauna.

A maximum of 1844 ha (16% of the local extent) of creek line vegetation will be cleared within the maximum mine disturbance area and pipeline corridors. However, due to the extensive amount of creek line habitat outside the local area, no significant impacts to this habitat type are expected on a regional level as a result of vegetation clearing.

A total of 27 ha or 83% of the 32 ha of rocky escarpments identified are within the maximum mine disturbance area (Table 30). Although this area is within the maximum mine disturbance area, the rocky escarpments are not within or near the actual proposed mine pit area, processing facilities or waste dumps. Therefore, Fortescue commits to avoiding any clearing within the rocky escarpment habitat type.

The total clearing for the Cloudbreak Project (proposed plus approved footprint) will not result in significantly higher impact than previously discussed (Table 30) with a maximum of 32% of any one habitat type being cleared in the local area, apart from the rocky escarpments.

Regional Impacts on Fauna Habitats

To provide regional context on the significance of the habitat clearing, land systems have been used, as these largely correspond to the habitat types in the Cloudbreak area (Table 31). The land system to be most affected by the Proposal is the Cowra land system (mostly Mulga woodland on the fringe of the Fortescue Marsh) with approximately 3% of this land system within the maximum mine disturbance area. As all clearing is less than 5% of any land system in the region, it is expected that there will be no significant impact on the availability of habitats regionally.

Table 31: Regional Impacts on Land Systems from the Proposal and Cumulatively with the Approved Project and Christmas Creek

| Land System | Extent within Pilbara | Proposed Maximum Disturbance | | Extent of Maximum Disturbance for Cloudbreak Project (includes approved footprint) | |
|-------------|-----------------------|------------------------------|-----|--|-----|
| | km ² | km ² | % | km ² | % |
| Turee | 9 277 | 11.0 | 0.1 | 11 | 0.1 |
| Christmas | 232 | 0.7 | 0.3 | 0.7 | 0.3 |
| Cowra | 203 | 6.0 | 3.0 | 6 | 3 |
| Jamindie | 11 833 | 92.0 | 0.8 | 134 | 1.1 |
| McKay | 4 274 | 20.0 | 0.5 | 22 | 0.5 |
| Marsh | 977 | 0.0 | 0.0 | 0 | 0 |
| Newman | 19 998 | 50.0 | 0.2 | 60 | 0.3 |

Habitat Fragmentation

Clearing also has the potential to result in fragmentation of habitats and lead to the inability of individuals to move between areas of habitat, as well as increase predation events as individuals move across cleared areas. Clearing within the mine footprint has the potential to create a barrier for some species that typically move north-south through this area to access the food, water and habitat resources of the Fortescue Marsh. However, the presence of contiguous habitat surrounding the Proposal area is expected to substantially mitigate the significance of the habitat fragmentation impact. Fragmentation of habitat will also be minimised through progressive rehabilitation, including re-establishment of major creek lines which may act as fauna corridors through the Proposal area.

Areas no longer required for the operation of the mine will be progressively rehabilitated as they become redundant.

9.5.2 Dewatering and Injection

Dewatering and reinjection activities will result in the raising and lowering of groundwater levels within and adjacent to the Proposal area. This can affect native fauna through the resultant effects on vegetation. Lowering the watertable can lead to impacts on phreatophytic vegetation that relies on constant access to groundwater to survive, as well as to carry out processes such as flowering and setting seed (Eamus et al. 2006). In contrast, raising the watertable as a result of water injection may result in bringing groundwater into the root zone of intolerant plants such as Mulga with consequent effects on vegetation health. Impacts to vegetation from groundwater drawdown and mounding are discussed in detail in Section 8.5.2 and summarised below.

The only vegetation communities known to be groundwater-dependent in the Proposal area are Coolabah (*Eucalyptus victrix*) and River Red Gum (*Eucalyptus camaldulensis*) communities, which tend to be concentrated in the riparian zone around creeks (Section 8.3.2). No creek line communities outside the maximum disturbance area are expected to be affected by groundwater drawdown (Figure 57).

Samphires may also be partially groundwater-dependent and may be affected by groundwater drawdown. Samphire vegetation is considered suitable habitat for the Night Parrot and the Fortescue Marsh is important for Migratory bird species. Up to 13 ha of Samphire may be affected by groundwater drawdown for two or more consecutive years which may affect the water available for the plants' survival. This equates to approximately 0.04% of the local extent of this habitat and as such will not significantly affect the availability of this habitat in the local area.

Mulga communities are known to be particularly susceptible to waterlogging and associated salinisation of the root zone. Mulga is considered suitable habitat for Mulgara, Bilby, Short-tailed Mouse and Bush Stone-Curlew (Table 28). Up to 14 ha of this habitat is within the groundwater mounding area where groundwater may rise to within the root zone of the Mulga (estimated to be within 2 m below ground level) for two or more consecutive years (this extended period of mounding may result in adverse effects on the health and/or survival of Mulga vegetation in this area – Section 8.5.2). This assessment indicates that there is unlikely to be any significant additional impact to this habitat type as a result of mounding.

9.5.3 Alteration to Surface Water Flow Regimes

Some habitats, particularly Mulga communities that are partially dependent on sheet-flow runoff, may be susceptible to alterations to surface water flow due to the presence of mine infrastructure upstream from these areas. Impacts on Mulga from alteration of surface water flows are discussed in detail in Section 8.5.3. Up to 222 ha of Mulga may be shadowed by mining infrastructure for more than two years. This equates to approximately 0.5% of the total Mulga habitat mapped in the local area, which does not significantly add to the proportion of this habitat type being directly affected by the Proposal (22% to 22.5%).

9.5.4 Trenching and Injection Infrastructure

Installation of pipelines for injection infrastructure has the potential to provide barriers for fauna movement as well as risk of stress, injury or fatality during construction where trenches are required. Pipelines will be installed above ground to minimise disturbance associated with this temporary infrastructure. To avoid creating a barrier to fauna movement, pipelines will be raised or buried at approximately 75 m intervals to allow for vehicle access, surface sheet-flow and fauna movement. The sections of pipelines to be buried below creek lines or to allow vehicle access will be short to limit the length of trenching required. During installation, ramps will be provided in any trenches left open overnight to allow fauna to egress if they fall in. Trenches will also be inspected each morning and any trapped fauna removed and translocated.

9.5.5 Vehicle Movements

Mortality of small and sedentary fauna unable to move out of the area prior to clearing may occur. *Ramphotyphlops ganeii*, Pebble-mound Mouse, Northern Short-tailed Mouse, Long-tailed Dunnart and Brush-tailed Mulgara are all small sedentary species in which there could be a local loss of individuals due to their limited ability to relocate to neighbouring areas of similar habitat. Clearing during the breeding season also has the potential to destroy nests, burrows and chicks of any species breeding within the Proposal area. Conservation significant species likely to breed within the Proposal area include Rainbow Bee-eater, Bush Stone-curlew, Australian Bustard, Grey Falcon, and Peregrine Falcon.

Preparation of the site and the passage of vehicles on haul roads and access tracks have the potential to result in the fatality or injury of individuals.

Implementation of speed limits designed to limit the likelihood of fauna road deaths, and restrictions on driving off-road will limit the impact of the Proposal. Isolated deaths of individuals are not expected to affect the conservation status and distribution of any fauna species.

9.5.6 Presence of Artificial water bodies

Artificial water bodies may attract native fauna, creating the risk of altering fauna behaviour, entrapping or poisoning animals if water quality is not suitable for consumption. The artificial water bodies may also attract and increase introduced fauna numbers. Artificial water bodies that will be created at the mine include tailings storage facilities and storage ponds to supply the injection wellfield operations.

There are existing artificial water sources in the vicinity of the Proposal area including stock bores and turkey nests dams (raised, earthen-walled reservoirs). The stock bores have provided a reliable supply of freshwater in the region for many decades and are spaced at intervals of 10-15 km along the northern side of the Fortescue Marsh. These bores are heavily used not only by stock (cattle) but by feral and native fauna. However, in most cases the water is contained to troughs or small overflow areas and do not support waterbirds to any great extent with the exception of Minga Well. Minga Well has a large (100 m plus) overflow area and over the last five years has had what appears to be a resident flock of Plumed Whistle-Ducks as well as small numbers of dotterels, grebes, herons and other duck species (Bamford M [Bamford Consulting Ecologists] 2011, pers. comm).

Additional artificial water bodies can have a number of impacts upon fauna:

- they can support additional livestock and feral fauna that rely on the artificial water bodies for drinking
- they can support additional native fauna that rely on the artificial water bodies for drinking. For example, kangaroos can increase in abundance and this can increase grazing pressure in surrounding areas. Artificial water bodies also support many bird species that would otherwise be uncommon or absent during dry periods. This includes granivorous species (e.g. finches and parrots) but also a suite of large, carnivorous birds such as butcherbirds. Interactions between these sorts of species and other bird species may be a concern and it has been found (Harrington 2002) that small, insectivorous birds decline in abundance close to artificial water bodies in pastoral areas, apparently due to interaction with large, carnivorous birds. When in flood, the Fortescue Marsh attracts large numbers of waterbirds which are unlikely to be attracted to small artificial water bodies. As the marsh dries out, however, waterbirds may be attracted to small water bodies rather than dispersing. The artificial water bodies can also be viewed as providing a refuge for waterbirds as the natural wetland dries out. Such interference with natural dispersal is probably of little significance given the usually small numbers of waterbirds involved, but could be a consideration if large areas of habitat were created
- they can attract waterbirds and other wildlife that subsequently die. Artificial water bodies may be perceived as habitat by waterbirds, but may be either toxic or simply sterile, with the result that waterbirds land on them and then die. Larger mammals can also become entrapped in mud around artificial water bodies.

As there are already artificial water bodies in the area, some of the above impacts are already occurring. The provision of additional artificial water bodies could be expected to increase these impacts. The nature of those impacts depends very much on the nature of the artificial water bodies. Tailings storage is proposed to be undertaken in completed mine pits which have no surrounding habitat value while in use and therefore having limited access to most fauna. The water storage ponds are contained without surrounding wetland vegetation.

To minimise the potential impacts of artificial water bodies on fauna, Fortescue will undertake the management measures described below as appropriate. In most cases, the aim of the following measures is to reduce accessibility or attractiveness of the artificial water body to fauna, with a focus on fauna where there is likely to be a conservation issue:

- fencing to exclude livestock and larger feral and native mammals from all artificial water bodies created by Fortescue
- while the intention is to exclude fauna from artificial water bodies, egress points will also be included in the water storage facilities to ensure that any fauna that do enter the waterbody can escape
- prevent overflow of artificial waterbodies in dry conditions
- confine water to as small an area as possible, with steep sides and a narrow cleared area surrounding the water to ensure that no wetland habitat is established or overhanging trees exist to encourage fauna use of the water body
- fauna deterrent devices, such as flapping high-visibility material on ropes strung over the artificial water body, will be used above water bodies that are observed to be attracting birds
- artificial water bodies will be removed once no longer required for mining.

With the above management measures in place, the presence of additional artificial water bodies in the Proposal area is not expected to have a significant impact on fauna.

9.5.7 Impacts to Fauna of Conservation Significance

The likelihood of impacts to species of conservation significance that have either been recorded or are considered likely to occur at the Proposal area is discussed below. Additional information regarding species listed under the EPBC Act can be found in Section 14.

Threatened Species

For the purpose of assessing impact to EPBC listed species, preferred and potential habitats were mapped within the Cloudbreak survey area (Figure 75, Figure 77, Figure 79, Figure 81 and Figure 83). The maximum disturbance was calculated based on the extent of the habitat within the maximum mine disturbance area and indicative pipelines compared to the extent within the Cloudbreak survey area (Table 32). It should be noted that previous habitat disturbance calculations (Section 9.5.1) have been based on a combined Cloudbreak and Christmas Creek survey area.

Table 32: Maximum Direct Disturbance of Habitats of EPBC Listed Species within the Cloudbreak Survey Area

| Species | Habitat in Cloudbreak Survey Area | Habitat in Maximum Mine Disturbance Area (excludes Approved Footprint) | | Habitat in Maximum Mine Disturbance Area (includes Approved Footprint) | |
|--|-----------------------------------|--|-----|--|-----|
| | (ha) | (ha) | % | (ha) | % |
| Night Parrot – preferred habitat | 3768 | 8 | 0.2 | 8 | 0.2 |
| Northern Quoll – preferred habitat | 32 | 27 | 84 | 27 | 84 |
| Greater Bilby - area with patches of potential habitat | 28 096 | 10 911 | 39 | 14 929 | 53 |
| Greater Bilby - potential habitat | 3768 | 8 | 0.2 | 8 | 0.2 |
| Mulgara | 3768 | 8 | 0.2 | 8 | 0.2 |
| Pilbara Leaf-nosed bat – potential foraging habitat only | 14 114 | 6915 | 49 | 8322 | 59 |
| Eastern Great Egret and other migratory waders | 16 063 | 1142 | 7 | 1751 | 11 |

Night Parrot (*Pezoporus occidentalis*)

The Night Parrot is a nomadic species, listed as Endangered under the EPBC Act. Records indicate the species occupies *Triodia* grasslands and chenopod and Samphire shrublands which occur within the Fortescue Marsh. Little is known of the species given its low numbers and reclusive behaviour, however it is thought that the species may be ground-dwelling and have the ability to live away from water sources; possibly returning to water sources during hot, dry conditions (Bamford 2010a).

After a series of unconfirmed sightings over several decades suggested the Night Parrot *Pezoporus occidentalis* still survived in areas in the vicinity of the Fortescue Marsh, the Night Parrot was reliably detected at Minga Well on Mulga Downs Station in April 2005 during surveys commissioned by Fortescue for the Environmental Impact Assessment of the approved Cloudbreak Mine. Eight Night Parrot surveys have since been conducted using a range of techniques and despite a high survey effort with numerous targeted surveys conducted within the Cloudbreak survey area no further individuals have been recorded. The survey conducted in December 2009 (Bamford 2010a) recorded a call and sighting of an unidentified bird near Cooke's Pool on the Fortescue Marsh. The bird had the potential to be a Night Parrot given the characteristics of the call and size of the bird, however, the sighting was made at dusk in low light conditions making it impossible to determine colour or markings of the bird. The 2010 Night Parrot survey (Bamford 2011) did not observe any known or possible Night Parrots, nor did the Ecologia (2011a) survey which included 13 hours of targeted searches.

Based on the predicted preferred habitat for the species, the chenopod shrubland and hummock grassland within and surrounding the Fortescue Marsh provides good conditions for the species and it should be considered as likely to occur, on at least an occasional basis, in these areas. A maximum of 8 ha (0.2% of Cloudbreak survey area extent) of this preferred habitat will be affected by the Proposal for the installation of injection infrastructure. *Triodia* communities are widely distributed throughout the area (and the Pilbara) and Samphire and chenopod shrublands are also represented extensively in the area within and on the fringes of the Fortescue Marsh. Consequently, if the Night Parrot is present in the area, it will not be directly affected by the small amount of habitat clearing. It is noted that the one record of Night Parrot in the Proposal area was in Mulga woodland at Minga Well. However this was most likely due to the presence of water in the area during a period of drought in the Pilbara (Ecologia 2011a) and although mulga woodland may be utilised by the Night Parrot, this vegetation type is not considered a key habitat for this species.

Changes to groundwater levels as a result of dewatering are also unlikely to affect a significant area of this potential habitat (Section 9.5.2).

Night Parrot surveys will continue annually to research the potential occurrence of Night Parrots in the vicinity of Cloudbreak Mine.

Northern Quoll (*Dasyurus hallucatus*)

There are very few records of Northern Quoll from the southern Chichester region, with one single record from the survey area at the edge of the Fortescue Marsh in 1980 (Figure 67). Northern Quoll scats have been recorded from rocky areas within the Cloudbreak area (ATA 2006a and 2006b) (Figure 67); however, there are only limited areas of rocky escarpments that may provide a small amount of suitable denning habitat for Northern Quoll. Approximately 32 ha of rocky escarpment habitat was recorded within the Cloudbreak survey area with 27 ha occurring within the maximum mine disturbance area (Table 32). During the Ecologia (2011a) survey, a motion camera was set up in potential den habitat for 36 hours but did not record any Northern Quoll activity. Regardless, Fortescue commits to avoiding direct impact on this habitat and will not place any mine pits or other infrastructure within the rocky escarpment habitat.

Due to the limited availability of habitat, it is not expected that many, if any, Northern Quolls are resident within the Proposal area. However individuals, especially males, may occasionally move through the Proposal area in search of food, water or females. Due to the low number of individuals and limited amount of suitable denning habitat that will be avoided, no significant local or regional impacts to the species are anticipated as a result of the Proposal.

Greater Bilby (*Macrotis lagotis*)

A Bilby was recorded from near Kardardarrie Well, 8 km west of the survey area in 2004 (Biota 2005) and a dead individual was recorded from Mulga Downs Station in 1997 (Bamford 2005a, Biota 2005, DEC database). Both these recordings are outside the Proposal area. No individuals or recently active burrows of the Bilby were recorded during the Ecologia (2011a) survey. One potential burrow was recorded (50K 721370E; 7531310N) but no signs of recent activity was present. A motion camera was set up in front of the burrow for 36 hours and no Bilby activity was recorded, confirming its inactivity. Recently used burrows were also identified near Cockeye Bore to the east of the Proposal area during the Bamford (2005a) survey in an area of Spinifex and chenopod shrubland on loam soil (Figure 67). The burrows were in an area of a few hectares and there were some older burrows in similar habitat within a few hundred metres. Similar habitat has been surveyed in the region without other burrows being found, so it would appear that Bilbies in the area are widely dispersed but that other colonies may be present (Bamford 2005a). Numerous diggings have also been recorded from across the survey area; potentially from Bilbies although this has not been confirmed (Ecologia 2010a).

Bilbies occur in a variety of habitats, including Spinifex grassland, *Acacia* shrubland, open woodland, and cracking clays (Maxwell *et al.* 1996). Bilbies most likely occur in the Proposal area, on at least an occasional basis, wherever soils allow them to construct burrows such as areas of sandy or sandy-loam in hummock grassland, Mulga woodland and areas along the edge of the Fortescue Marsh. Up to 8 ha or 0.2% of the Bilby's preferred hummock grassland and halophytic shrubland habitat within the Cloudbreak survey area will be affected by this Proposal (Table 32). Of the 28 096 ha that may contain patches of suitable burrowing habitat, up to 10 911 ha may be directly impacted by the Proposal (Table 32)..

The Proposal is not expected to result in significant additional impact on these habitats as a result of changes in groundwater levels and surface water regime (Sections 9.5.2 and 9.5.3 respectively).

Based on the proposed clearing amounts and the availability of suitable habitat outside of the Proposal area, the Proposal is not expected to result in significant impacts to the Greater Bilby. In addition, Fortescue has been and will continue to implement a feral cat control program in consultation with DEC to assist in alleviating threats to the species from predation.

Peregrine Falcon (*Falco peregrinus*)

Peregrine Falcon has been previously recorded in the Cloudbreak survey area and it is probable that at least one pair occurs in the area and nests either on a ledge in the nearby ranges, north of the Proposal area, or in a tall tree along a creek line (Bamford 2005a). The species is likely to hunt in the ranges, along creek lines and the Fortescue Marsh (Ecologia 2010a), although it was not recorded during the Ecologia (2011a) survey. Clearing will result in the removal of up to 21% of the local extent (combined Cloudbreak and Christmas Creek survey area) of creek line habitat and 26% of range habitat; however, there will be no direct impacts to the Fortescue Marsh. The removal of potential hunting and breeding habitat is not expected to result in significant impacts to the Peregrine Falcon as this species has the ability to move away from disturbances and similar habitat is widespread in the surrounding areas. Regionally, less than 0.01% of potential hunting habitat (Newman and McKay land systems) will be affected by the Proposal. The only potential local impact is the destruction or abandonment of nests as a result of vegetation clearing during the breeding season if it occurs in close proximity to rocky ledges or large trees.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

The Pilbara Leaf-nosed Bat is unlikely to roost in the Cloudbreak area due to a lack of suitable roosting habitat. As with all cave-roosting bats, the Pilbara Leaf-nosed Bat has separate diurnal and nocturnal habitats - the roost and foraging sites. Dry season roosting sites for the Pilbara Leaf-nosed Bat are restricted to caves and mine adits (horizontal shafts) with stable, warm and humid microclimates because of its poor ability to thermoregulate and retain water (SEWPAC 2011). Such roosting habitats have limited availability in the Pilbara. However, the species may forage in the upland parts of the Proposal Area (Figure 83). Approximately 8322 ha of potential foraging habitat will be directly affected by the Proposal (Table 32); however, as roosting habitat is considered to be the limiting factor for this species, it is unlikely that Proposal will result in significant impact on the Pilbara Leaf-nosed Bat.

Migratory Bird Species

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater was recorded foraging near Minga Well during the Ecologia (2011a) survey. The species has been recorded from almost all surveys within and surrounding the survey area (Bamford 2005, Biota 2005, Ecologia internal database, ENV 2008, NatureMap). The species breeds throughout most of its range and is thought to adapt well to disturbance. It is represented in a wide range of habitats (SEWPAC 2011) including the Proposal area (Figure 68). Given the widespread occurrence of the species in the region and Australia and the range of habitat available, it is considered that the species will not be significantly affected by the Proposal.

Eastern Great Egret (*Ardea modesta*), Wood Sandpiper (*Tringa glareola*), Common Greenshank (*Tringa nebularia*), Red-necked Stint (*Calidris ruficollis*), White-bellied Sea-eagle (*Haliaeetus leucogaster*)

These species are likely to be most common along the edge of the Fortescue Marsh, particularly after rain. A maximum of 0.03% of the local extent of Fortescue Marsh and fringing habitat will be directly affected by the Proposal and therefore should not significantly affect the presence of these species. No impact on surface water levels in the marsh, and consequently the availability of water for these birds, is expected due to the Proposal as this is driven by rainfall and surface runoff. A total of 16 063 ha of habitat suitable for these species was found in the survey area (Table 32). Of this, 1751 ha (11%) may be directly impacted by this proposal. Much of this habitat is ephemeral creek lines, which will only provide habitat when the creeks are infrequently flooded (Table 32).

In addition, similar habitat is well represented outside of the Proposal area. As a result, the Proposal is not expected to impact the foraging area available to these species, and hence no regional impacts are anticipated.

Priority Species

Grey Falcon (*Falco hypoleucos*)

Records from within the Proposal area indicate that a small number of Grey Falcon may nest and/or hunt within the Proposal area (Figure 68), although they were not recorded in the most recent survey (Ecologia 2011a). There may therefore be a small local impact as a result of vegetation clearing as these birds are forced to relocate to surrounding areas. As a result of the ability of Grey Falcons to move away from disturbances and the presence of similar habitat in the surrounding areas, the Proposal will result in no significant impact to Grey Falcons on a regional scale. The only potential local impact is the destruction or abandonment of eggs and nestlings as a result of vegetation clearing or human disturbance during the breeding season.

Australian Bustard (*Ardeotis australis*), Bush Stone-curlew (*Burhinus grallarius*)

These birds have been recorded throughout the Proposal area almost entirely from the Snakewood and Mulga woodland habitat (Figure 68), and are likely to forage and breed within this area. However, the species' have the ability to move away from disturbances and coupled with the widespread presence of habitat similar to that which exists in the Proposal area in the surrounding areas, no significant impact to the species is expected.

Star Finch (*Neochmia ruficauda subclarescens*)

Minga Well is likely to be the only area of suitable habitat in proximity to the Proposal area for the Star Finch. No disturbances to Minga Well are planned to occur and hence no significant local or regional impacts are anticipated.

Pebble-mound Mouse (*Pseudomys chapmani*)

Numerous active and inactive mounds of the Pebble-mound Mouse have been recorded throughout the Spinifex-covered hillslopes along the northern edge of the Proposal area (Figure 67). This area provides excellent habitat for the species and they are likely to be moderately common in the area. Approximately 24 272 km² of Spinifex-covered hills and ranges exist within the Pilbara region (Newman and McKay land systems). Only 129 km² (0.5%) of these land systems are within the Proposal area. As the species potential habitat is widespread throughout the Pilbara and the species is generally common in the Pilbara, including the Chichester Range, no regional impacts to the species are anticipated. However, Western Pebble-mice have a very limited ability to move away from disturbance and hence vegetation clearing of the Spinifex-covered hillslope habitat within the Proposal area is likely to impact local populations, resulting in a local loss of individuals.

Brush-tailed Mulgara (*Dasycercus blythi*)

Brush-tailed Mulgara may occur within the Proposal area, however targeted searches for the Brush-tailed Mulgara resulted in no positive records of either individuals or secondary evidence (burrows) of this species (Ecologia 2011a). Potential burrows have been previously observed within the maximum mine disturbance area, however there is little suitable habitat and few local records of the species. Mulgara habitat within the maximum mine disturbance area is considered to be limited, with only 8 ha likely to be affected, and therefore it is unlikely that the Proposal will result in significant impact to this species.

Northern Short-tailed Mouse (*Leggadina lakedownensis*)

The Northern Short-tailed Mouse is considered likely to occur in the Proposal area, although they were not recorded during the most recent survey (Ecologia 2011a). Northern Short-tailed Mice have a limited ability to move away from disturbance and hence vegetation clearing within the Mulga, Snakewood and other Acacia woodland habitat of the mine footprint and pipeline corridors is likely to cause impacts to local populations and result in a local loss of individuals. As the species is generally common in the Pilbara, including the Chichester Range, no regional impacts to the species are anticipated.

Ghost Bat (*Macroderma gigas*)

There are no anticipated impacts to Ghost Bat populations due to the likely absence of any roosting sites (such as caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles) within the Proposal area. If present within the area, some individuals may be impacted through a minor loss of hunting territory as a result of vegetation clearing, but it is anticipated these individuals will be able to find new hunting ranges in the surrounding areas. No regional impacts to the species are expected.

Short-Range Endemic Invertebrate Species

Habitat types reflect underlying geology, soil, surface hydrology and position in the landscape, and generally provide a reasonable surrogate of habitat parameters in respect to SREs. However, the Ecologia (2011b) survey indicated that habitat type was not found to be a significant determinant of species richness and species abundance of SREs. The results demonstrated that the SRE groups have no preference for any of the four habitats in which they were located. The Low Halophytic Shrubland was the only habitat that did not record any SRE species. This is likely to be caused by the lack of tall vegetation and leaf litter resulting in very few suitable micro-habitats for SRE groups. The creek line habitat is likely to be the most diverse in terms of SRE richness (Ecologia 2010b). All the habitats described in the Proposal area are very well distributed in the surrounding area, reducing the likelihood of SREs being confined to the proposed disturbance area (Ecologia 2010b). Impacts to fauna habitats are discussed in Section 9.5.1.

Predicted impacts on potential SRE species and the likely and confirmed SREs recorded during the Ecologia (2011b) are described below:

- *Aname* 'MYG001 group' and *Austrohorus* sp. were recorded outside of the Proposal area within habitat that will not be significantly affected by the Proposal (0.4% the local extent of hummock grassland on the fringe in the Fortescue Marsh is predicted to be directly affected), hence it is unlikely that the abundance and distribution of this species will be affected by the Proposal
- *Antichiropus* 'Cloudbreak' and *Urodacus* sp. were recorded in creek line habitat within the maximum mine disturbance area. This species potentially exists along the entire length of the creek and may therefore be found outside the Proposal area. Approximately 20% of the mapped extent of the creek line habitat will be disturbed as a result of the Proposal
- *Conothele* sp. and *Beierolpium* 'sp. 8/2' were recorded within and outside the Proposal area in both creek line and hummock grassland habitat (*Beierolpium* 'sp. 8/2' was also recorded in Mulga and Snakewood habitat). Considering that these species have been found across at least two habitats and the hummock grassland habitat will only have 0.4% of its mapped extent affected by the Proposal, impacts to this species are not likely to be significant
- *Linnaeolpium* sp. was recorded outside of the Proposal area and as such will not be affected by the Proposal. Potential habitat for this species includes Mulga and Snakewood habitat which although is being affected by the Proposal (21% of mapped extent), is well represented in the area and extends beyond the current mapped area
- based on literature, database searches and current survey knowledge, the only potentially highly restricted SRE species recorded in the Proposal area is the Opilionid *Dampetrus* 'Pilbara 1'. This species was found at two sites but is likely to occur within similar refugial sites in the region (Harvey 2006).

The other recorded potential SRE species identified as occurring in the WAM database (Ecologia 2010b) generally occur elsewhere in the Pilbara, hence no regional impacts to the species are anticipated (Dr Roque-Albelo L August 2010, pers. comm).

The following impacts are expected to the three Priority Two SRE species identified as potentially occurring within the Proposal area.

***Antipodogomphus hodgkini* and *Nososticta pilbara* (Dragonfly)**

These species inhabit streams, rivers and riverine pools, hence areas such as Minga Well and pools (yintas) of Fortescue Marsh may provide potential habitat (Dr Roque-Albelo L August 2010, pers. comm). Minga Well will not be affected by the Proposal; however, there may be some reduction in surface water catchment areas for the yintas of the Fortescue Marsh (Section 7.5.1). As the short term reduction in catchment area during mining is less than 10% and the long term reduction post-closure is 2% or less for the yintas, there is not expected to be any significant long term impact on this habitat. If these species are present, the Proposal should not significantly affect the abundance and distribution of these species.

Dupucharopa millestriata

Creek lines, wells and rock outcrops are potential habitat for this species, hence local populations, if present, may be affected by the Proposal. However, extensive areas of similar habitat occur outside the Proposal area, therefore, the species should not be adversely affected on a regional level (Dr Roque-Albelo L August 2010, pers. comm).

Subterranean fauna

Stygofauna

Stygofauna may be affected by pit excavation, groundwater abstraction and groundwater injection.

Groundwater abstraction to draw the watertable below the level of mining may cause significant risk to restricted stygofauna species. If drawdown occurs through the full thickness of the aquifer, any stygofauna species restricted to the drawdown area will be affected. The impacts of injection of hypersaline water are difficult to predict and largely depend on the resultant salinity profile in the area of injection. There is some evidence that fresh and brackish water stygofauna species occur in groundwater above the halocline around Fortescue Marsh. However, injection into the Oakover Formation aquifer should have little effect on the salinity of water in the alluvium/detrital aquifer as discussed in Section 6.5.5.

The area surrounding the Proposal area contains a stygofauna community that is only moderately rich and consists mostly of widespread species (Bennelongia 2011). No stygofauna species is restricted to an area where the Proposal is likely to cause significant impact through pit excavation or groundwater drawdown, although one species, the copepod *Parapseudoleptomesochra* sp. B1, will experience about 1 m of drawdown for possibly several years (Figure 65). *Parapseudoleptomesochra* sp. B1 and the apparently restricted copepod, *Goniocyclops* sp. B2, occur in an area where there may be some impact from the injection of hypersaline water, although existing investigations suggest the injection of saline water into the Oakover Formation will not affect the shallow groundwater where both species were recorded.

Troglofauna

Data with which to characterise the troglofauna community at the Proposal area are very limited; however, sampling at mine sites to the east suggests that a relatively low to moderate number of troglofauna species may occur in Marra Mamba Formation within the mine footprint.

Impacts to troglofauna may occur through the removal of potential habitat during pit excavation. The area where troglofauna have been previously recorded (Figure 66) will not be subject to excavation for mine pits or other infrastructure. Injection infrastructure will mostly remain above ground with the exception of occasional section that may need to be buried to allow for fauna movement and surface water flow. This is not expected to affect troglofauna habitat.

Fortescue has commissioned a troglofauna survey that involves the collection of 180 troglofauna samples from the Cloudbreak tenement and adjacent exploration leases to the north. Results from this survey are expected to be available in June 2011.

9.6 CUMULATIVE IMPACTS

The main potential cumulative impact is the combined effect of clearing of Mulga habitat from Cloudbreak, Christmas Creek Mine and Roy Hill Mine. Cumulative impacts of Mulga are discussed in more detail in Section 8.6. Cumulative impacts to creek line habitat (groundwater-dependent vegetation) and halophytic shrubland (Samphire) are also discussed in Section 8.6. Generally, all habitat types that will be affected by the Proposal occur in other project areas and will have some cumulative impact to the local representation of these habitat types. However, all of these habitats occur in the wider region and cumulative impacts are not expected to have significant impacts on the distribution and abundance of fauna species.

9.7 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

9.7.1 Ground Disturbance

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a GDP). Under the permitting process areas of vegetation which may comprise high value flora and vegetation, including of habitat value such as Mulga and 'habitat' trees, may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered, such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted, further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the proposed 2015 pastoral lease exclusion zone.

9.7.2 Adaptive Management of Groundwater

Impacts to significant fauna habitat such as Mulga Woodland and the Fortescue Marsh from groundwater mounding and drawdown will be managed under an Adaptive Management Framework. This approach is discussed in more detail in Section 8.7.2.

9.7.3 Environmental Management Plan

Management of potential impacts on fauna from this Proposal are also addressed in Biodiversity Management Plan in the EMP (Appendix A) and includes the following key management actions:

- clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above)
- significant fauna habitat will be spatially identified and where appropriate demarcated on site
- all lined surface water storage areas will have fauna egress points
- vehicles speeds will be restricted across the Proposal area
- off road driving or driving on restricted access routes will be prohibited other than for emergency situations
- clearing will not be undertaken outside authorised areas
- rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented

- appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes
- low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards
- lighting will be directed onto construction or operational areas.

9.8 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to terrestrial fauna:

- 1) Approximately 12 600 ha of fauna habitat will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga, Snakewood and other Acacia woodland and Spinifex hills and ranges habitat.
- 2) There will be some loss of creek line habitat but very little clearing within halophyte shrubland and hummock grassland habitats.
- 3) There will likely be some localised impacts to the Priority fauna species Pebble-mound Mouse and Northern Short-tailed mouse due to clearing activities. However, these species are widespread in the region and the Proposal is unlikely to significantly affect their regional abundance or range.
- 4) Significant regional impact to fauna is highly unlikely as five of the six habitats that occur within the Proposal area also occur extensively outside the Proposal area. Clearing will be avoided in the rocky escarpment habitat which does not occur widely outside the Proposal area.
- 5) The Proposal itself will not conflict with the WC Act, as no fauna species will cease to exist or have its conservation status affected as a result of the implementation of the Proposal.
- 6) Significant regional impact to SRE species is not expected to occur as a result of the Proposal as it is likely species occurring within the Proposal area occur in the wider region.
- 7) A troglofauna survey will be undertaken to better understand the impacts to troglofauna communities in the Proposal area.
- 8) It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under either the WC Act or EPBC Act.

- 9) Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal potentially adding to the body of knowledge available on this rare species.

Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.

10. FORTESCUE MARSH WETLAND IMPACT ASSESSMENT

10.1 RELEVANT ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

10.1.1 EPA Objectives

The EPA applies the following objectives in assessing proposals that may affect areas of natural heritage:

- To protect the environmental values of areas identified as having significant environmental attributes.
- To maintain the integrity, functions and environmental values (of the Fortescue Marsh).

10.1.2 Legislation, Policy and Guidance

The following policies are relevant to the identification and protection of the Fortescue Marsh.

Directory of Important Wetlands

A comprehensive inventory of Australia's nationally important wetlands was undertaken in the 1990s under the auspices of the National Wetlands Program. This resulted in the publication of the *Directory of Important Wetlands in Australia* (the Directory) (Environment Australia 2001).

The Directory is designed to be a source of information for policy makers, biodiversity professionals and the wider community. Its fundamental purpose is to inform policy development and decision making on wetland protection and the sustainable utilisation of wetland resources.

A wetland may be considered nationally important if it meets at least one of the following criteria (Environment Australia 2001):

- 1) It is a good example of a wetland type occurring within a biogeographic region in Australia.
- 2) It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
- 3) It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.
- 4) The wetland supports 1% or more of the national populations of any native plant or animal taxa.

- 5) The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level.
- 6) The wetland is of outstanding historical or cultural significance.

The Fortescue Marsh has been identified as meeting criteria 1, 2 and 6 and is therefore considered as a Wetland of National Importance.

Figure 69 shows the boundary of the marsh as identified by SEWPAC.

Register of the National Estate

The Register of the National Estate (the Register) is a list of natural, Indigenous and historic heritage places throughout Australia. The Register is maintained by the Australian Heritage Council, which is the principal adviser to the Australian Government on heritage matters.

The Fortescue Marsh is listed as an 'Indicative Place' on the Register of the National Estate due to its importance as a habitat for migratory birds (SEWPAC 2010a). Nomination for inclusion on the Register is based on the following:

- importance for conservation of waterbirds
- importance for periodic breeding by colonial waterbirds, especially Australian Pelican (*Pelecinus conspicillatus*) and Black Swan (*Cygnus atratus*). It is the only pelican breeding area in the bioregion and is isolated by large distances from other pelican breeding areas
- comprises an unusual type of wetland and natural landscape, being a large arid-zone floodplain contained in a broad valley between ranges, with no outlet (i.e. a terminal drainage basin), which is unique in WA. It is a good example of its type in terms of size, condition and integrity
- possibility that other cultural values, both indigenous and non-indigenous, of National Estate significance may exist in this place (SEWPAC 2010a).

Ramsar Conventions on Wetlands of International Importance

The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation of wetlands and their resources. Australia was one of the first countries to sign the Convention, adopted in 1971, and has been an active member since it came into force in 1975.

Signatories to the Ramsar Convention commit to maintaining the ecological character of their Wetlands of International Importance, and to plan for the "wise use" of all of the wetlands in their territories (SEWPAC 2010b). The Fortescue Marsh has been proposed as a future Ramsar wetland but there has been no formal nomination at this stage (DEC 2009). If listed, the Fortescue Marsh will become legally recognised as an area of National Environmental Significance, subject to the provisions of the EPBC Act.

JAMBA, CAMBA and ROKAMBA Treaties

The Japan Australia Migratory Bird Agreement (JAMBA), China Australia Migratory Bird Agreement (CAMBA) and Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) are Treaties for the protection of certain migratory bird species. The Treaties require each country to take appropriate measures to preserve and enhance the environment of bird species subject to the Treaty provisions.

The Fortescue Marsh is recognised as providing habitat for several bird species listed under the JAMBA and CAMBA Treaties; and possibly also the ROKAMBA Treaty which came into force in 2007 (SEWPAC 2010c).

All species listed under the JAMBA, CAMBA and ROKAMBA Treaties are subject to the legislative protection of the EPBC Act. Species listed under JAMBA Treaty are also protected under Schedule 3 of the *Wildlife Conservation Act 1950*.

Threatened and Priority Ecological Communities

A TEC is defined as “a naturally occurring biological assemblage that occurs in a particular type of habitat - which is found to fit into one of the following categories; “presumed totally destroyed”, “critically endangered”, “endangered” or “vulnerable”” and listed TECs are defined under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 as environmentally sensitive areas (DEC 2007a).

For an ecological community to be classified as a TEC, there is a requirement for detailed biological surveys to be completed. DEC maintains a list of PECs that have been identified as possible TECs but have not been adequately surveyed or evaluated under the TEC listing criteria. PECs are ranked in order of priority, with Priorities 1, 2 and 3 denoting the order of priority for further investigation (DEC 2007b).

The marsh has recently been classified as a Priority 1 PEC and comprises an area from east of Mulga Downs to Marillana and Roy Hill Stations. The Fortescue Marsh PEC classification was based on the following:

- occurrence of endemic *Eremophila* species (locally restricted) and several near endemic and new to science Samphire species
- it is a recorded locality for the Night Parrot and Greater Bilby, both of which are listed as rare and endangered under State and Commonwealth legislation
- occurrence of several locally restricted aquatic invertebrates
- occurrence of specific vegetation types (of conservation interest) found only around the marsh on Mulga Downs station and an unusual vegetation system further downstream.

The significance of vegetation types within the Fortescue Marsh is further described in Section 8.3.

Fortescue Marsh Strategic Planning

The EPA has initiated a strategic planning process focused on protection of the Fortescue Marsh from mining activities in the Upper Fortescue River Catchment. Under the process, a project working group has been established including representatives from the EPA, DoW, DEC, DMP, Fortescue, Rio Tinto Iron Ore (RTIO), BHP Billiton, Roy Hill Iron Ore (RHIO), Brockman Resources and BC Iron. Advice has been provided by DEC to the working group regarding the values of the Fortescue Marsh as summarised in Table 33.

Table 33: Summary of DEC Advice Regarding the Values of the Fortescue Marsh

| Value | Advice |
|--|--|
| Biogeographical Significance | The Samphire shrubland is the largest ephemeral wetland in the Pilbara Bioregion. Fringing Mulga woodlands (floristic community types) are at the northern limits of their continental distributional range and at the northern limits of the 'Acacia-Triodia transition zone'. |
| Flora | An endemic genus may possibly occur (i.e. <i>Eremophila spongiorarpa</i>). Three to four endemic Samphire species have been recorded with another two near-endemic taxa known. Numerous Priority flora taxa have been recorded. Several range end – disjunct outlying plant populations occur. |
| Floristics & Vegetation | The Samphire community of the marsh is unique. The fringing Mulga woodland to the north is in excellent condition – with little or no Buffel Grass. |
| Fauna | The marsh constitutes an arid wetland for waterbirds of national importance: 260 000 – 276 000 individuals from 47 species were recorded when the marsh was inundated in 1999 & 2003. The marsh is the second largest nesting sites for Pelicans recorded in Western Australia. Contemporary records have been made of the Critically Endangered Night Parrot from the marsh. Suitable habitat for the Bilby and Mulgara is present on the apron to the marsh. Significant aquatic invertebrate assemblages are associated with the marsh. Endemic taxa of macro-invertebrates are known only from the marsh and there is high species richness. |
| Threatened & Priority Ecological Communities | The marsh has recently been listed as a PEC. |
| Landscape/land systems | Three land systems are unique to the marsh (the Marsh, Marillana & Turee Land Systems). Only two of the twelve land systems associated with the marsh occur in the conservation estate. |
| Status & Reservation | The marsh is: <ul style="list-style-type: none"> • a wetland of National Significance in the Directory of Important Wetlands in Australia • an "Indicative Place" on the Register of the National Estate – Waterbirds • nominated for RAMSAR listing • earmarked for reservation under pastoral lease renewal arrangements scheduled for 2015. |

10.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the Proposal may affect the conservation areas of the Fortescue Marsh (Figure 70):

- dewatering and injection of groundwater may affect groundwater levels and vegetation health in areas with shallow groundwater such as the edge of the Fortescue Marsh
- installation of linear infrastructure, mine pits and waste landforms may result in interference with natural surface water flow regimes and increased erosion risk.

10.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

The hydrology of the Fortescue Marsh is described in Sections 6.3 (groundwater) and 7.3 (surface water). The text below represents a summary of these sections.

Surface Water

The Fortescue Marsh is an intermittently inundated wetland with broad-scale inundation occurring approximately one year in ten for a period of three to six months (SEWPAC 2010a). During smaller rainfall and runoff events, isolated pools form on the Fortescue Marsh at the main drainage inlets. Surface water runoff to the Fortescue Marsh is typically of low salinity but high turbidity (SEWPAC 2010a). Outflow from the marsh into the Lower Fortescue River does not occur (SEWPAC 2010a) as the marsh is internally draining with water discharging through evaporation and evapotranspiration.

The Fortescue Marsh and some semi-permanent water pools along its northern shoreline have been identified as having cultural significance. The semi-permanent water pools or “yintas” are considered to be associated with seasonal surface water flows and superficial aquifer expression rather than regional groundwater levels (Fortescue 2010a). Sections of the Proposal area are within the catchment of two yintas: Yinta 1 and Yinta 2 as shown on Figure 41.

Groundwater

The Fortescue Marsh is both a groundwater discharge and recharge zone. In the upslope areas, water percolates into the aquifer during rainfall events and flows towards the marsh and is then removed from the system by evaporation and evapotranspiration processes (Fortescue 2010a). Following a flood event, it is considered that a portion of the ponded surface water in the Fortescue Marsh will infiltrate (Fortescue 2010a) although this may be slowed by the presence of low permeability layers below the marsh surface.

Salinity in the upper aquifer underneath the marsh is greater than 50 000 mg/L (Fortescue 2010a). Groundwater under the marsh is stratified, with groundwater salinity below the marsh increasing with depth.

Numerical modelling of groundwater levels in the marsh shows that the main driver of groundwater levels in the marsh is the large rainfall events (generally greater than 100 mm/month) that cause periods of elevated groundwater level. The periods of inundation in the marsh are also related to these events.

10.3.1 Fortescue Marsh Vegetation

Vegetation of the Fortescue Marsh is dominated by Samphire species. The marsh also includes extensive areas with little or no vegetation that occur in lower elevation areas and appear to correlate with prolonged inundation areas associated with historical flood events. The marsh has recently been classified as a Priority 1 PEC. The Fortescue Marsh PEC is characterised by the presence of endemic and new to science *Eremophila* and Samphire (*Tecticornia*) species occurring on the fringe of the Fortescue Marsh. The Marsh vegetation is further described in Section 8.3.

10.3.2 Fortescue Marsh Fauna

The Fortescue Marsh is potentially utilised by the Night Parrot, which is a nomadic species listed as Endangered under the EPBC Act. Records indicate the species occupies *Triodia* grasslands and chenopod and Samphire shrublands that occur within the Fortescue Marsh. However, there are no records of the species occurring in the area. Bilbies and Mulgara are likely to occur in areas along the edge of the Fortescue Marsh.

Waterbird species including the migratory species Eastern Great Egret (*Ardea modesta*), Wood Sandpiper (*Tringa glareola*), Common Greenshank (*Tringa nebularia*), Red-necked Stint (*Calidris ruficollis*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*) are common at the edge of the Marsh, particularly following rain.

Fauna species present in the marsh are further discussed in Section 9.3.

10.3.3 Further Investigations

The Fortescue Marsh is recognised as having a range of important ecological values. Because of this, Fortescue is undertaking further studies to better understand the Marsh and associated vegetation communities. Fortescue's work has identified the following areas that would benefit from further investigation to manage any potential impacts of mining on the marsh:

- composition and spatial extent of vegetation types
- water sources used by the vegetation and the relative importance of these sources
- vegetation recruitment ecology
- marsh hydrogeology
- potential response of watertables in the marsh to dewatering and injection activities.

Fortescue is undertaking additional monitoring and modelling and investigations on the marsh to assist in further understanding of the marsh. This includes:

- a drilling investigation program for the Fortescue Marsh is consequently planned to progressively enhance the understanding of the Fortescue Marsh hydrology and water requirements of the Samphire
- funding work by UWA on the relationships between Samphire populations and water salinity and availability
- modelling of marsh water balances to determine vegetation response to changing groundwater and surface water conditions.

Until the relationship between ecology and hydrology on the Marsh is better understood, Fortescue's impact assessments are taking a precautionary approach that assumes the Samphire to be groundwater-dependent.

10.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

Alternative locations to avoid or minimise impact are somewhat limited as the location of the mine is dictated by the extent of resource. The key management strategy to limit impact on the Fortescue Marsh is the design of the dewatering and injection management system. The injection of excess water between the mining areas and the Fortescue Marsh largely mitigates the propagation of groundwater drawdown towards the marsh. This is a key objective of the water management strategy.

The dewatering and injection system is also designed so that under normal circumstances, all water not required for mining will be injected back into the aquifer rather than discharged to the surface. Discharge to the surface will only occur as a contingency measure. For current mining operations, this has not been required for over 12 months.

Vegetation within the marsh area will not be directly cleared as a result of this Proposal. This will limit the impact of the Proposal on flora and fauna in the marsh.

10.5 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

10.5.1 Surface Water

Reductions in catchment area as a result of the mine footprint are not expected to have a significant impact on the water balance of the marsh. As the Proposal area is completely within the catchment area of the marsh, flow diversions will still flow into the marsh and the potential impact is limited to increased infiltration in the mine areas. The Proposal will result in an estimated maximum of 16.5 km² of catchment reduction (mine footprint) in Stage 12, and 10.9 km² in the post closure scenario (Worley Parsons 2011). As the total catchment of the marsh is 26 000 km², this change is not large enough to impact significantly on the marsh hydrology. No change in surface water levels is expected as a result of the Proposal.

There will be some reduction in catchment areas for the yintas and the major creek lines that supply them (Section 7.5). However, as the short term reduction in catchment area during mining is less than 10% and the long term reduction post-closure is 2% or less for the yintas, there is not expected to be any significant long term effect on the water inflows to the yintas.

As surface water currently entering the marsh is turbid and becomes saline as it evaporates, the Proposal is unlikely to affect the marsh surface water quality. Measures will be taken to prevent chemicals entering surface and groundwater as outlined in Appendix A.

10.5.2 Groundwater

Abstraction and injection of water associated with mining may alter groundwater levels on the northern edge of the marsh.

Modelling indicates that a total of 150 ha of the marsh may be affected by drawdown greater than 1 m for a period of less than three non-consecutive years (Section 6.5.3, Figure 57). It is considered that this is unlikely to impact upon the marsh.

Mounding of greater than 1 m does not occur within the marsh area. Mounding of less than 1 m in magnitude may occur in limited areas and is expected to be of less than two years duration. As Samphire is tolerant of waterlogging and inundation, temporary mounding in this area is unlikely to have a significant impact on the vegetation.

Groundwater quality is not expected to be affected by the Proposal, as the groundwater below the marsh is hyper-saline. Injection of water adjacent to the marsh will be limited to saline injection water (Fortescue 2010a).

10.5.3 Vegetation and Flora

No clearing of vegetation will occur within the marsh area as a result of this Proposal.

Over the life of the Proposal, drawdown of greater than 1 m is expected to occur in approximately 150 ha of the marsh and for only one year at any given location. If this drawdown period coincides with a year where there is average or above rainfall, the Samphire would be likely to survive this short term drawdown as they are drought tolerant and can utilise even low levels of soil moisture from rainfall. Approximately 13 ha of Samphire may be affected by groundwater drawdown for two or more consecutive years, increasing the risk that the drawdown period may coincide with dry rainfall conditions and significantly affect the water available for plant survival in that 13 ha area.

The Fortescue Marsh is subject to a highly variable hydrological regime in terms of both magnitude and frequency, and the flora and fauna of the marsh have evolved to adapt to the consequent high variability in water availability.

10.5.4 Terrestrial Fauna

No impact on terrestrial fauna in the Fortescue Marsh is expected from this Proposal because:

- there is no clearing of vegetation within the marsh and only small areas may be affected by groundwater drawdown. The habitats within the marsh are widespread and 13 ha of Samphire that may be affected by drawdown for two or more years would not significantly affect the habitat available for fauna
- there is no impact expected on the extent or duration of surface water inundation in the marsh, therefore, the value of this ephemeral waterbody for birds and other fauna will be maintained.

10.6 CUMULATIVE IMPACTS

There is potential for cumulative impacts on the marsh due to the presence of four mines in the vicinity of the Fortescue Marsh, being Cloudbreak, Christmas Creek (Fortescue), Roy Hill mine (Hancock) and Marillana (Brockman Resources).

In terms of total surface water catchment area reduction, the maximum mine disturbance area at Cloudbreak is estimated at 230 km². The respective losses of catchment for mine voids and waste landforms for the other mines are:

- Christmas Creek – 101 km² (Fortescue 2010a)
- Roy Hill – 120 km² (Environ 2009)
- Marillana – 31 km² (EPA 2005).

The estimated total area of catchment lost is 482 km², or approximately 2% of the 26 000 km² marsh catchment area. This is not considered to be a significant proportion of the total catchment area and is not expected to have a significant impact on water inflows to the marsh.

Cumulative impacts may also occur due to drawdown and mounding adjacent to the marsh, should there be overlaps in mine drawdown or mounding areas adjacent to the marsh. Figure 40 shows the cumulative impact of Cloudbreak, Christmas Creek, Roy Hill and Marillana on groundwater levels adjacent to the marsh in 2015, the year for which most information was available. There is expected to be negligible overlap between the drawdown and injection zones from the Cloudbreak Proposal with Roy Hill and Marillana (Fortescue 2010a).

10.7 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

Potential impacts to significant vegetation communities, such as Samphire communities within the marsh, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in the EMP (Appendix A). The adaptive management approach is based on responding to information provided through implementation of hydrological and biological monitoring programs coupled with a response plan. If monitoring indicates that unexpected and significant impacts are likely, then Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management approach outlined in Appendix A.

To support this monitoring and management framework, a water balance model for the Samphire communities of the Fortescue Marsh will be developed. This will be informed by the outputs of research projects undertaken by Fortescue and the University of Western Australia.

10.8 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

The key potential impact to the Fortescue Marsh from the Proposal is the potential for changes in groundwater levels and secondary effects on vegetation and fauna. However, hydrogeological modelling has predicted that any impact on marsh hydrology is unlikely to be significant and only small areas of vegetation may be affected.

It is expected that the integrity, function, environmental and heritage values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.

11. PROPOSED CONSERVATION RESERVE IMPACT ASSESSMENT

11.1 RELEVANT ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

11.1.1 EPA Objectives

The EPA applies the following objective in assessing proposals that may affect conservation areas:

- To protect the environmental values of areas identified as having significant environmental attributes.

11.1.2 Legislation, Policy and Guidance

The following policies are relevant to the identification and protection of areas of conservation significance.

Conservation Area Reservation

Establishment of a comprehensive, adequate and representative (CAR) conservation reserve system is an objective reflected in a range of national and State policies and strategies, including *The National Strategy for the Conservation of Australia's Biological Diversity* (Department of the Environment, Sports and Territories, 1996) the *National Objectives and Targets for Biodiversity Conservation 2001-2005* and *The Western Australian State Sustainability Strategy – Consultation Draft* (CALM 2003). DEC is responsible for establishment and management of a CAR conservation reserve system in Western Australia (CALM 2003).

The terms 'comprehensive', 'adequate' and 'representative' (CAR) together describe the attributes of an ideal reserve system. These terms are defined in the Australian and New Zealand Environment and Conservation Council 1999 *Guidelines for Establishing the National Reserve System* as (CALM 2003):

- comprehensiveness – inclusion of the full range of ecosystems recognised at an appropriate scale within and across each bioregion
- adequacy – the maintenance of the ecological viability and integrity of populations species and communities
- representativeness – the principle that those areas that are selected for inclusion in reserves reasonably reflect the biotic diversity of the ecosystems from which they derive.

In addition to using the scientifically based CAR criteria, spectacular landforms and scenery as well as natural areas of high public use are also commonly included in parks and reserves.

DEC has identified that there are significant gaps in the WA conservation reserve system and it has yet to meet the CAR criteria. A number of strategies exist to create additional reserves and to progress the fulfilment of the CAR criteria. One of the strategies includes identification of whole and part pastoral leases required for conservation purposes that should not be renewed when leases expire in 2015 (CALM 2003).

The State Government determined in 2002 that portions of the Mulga Downs, Hillside, Marillana and Roy Hill stations be excluded from renewal of pastoral leases in 2015 and managed for conservation by DEC. The proposed conservation reserve (PCR) will encompass a considerable proportion of the Fortescue Marsh, as well as part of the Proposal area (Figure 69), including mining leases M4600406, M4600423, M4600424, M4600414, M4600420, M4600335 and M4600342 as well as exploration leases E4600612 and E4600611 (Figure 70). DEC considers that the area within this boundary, subject to completion of the necessary administrative processes under the *Land Administration Act 1997* and *Native Title Act 1993*, be included in the public reserve system for the purpose of conservation of flora and fauna.

The total area of the PCR is 213 049 ha, of which 19 246 ha (9%) is within the Cloudbreak Proposal area including sections of the approved footprint (Figure 70).

In recommending the creation of other conservation reserves in the Pilbara, DEC has recognised that a multiple-use framework of land management is required where the proposed new reserve envelopes other interests, such as areas with significant mineral interest and within the claimed boundaries of Native Title aspirants (CALM 2003). It is anticipated that DEC-led consultation and agreement under a multi-use framework process will apply in this case. Should conservation be the State's preferred land use for the site following mining, then closure processes will be discussed with DEC and developed in a manner that is complimentary to this land use.

11.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the Proposal may affect the PCR (Figure 70):

- **clearing and earthworks** associated with mining will remove vegetation within the proposed conservation reserve.
- **dewatering** of mine pits will lower watertables and potentially stress or cause death of groundwater-dependent vegetation communities within the PCR
- **injection of excess groundwater** may result in groundwater mounding and potentially stress or kill vegetation communities within the PCR due to waterlogging and/or salt accumulation in the vegetation root zone
- **disruption of surface hydrology** may affect vegetation communities in the PCR that rely on surface water flows.

11.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

Fortescue has undertaken vegetation mapping of 54 728 ha or approximately one quarter of the PCR. The predominant vegetation units are fringes of Samphire flats containing Samphire (26 912 ha) and flats and broad plains containing Mulga (19 089 ha) (Table 33).

Fortescue is undertaking modelling, monitoring and investigations into the Fortescue Marsh, as discussed in Section 10.3.3.

11.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

Alternative locations to avoid or minimise impact is somewhat limited as the location of the mine is dictated by the extent of resource. Should the State decide that conservation should be the ultimate land use for the Proposal area, the site will be rehabilitated appropriately prior to and at closure.

Vegetation within the marsh area of the PCR will not be directly cleared as a result of this Proposal. This will limit the impact of the Proposal on flora and fauna in the Fortescue Marsh.

11.5 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

The total area of the PCR is 213 049 ha, of which 19 246 ha is within the Proposal area and 4356 ha is within the Approved Footprint. A maximum of 7155 ha of the PCR is expected to be directly or indirectly disturbed (Table 34) by the Proposal. This represents 3.1% of the PCR.

The areas directly and indirectly disturbed will be predominantly flats and broad plains containing Mulga (4069 ha) and ranges, hills and hillslopes (1892 ha) (Table 34). This represents 21.3% of the mapped flats and broad plains containing Mulga and 65.9% of the ranges, hills and hillslopes mapped within the PCR. Very little disturbance will occur in the fringes of the Samphire Flats containing Samphire (10 ha) or the fringes of the Samphire Flats not containing Samphire (4 ha). These communities are well represented within the mapped area of the PCR, so the impact for both vegetation types is less than 1%. Because only a quarter of the PCR has been mapped, percentages of communities to be disturbed are most likely to be significantly overestimated.

The maximum cumulative area to be disturbed from the Proposal and the approved Cloudbreak mine is expected to be up to 10 808 ha (Table 34) which represents approximately 5% of the total area of the PCR.

Table 34 Direct and indirect impacts on broad vegetation types in the Proposed Conservation Reserve

| Broad vegetation type | Vegetation units | Total mapped area of vegetation type in PCR (ha) | Maximum direct disturbance amount in PCR (ha) | Maximum indirect disturbance* in PCR (ha) | Total maximum disturbance (ha) | % disturbance of mapped vegetation within PCR | Cumulative maximum disturbance with Approved Footprint (ha) | Cumulative % maximum disturbance |
|---|--------------------|--|---|---|--------------------------------|---|---|----------------------------------|
| Creek lines and drainage lines – Coolibah/River Red Gum dominated | 1 | 414 | 199 | - | 199 | 48.1 | 273 | 65.9 |
| Creek lines and drainage lines – Mulga dominated | 2 | 3653 | 495 | 5 | 500 | 13.7 | 839 | 23.0 |
| Creek lines and Drainage lines – other Acacia dominated | 8, 9 | 820 | 358 | - | 358 | 43.7 | 526 | 64.1 |
| Flats and broad plains containing Mulga | 3, 4, 10 | 19089 | 3852 | 217 | 4069 | 21.3 | 6614 | 34.6 |
| Flats and broad plains without Mulga | 15 | 200 | 123 | - | 123 | 61.5 | 123 | 61.5 |
| Ranges, hills and hillslopes | 7, 16, 17, 18 | 2871 | 1892 | - | 1892 | 65.9 | 2419 | 84.3 |
| Fringes of Samphire Flats containing Samphire | 12, 13, 22, 25, 26 | 26912 | 2 | 8 | 10 | 0.04 | 10 | 0.04 |
| Fringes of Samphire Flats without Samphire | 11, 14, 20, 27 | 770 | 4 | - | 4 | 0.5 | 4 | 0.5 |
| Other vegetation units not recorded within the Cloudbreak Proposal area | NA | 8524 | NA | NA | NA | NA | NA | NA |
| Total | | 63253 | 6925 | 230 | 7155 | 11.3 | 10808 | 17.1 |

* Potential indirect disturbance from groundwater mounding, groundwater ponding and sheet flow shadow

** the extent of each broad vegetation type within PCR most likely much larger than the area mapped

11.6 CUMULATIVE IMPACTS

Cloudbreak is the only mine within the PCR. A small portion (12 ha) of the saline injection zone of Fortescue's approved Christmas Creek mine is also within the Proposed Conservation Reserve (Fortescue 2010c).

The predominant impact on the PCR is from Cloudbreak, with only minor disturbance expected as a result of the Christmas Creek proposal.

Cumulative impacts due to drawdown and mounding adjacent to the marsh are discussed in Section 10.6.

11.7 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a GDP). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the PCR.

Potential impacts to significant vegetation communities within the PCR, such as Mulga Woodland and Samphire communities, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in Appendix A. The adaptive management approach is based on responding to information provided through implementation of hydrological and biological monitoring programs coupled with a response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management approach outlined in Appendix A.

Fortescue undertook consultation with the DEC regarding the PCR as part of the site tour to Fortescue's mining activities between 26 and 28th July 2010. Ongoing consultation will occur with DEC regarding the PCR. The PCR consultation process is expected to include consolidation of all parties' commitments and obligations with respect to reserve management. Should it be determined that the best use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this use.

In addition, Fortescue is committed to developing an offset package in consultation with the EPA and DEC which is consistent with and addresses the EPA Guidance Statement 19 and EPA Position Statement 9. This package will be targeted at enhancing the long term conservation value of the PCR through improved management and understanding of threatening processes.

11.8 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

The PCR would add local pastoral leases to the conservation estate upon lease expiry in 2015. The overall percentage of the PCR that will be affected by the mine is less than 4%. This area will be rehabilitated following closure. Should it be determined by Government that the end land use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this end land use.

Fortescue will also participate in the anticipated consultation process to be conducted by DEC as part of the establishment of a multi-user framework agreement with respect to the PCR.

It is expected that the potential impacts of the Proposal are consistent with Government planning for the PCR which recognises mining interests in the area and that rehabilitation will be undertaken consistent with the long term management objectives for this area.

12. ABORIGINAL HERITAGE

12.1 IMPACT ASSESSMENT, RELEVANT ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

12.1.1 EPA Objective for Aboriginal Heritage

The EPA applies the following objective to the assessment of proposals that may affect Aboriginal Heritage:

- To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

EPA Guidance Statement No. 41

EPA Guidance Statement No. 41 (EPA 2004b) provides guidance on the process for the assessment of Aboriginal heritage as an environmental factor. Where Aboriginal heritage is determined to be a relevant factor, the EPA will expect the proponent to properly consider how to minimise any impact to heritage values resulting from the proposal.

Aboriginal Heritage was identified as a key environmental factor in the Scoping Document. EPA Guidance Statement No. 41 (EPA 2004b) details actions that may be pertinent to the factor of Aboriginal heritage, including:

- consulting with Department of Indigenous Affairs (DIA) staff and conducting a desktop review of sites
- undertaking an Aboriginal heritage and/or archaeological survey in consultation with relevant Aboriginal representatives
- informing relevant Aboriginal people of the proposal and conduct an appropriate consultation
- demonstrating that any concerns raised by the Aboriginal people have been considered in the environmental management of the factor and that this is made known to the relevant Aboriginal people.

12.1.2 Regulatory Framework

The Minister for Indigenous Affairs is responsible for the administration of the *Aboriginal Heritage Act 1972* (WA) (AH Act). The Minister's responsibility is to ensure that all places of traditional or current sacred, ritual or ceremonial significance to Aboriginal people should be recorded and their importance evaluated on behalf of the community. Under Section 18 of the AH Act, consent from the Minister is required to disturb Aboriginal sites.

12.2 POTENTIAL SOURCES OF IMPACTS

The primary aspects of the Proposal that may potentially affect Aboriginal heritage values are:

- **physical disturbance of the land surface** during clearing and removal of topsoil and overburden has the potential to disturb heritage sites and affect ethnographic values
- **presence of construction and operational personnel** has the potential to disturb heritage sites and affect ethnographic values
- **Alteration of surface water flows** has the potential to result in erosion of Aboriginal heritage sites.

Other indirect impacts on Aboriginal heritage sites from dust and vibration are not expected to occur. In addition, these emissions are not expected to be any greater than that already assessed for the approved Cloudbreak Mine and have not been addressed in this document. These aspects are currently managed through existing management plans.

No significant impact from the Proposal is expected on the semi-permanent pools of Aboriginal heritage value on the Fortescue Marsh (Yintas) (Section 7.5). Consultation with Traditional Owners regarding the Yintas will occur throughout the life of the project.

12.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

12.3.1 Archaeological and Ethnographic

Aboriginal heritage surveys (archaeological and ethnographic) continue to be conducted in and around the expansion area and during construction activities at Cloudbreak. Heritage surveys have been undertaken across the current site and expansion area since 2003, with approximately 1573 heritage sites located within the Chichester Project area (Cloudbreak and Christmas Creek) which includes 567 salvaged¹³ sites. These sites comprise artefact, man-made structure, mythological, repository, ceremonial, grinding patch, midden, skeletal material/burial, engraving, historical, scarred tree and quarry sites. Artefact scatters account for over 80% of the identified sites within the Chichester Project area. Table 35 outlines the Aboriginal heritage site types, descriptions.

¹³ Salvaged sites are those sites approved under Section 18 of the AH Act to be disturbed and where Archaeologists and Traditional Owners record details of the Heritage site and collect artefacts found at the Site prior to disturbance.

Table 35: Aboriginal Heritage Sites Located within the Chichester Project Area

| Site Type | Description |
|--------------------------|--|
| Artifacts | Place where human activity is identifiable by the presence of a portable object/s (e.g. stone, glass, bone, shell) utilised or modified by Aboriginal people in relation to traditional cultural life past or present. |
| Man-made structure | The placement or arrangement by Aboriginal people of stone, wood or other material made into a structure for ceremonial or utilitarian purposes. |
| Mythological | A place that is connected to the Great Spirit ancestors, in their various manifestations, of the 'Dreamtime' which continues to be important and of special significance to persons of Aboriginal descent. |
| Repository | Places where cultural or utilitarian objects are/were taken, stored, by Aboriginal people, either past or present. |
| Ceremonial | A place used for a formal act or series of acts prescribed by ritual, belief in a mythological manifestation, religious belief or observance, protocol or convention that is connected with the traditional cultural life of Aboriginal people past or present. |
| Grinding patches/grooves | Places where grinding patches or grooves can be found. Grinding patches or grooves are smooth areas or grooves on rock surfaces (non-portable) that have been created by grinding activity associated with food production such as seed milling, preparation of pigments, tool manufacture and/or maintenance and ritual. |
| Skeletal material/burial | <p>A place where Aboriginal skeletal material is buried and/or where mortuary practices occurred. At least one of the following pieces of evidence is required that the reported place is of Aboriginal origin:</p> <ul style="list-style-type: none"> Aboriginal skeletal material is visible Aboriginal mortuary/burial markers and or ethnographic evidence about the burial/skeletal material. |
| Engravings | A motif (either figurative or non-figurative) on a rock surface produced by percussion or abrasion. Engravings are also often referred to as petroglyphs. |
| Historical | A place that has historical associations with Aboriginal People and may or may not contain physical evidence of those associations. |
| Modified or scarred tree | A place with one or more tree(s), living or dead, that has been modified by Aboriginal people by removing the bark or wood resulting in the formation of a scar. This sort of modification was and is frequently done for the making of implements, tools and other materials that were used in traditional cultural practices. |
| Quarry | Places where there is evidence for the extraction of stone or ochre. |

12.3.2 Native Title

The Proposal area expansions are located within areas subject to the following Federal Court Native Title Claims (Figure 6):

- Nyiyaparli (WC99/4)
- Palyku (WC99/16).

The Proponent, Pilbara Native Title Service and the Yamatiji Land and Sea Council recognise these claimants as the Traditional Owners of Proposal area.

12.4 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

12.4.1 Native Title

In October 2005, Fortescue secured Land Access Agreements (LAAs) covering all claim areas of the Nyiyaparli and Palyku people. The LAAs include comprehensive provisions about cultural heritage protection, and how Fortescue and the Traditional Owners will deal with heritage matters. The LAAs set out how heritage surveys are conducted as well as the consultation process in the event that Fortescue needs to make a section 18 application to disturb a heritage site.

Fortescue consults regularly with the relevant Traditional Owners over all aspects relating to the identification, protection and management of their cultural heritage, consistent with the Cultural Heritage Principles agreed between Fortescue and the Traditional Owners are set out in the LAAs. Each Traditional owner Group has established a Heritage Subcommittee to consult with Fortescue over heritage matters. Fortescue will continue to consult with the Nyiyaparli and Palyku people throughout implementation of the Proposal.

12.4.2 Disturbance to Land Surface

All new ground disturbances require a Fortescue Ground Disturbance Permit (GDP) prior to works commencing. All areas of proposed ground disturbing activities are subject to both an Archaeological and Ethnographic survey prior to approval of a GDP. The aim of these surveys is to identify whether Aboriginal heritage sites exist, and if so, the extent and significance of these heritage sites so that Fortescue can ensure that planning of its project minimises impact to heritage.

Heritage Site Delineation

Aboriginal heritage site perimeters are identified by the Archaeologists and Traditional Owners during heritage surveys using pink/black survey tape tied to shrubs and trees. This is the accepted marker for Aboriginal heritage site boundaries across Fortescue project areas. The Heritage Compliance team will return to these sites and re-flag using star pickets with pink/black heritage flags on pins. Prior, or during this return visit, the heritage site is assessed for any potential impact that may result from the proposed scope of works specified in the relevant Ground Disturbance Permit. This assessment determines mitigation measures to be implemented around the Heritage site.

Approved Disturbance to Aboriginal Heritage Sites

Where identified heritage sites cannot be avoided by project operations, the Fortescue will apply to the Minister for permission under section 18 of the AH Act to impact an Aboriginal heritage site. The Minister may grant consent to either totally or partially impact a heritage site and may impose conditions on the consent including the condition to salvage a site or to conduct further recording or analysis.

Once a section 18 approval has been granted, salvage of heritage sites is conducted by Archaeologists and the Traditional Owners, utilising a methodology which meets DIA guidelines. No ground disturbance permits will be approved until identified heritage site(s) have been successfully salvaged. Once the ground has been cleared of artefacts, normal Ground Disturbance Permit procedure then applies.

Salvaged archaeological material is received and stored in an agreed place of safe keeping.

Blasting

Blasting regularly carried out during mining and construction activities has the potential to impact heritage sites in close proximity. Fortescue has developed a blasting procedure for application near Aboriginal Heritage sites. This procedure was updated after construction of the Port Hedland to Cloudbreak rail corridor, and includes knowledge derived from that experience.

12.4.3 Disturbance by Personnel

Fortescue does not consider unauthorised visitation as a significant issue for the Proposal. Construction/mining workers are managed with a series of management controls in place including inductions, training and the clear delineation of heritage sites (see Section 12.4.2).

Fortescue has a comprehensive staff education program intended to raise awareness of Aboriginal cultural heritage. It is company policy that all personnel working on Fortescue projects attend a general site induction prior to commencement of work. At Cloudbreak, the following components have been included:

- Cross Cultural Awareness Training (compulsory for all Fortescue employees)
- Cultural Heritage Induction (compulsory for all personnel working in the project area)
- Field Compliance Induction.

12.4.4 Indirect Disturbance

Alteration of surface water flow may potentially affect Aboriginal Heritage sites through erosion.

Erosion is a common process in the Pilbara due to the intense nature of cyclonic rainfall events and the lack of vegetation that holds soil in place. This is shown by the high turbidity of surface flows. Reducing the area over which a stream can spread in a storm event by construction of mining landforms can result in an increase in stream velocity, and hence erosion potential around the location of the change. If large enough, these changes could potentially result in erosion of Aboriginal heritage sites such as middens or artefact scatters.

Analysis of increase in stream velocity in the 1 in 2 and 1 in 100 year storm events was undertaken by Worley Parsons (2011) (Section 7.5.1 and Appendix G).

For the 100 year ARI flood, the model typically showed isolated increases in flow velocity because pits and dumps encroach on the floodplains, reducing the overall flow path width resulting in a velocity increase. Post-development velocities in the 1 in 100 year event were generally similar to pre-development velocities, with variations usually less than 20%, but up to 45% (Worley Parsons 2011). These changes generally occurred higher in the catchment, and were dampened downstream, with little or no change in velocity at the outlet.

For the 2 year ARI flood, the estimated impact was often a decrease in velocity (Worley Parsons 2010). This is considered to be the result of flows being pushed out of the main channels, into the flatter floodplain area where high velocities cannot be achieved due to surface roughness (Worley Parsons 2011).

The post development changes in velocity in the 1 in 2 and 1 in 100 year events are generally localised and are considered unlikely to cause significant increases in erosion. It is therefore considered unlikely that the Proposal will result in increased erosion of Aboriginal Heritage sites.

12.5 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

12.5.1 Cultural Heritage Management Plan

The Cultural Heritage Management Plan (CHMP) will be implemented within the Proposal area which will provide for Aboriginal monitors to oversee construction of the expansion within the relevant native title claims to ensure that no known Aboriginal sites are inadvertently affected. This will also ensure that changes to the physical environment do not affect Aboriginal heritage and culture. The CHMP is included in the EMP (Appendix A).

The key measures of the CHMP include:

- identification of Aboriginal Heritage sites for inclusion into the Fortescue Aboriginal Sites Register
- undertaking additional survey work within impact areas required to identify additional heritage sites
- undertaking ongoing consultation with Traditional Owners together with their chosen heritage professionals
- implementation of compulsory GDP prior to works commencing which is managed through the Business Management System
- preventing unauthorised ground disturbance through the implementation of the Proponent's heritage disturbance procedures
- implementing heritage compliance procedures including the appointment of dedicated Heritage Field Officers whose primary roles include both supporting the heritage surveys and to enforce the obligations under the AH Act and the Land Access Agreements

- delineation of heritage sites and implementing standards for identifying and assessing appropriate mitigation measures for each delineated site
- ongoing auditing and reporting to ensure no further impact has occurred as a result of construction or operational activities
- ongoing improvement of Aboriginal Heritage management procedures and reporting through the Business Management System
- heritage incident reporting and response which would include the development of preventative actions to improve the heritage management plan
- cultural heritage education, training and inductions of all staff with programs developed by local traditional owners employed by the Proponent.

12.5.2 Fortescue Operations Aboriginal Sites Register

The site register manages the status of heritage sites located within the Fortescue Project areas and includes the following details:

- heritage site details:
 - a description of the place and its setting
 - the Fortescue number and the DIA number
 - who recorded the site and report title
 - an identification of the relevant Traditional Owners
 - sources of information (reports, publications etc)
- heritage site condition:
 - assessment of the physical condition (i.e. heritage site delineation condition)
 - mitigation undertaken (e.g. fencing) or as required such as site inspection and audits undertaken by Heritage Field Officers
 - future actions regarding the site.

12.6 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

The Proponent has committed to undertake ethnographic and archaeological surveys and investigations in consultation with the Traditional Owners, native title claimant groups and DIA prior to any ground disturbance to identify any potential sites of Aboriginal significance. The Proposal will be carried out in accordance with EPA Guidance Statement No. 41 (EPA 2004b) through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group LAAs.

The outcome is expected to be limited to impacts on Aboriginal heritage sites to the extent permitted under the AH Act Section 18 consent to disturb.

13. LANDFORM, MINE CLOSURE PLANNING AND REHABILITATION

13.1 RELEVANT ENVIRONMENT OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

13.1.1 EPA Objectives

In most circumstances, including this assessment, the EPA applies the following objectives in its assessment of Proposals that have a closure component:

- To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.
- To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.

13.1.2 EPA Guidance Statement No. 6

EPA Guidance Statement No. 6 (EPA 2006b) provides guidance of terrestrial ecosystems following disturbance. The Guidance Statement states that the key aims of rehabilitation are to:

- ensure the long-term stability of soils, landforms and hydrology required for the sustainability of sites
- partially or fully repair the capacity of ecosystems to provide habitats for biota and services for people.

Actions relevant to rehabilitation planning and design include the identification of relevant rehabilitation objectives, as well as the development of clear targets for rehabilitation that can be effectively monitored and audited to confirm objectives are achieved. Rehabilitated sites should (EPA 2006b):

- include safe, stable and resilient landforms and soils
- include appropriate hydrology
- provide visual amenity
- retain heritage values
- be suitable for agreed land uses
- include resilient and self-sustaining vegetation comprised of local provenance species
- reach agreed numeric targets for vegetation recovery
- comprise habitats capable of supporting all types of biodiversity.

13.1.3 Other Guidelines

Mine Closure Plans are required to be developed during mining under recent amendments to the *Mining Act 1978*. Regulatory agencies and industry bodies have established guidelines to assist mining companies to achieve acceptable standards of mine closure and rehabilitation. While there are no legislative requirements to adhere to these guidelines, the Proponent subscribes to the intent and advice of such guidelines.

The DMP is the regulatory agency of mining in Western Australia. The DMP has developed a number of guidelines and environmental notes in relation to mining and rehabilitation, which include:

- *Draft Guidelines for Preparing Mine Closure Plans* (DMP 2010)
- *Environmental Notes on Mining – Waste Rock Dumps* (DMP 2009a).

Other key government and industry guidelines relevant to mine closure and rehabilitation include:

- *Strategic Framework for Mine Closure* (ANZMEC and MCA 2000)
- *Enduring Value – the Australian Minerals Industry Framework for Sustainable Development* (Minerals Council of Australia 2004)
- *Best Practice Environmental Management in Mining Series* (EPA 1995, Environment Australia 1998, 2002).

13.2 POTENTIAL SOURCES OF IMPACT

The potential sources of impact at closure (including progressive closure) are:

- waste dumps, mine pits and tailings facilities may affect surface or groundwater quality if their chemical composition is different to the receiving environment
- altered landform and the effect on surface water flows and erosion potential
- erosion potential of the altered landform and associated potential water quality effects
- rehabilitation of disturbed areas.

13.3 FINDINGS OF INVESTIGATIONS

13.3.1 Mine Waste Geochemistry

Geochemical characterisation of mine waste samples was undertaken by Graeme Campbell and Associates (2005) to determine the potential for PAF material within the mine waste at Cloudbreak. The study focussed on the potential acid generating properties of the waste material, testing samples for pH, salinity and sulphur forms. The samples tested indicated that, geochemically, the assayed samples did not present characteristics of PAF material with low contents of environmentally significant elements. The waste materials produced during life of mine operation therefore are expected to be non-acid forming.

PAF material does occur within the Roy Hill Shales located below the Cloudbreak deposit. Mining will not extend into the Roy Hill Shales, so this is not expected to affect the chemistry of the mine waste or pits (Section 6.5.5).

The risk of acid, metal or metalloid contamination of mine drainage is considered to be very low (Section 6.5.5). Hence the impacts of such contamination of mine drainage post-closure have not been considered.

13.3.2 Life of Mine Tailings Storage Facility Design

The proposed method for tailings disposal is for in-pit disposal of tailings above the watertable. Coffey Mining Pty (2010) conducted a life of mine tailings storage design study for the Proposal area on this basis (Appendix H). The study involved the identification and assessment of suitable mined out pits for use as in-pit TSFs to allow the Proponent to develop an appropriate tailings management strategy for the life of mine. Coffey developed the TSF design in general accordance with DMP standards and in particular with *Mining Environmental Management Guidelines, Safe Design and Operating Standards for Tailings Storage* (DMP 1999).

The assessment of future TSF design was based on eight proposed mine pits for use as future in-pit TSFs. The proposed pits were assessed for deposition methods, sequencing, capacity and required maximum embankments (Coffey 2010). Groundwater information was also assessed to identify where the pit floor was in relation to the pre-mining groundwater table (Coffey 2010) with storage volumes of the pits (i.e. area above watertable) determined based on the average groundwater elevation.

Based on the preliminary assessment undertaken by Coffey, considering only above ground storage availability in the eight pits initially identified by the Proponent, there was insufficient above groundwater table tailings storage for the life of mine. The Proponent therefore has identified additional pits to ensure all tailings are deposited above the water table, which are included within this Proposal (Figure 15).

The study also identified the potential for saline seepage to groundwater from saline tailings deposited above the groundwater table.

The life of mine tailings storage design also included a consolidation analysis to assess the expected settlement and deformation of tailings deposited in-pit. The study concluded that the timing of rehabilitation works would largely depend upon tailings drying and consolidation with revegetation and rehabilitation to be carried out progressively during the life of mine and during the mine closure period. This will be addressed in the progressive rehabilitation plan.

13.3.3 Ongoing Investigations

Investigations will be carried out over the life of mine to assist the ongoing life of mine planning for the Proposal. Investigations include, but are not limited to, rehabilitation design and layout, geochemical characterisation and ongoing monitoring of pit and waste rock dump stability. The outcomes of these investigations will be used to refine draft closure criteria and the final rehabilitation strategy.

13.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

The purpose of closure is to minimise the long term impact of mining, therefore the evaluation of options is limited to the methods used for rehabilitation and the final landform.

13.4.1 Waste Landforms

The final position of the permanent waste landforms within the Proposal area landscape has been considered to maximise the use of upper drainage systems where practicable. The planned waste landforms will be primarily positioned in the northeast perimeters of alluvial fans, on the boundary of interfan areas (Figure 71).

The positions of these landforms have been defined based on the natural landforms north of the Proposal area. These waste landforms are considered optimal as they mimic the naturally occurring landscape and avoid major drainage lines within the Proposal area. Optimising the position of these landforms, will be further refined, based on ongoing scientific investigations into safety and stability of the final structures.

13.4.2 End Land Use

The end land use of the mine site area will either be pastoral grazing or part of future conservation areas as identified by the Pastoral Exclusion Zone (Section 11). If the area is to become a conservation area, it is assumed that the area will be managed by the DEC. A process to consult effectively with the final land manager, to understand the expectations of the DEC for the conservation estate post closure and its influences on closure activities have been included within the Conceptual Mine Closure Plan (CMCP) and will influence closure planning decisions (Appendix I).

13.4.3 Tailings Storage

The life of Mine tailings storage design involved the identification and assessment of suitable mined out pits for use as in-pit TSF (Section 13.3.2). The tailings storage approach was chosen for the Proposal as key benefits associated with the use of in-pit TSFs included:

- a reduction in clearing of natural vegetation when compared with above ground alternatives
- greater long-term integrity of tailings containment when compared with above ground alternatives
- no long-term aesthetic impact, unlike above-ground TSFs
- lesser capital costs for development compared with alternative forms of TSFs
- lesser rehabilitation costs compared with above-ground TSFs.

13.5 CLOSURE MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

13.5.1 Closure Objectives

Closure management will assist in ensuring that disturbed areas are safe and suitably rehabilitated for the long term end land use as determined in consultation with relevant stakeholders and the community. Fortescue's environmental objectives in relation to rehabilitation and closure are to:

- establish a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term
- re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment
- leave site in a safe, stable, non-polluting and tidy condition with no remaining plant or infrastructure that is not required for post-operational use
- minimise downstream impacts on vegetation due to interruption of drainage
- identify any potential long-term soil, surface water or groundwater pollution associated with the operations and formulate an action plan to address this
- develop a stakeholder consultation group prior to closure, to facilitate discussion of closure planning
- continue to monitor environmental performance during decommissioning, rehabilitation and post-closure stages of the project and take appropriate action until the approved completion criteria have been met.

13.5.2 Closure Planning

The closure objectives will be achieved through the implementation of the decommissioning and rehabilitation measures specified in a Closure Management Plan to be developed two years prior to mine closure.

Planning for mine closure has commenced in the feasibility stage of the Proposal and will continue through the life of mine up to final closure and management. Investigations and studies undertaken during the life of mine will inform the mine closure planning process. A CMCP (Appendix I), has been developed in accordance with EPA Guidance Statement No. 6 (EPA 2006b). This plan has identified the key aspects of closure that will require further investigation and refinement through the life of the Proposal and the risks associated with these aspects. The CMCP also identifies key mitigation measures to achieve the closure objectives post-mining.

Closure planning is a dynamic process that will require regular review (every three years until completion of closure) and development throughout the life of mine, to take into account changes in legal obligations, corporate requirements, community expectation and changes in technical knowledge.

The key considerations relating to closure that have been identified in the CMCP include:

- landforms
- drainage
- mining infrastructure
- heavy industrial infrastructure
- groundwater infrastructure
- light industrial infrastructure
- water containment features.

Closure Objectives and Targets

Specific closure objectives and targets have been proposed for the Proposal in order to achieve the overall closure vision, land use and to drive continual improvement in closure planning. The objectives and related targets will become the 'completion criteria' for the Proposal upon which the success of closure activities will be measured. These initial objectives may evolve during the life of the Proposal, which will also be subject to review by key internal and external stakeholders. The closure objectives are presented in Table 36 and more detailed objectives are presented in Appendix I.

Table 36: Closure Objectives and Targets

| Objective | Target |
|---|---|
| Decommissioning | |
| Relinquish the site in a condition that minimises the risks to the flora, fauna, groundwater, surface water, human health and final land use. | Incident free decommissioning of all infrastructure and facilities. |
| Relinquish the site in a condition that minimises the risks to the flora, fauna, groundwater, surface water, human health and final land use. | Appropriate management/disposal of all infrastructure and materials removed from site. |
| Decontamination | |
| No ongoing contaminated site management is required beyond 5 years post-closure. | Any contaminated sites to be remediated with levels of contaminants in soil in compliance with the <i>Contaminated Sites Act 2003</i> and DEC guidelines for Assessment Levels for Soil, Sediment and Water 2010 and the ANZECC 2000 Guidelines for Fresh and Marine Water Quality. |
| Rehabilitation and revegetation | |
| Establish safe and stable post –mining landforms which support vegetation growth and are erosion resistant. | Results of waste landform geometry and materials placement monitoring reflect that waste landforms are stable and are erosion resistant. |
| The position and orientation of waste landforms to be located to minimise impacts to surface water drainage. | Waste landform internal drainage designs maintaining sediment transportation at pre-mining levels. |
| Maintenance of quantity and quality of surface water flows, runoff patterns and landform integrity through to the Fortescue Marsh, and adjacent to the Proposal area. | Compliance with post mining surface drainage management plan. |
| Minor drainage systems requiring permanent diversion, due to landform placement, to be used to re-establish surface water flows to rehabilitated areas. | Topsoil and rehabilitation materials reclaimed from creek disturbance areas are segregated and used to establish minor creek lines post closure. |
| Groundwater recovers to a functioning groundwater regime similar to that (level, quality and quantity) as existed prior to mining. | No long term impact to groundwater salinity with the interface between fresh and saline aquifers maintained. |
| Rehabilitated areas are stable, self – generating ecosystems comprising flora and fauna species that are representative of pre-mining ecosystems. | Flora species on rehabilitated areas are representative of their target ecosystem, with structurally dominant species from each strata of the target ecosystem present. |
| All areas affected by salt accumulation from dust suppression activities are rehabilitated so that the final surface is suitable for the establishment of self-generating ecosystems comprising flora and fauna species that are representative of pre-mining ecosystems. | Soil sampling of the final surface in areas previously affected by salt accumulation indicates that the soil has similar salinity levels to unaffected areas and is suitable for sustaining vegetation growth. |
| Downstream Mulga and open eucalypt woodland communities continue to be stable and self-sustaining. | Downstream Mulga and open eucalypt woodland communities' vegetation health and species composition is maintained at pre-mining levels. |
| Minimising downstream impacts on vegetation from interruption of drainage. | Limited impact to flow regime post closure. |
| Retaining the original catchment divides and discharge locations. | Major watercourses are re-established with appropriate geometry immediately following cessation of mining in their original location. |
| Fauna access from the Chichester Range to the Fortescue Marsh is maintained. | Fauna habitat structures (rock or timber) have been established in rehabilitated areas consistent with original habitat values. |

| Objective | Target |
|--|---|
| Stakeholder consultation | |
| Stakeholder requirements in relation to closure have been taken into consideration in development of the closure plan. | Stakeholder priorities are recognised and considered during the closure planning process. |
| Areas of significant cultural or heritage value are maintained. | Cultural, heritage and stakeholders surveys are undertaken for all areas prior to disturbance and outcomes considered at closure. |
| Maintain and document stakeholder information in accordance with the stakeholder engagement strategy during closure planning and post closure. | Stakeholder priorities are recognised and considered during the closure planning process. |

Decommissioning Measures

A detailed decommissioning program/plan will be developed as part of the closure planning process two years prior to mine closure. Decommissioning measures outlined within the Closure Section of the Environmental Management Plan for the removal of mining, heavy and light infrastructure and water infrastructure will be further refined with ongoing stakeholder consultation and ongoing investigations that may occur during the life of mine.

General decommissioning of infrastructure requirements include:

- the progressive removal of all existing infrastructure including OPF, conveyor, workshops, concrete pads, buried pipes, buildings, infrastructure and workshops
- the progressive removal of water related infrastructure, including wastewater treatment plant and injection infrastructure
- capping of groundwater bores no longer required and removal of associated infrastructure
- the progressive removal of light industrial infrastructure, tonnages of steel, copper cabling and removal/burial of concrete footings
- the progressive removal of roads, culverts and floodway infrastructure not required for the end land use
- removal of bitumen surfaces within the site
- the removal of all soil affected by spills or other contamination for bioremediation
- the burial of soil affected by salt accumulation from dust suppression below soil and topsoil suitable for vegetation growth
- the removal of all water containment infrastructure to reinstate natural drainage flows
- the removal of services (power, water and communications) unless otherwise required by neighbouring stakeholders with stakeholder agreements.

Decommissioning requirements for infrastructure will be dependent on final land use risk assessment and stakeholder agreements. It is possible that groundwater bores, surface water infrastructure and roads may be retained to assist neighbouring stakeholders or future land use and/or developments within the vicinity of the Proposal.

Decontamination Measures

Areas of contamination within the Proposal area will be identified, remediated and managed according to the CMCP (Appendix I). Remediation will be undertaken during and after closure, if required, to ensure that the land is left in a condition that does not present a threat to future land use.

As part of the site CMCP, a contaminated sites register as required by the *Contaminated Sites Act 2003* will be maintained for the Proposal during operations. Chemical and hydrocarbon spills and leaks will be remediated according to the approved Chemical and Hydrocarbon Management Plan (FMG 2007). The register will be maintained throughout the life of the Proposal and will be used during the development of the final decommissioning plan to determine any contaminated sites remaining at the site and clean-up requirements.

Rehabilitation and Revegetation Measures

Rehabilitation will occur progressively throughout the life of mine in accordance with the EMP and the CMCP (Appendix I). Rehabilitation and revegetation of disturbed areas will be undertaken with the measures outlined below.

Topsoil and Vegetation Stockpiling

Vegetation will be cleared, mulched and stockpiled for future use. The topsoil (top 0.25 m) will then be removed and stockpiled until an area is available for rehabilitation. Creek line topsoil will be stockpiled separately for rehabilitation of creek lines.

Management of topsoil and vegetation is of critical importance as part of the rehabilitation process. Topsoil provides the essential resources of the establishment of vegetation as it contains the nutrients, mycorrhiza and native seed required for successful rehabilitation of disturbed areas.

If possible, topsoil will be placed directly on a rehabilitation area to minimise any loss of seed bank. However, if the topsoil is required to be stockpiled, topsoil will be layered in strips no more than 2 m in height and as close as possible to where they are to be used in future rehabilitation work with the cleared vegetation spread on stockpiles.

Erosion Control

The angles of the slopes in rehabilitated areas will be minimised to reduce the velocity of the down slope water flow. Final angles will be refined based on site specific information, waste characterisation studies and surrounding topography as closure planning progresses. Typically, the slopes will be less than 20° with the maximum height of 10 m between berms.

Progressive Seeding

Seeding using local provenance seed, sourced on site prior to clearing, will be used where possible. A species list will be developed and included within the rehabilitation plan, which will be continuously refined based on ongoing rehabilitation trials and monitoring. Species targeted for seeding will be flora identified during investigations carried out as part of the environmental impact assessment process for this Proposal.

Monitoring

The rehabilitated and revegetated areas will be monitored to determine the progress of the rehabilitation program. Monitoring will consist of a combination of methods which may include photographic monitoring, transects and standard plot areas. Monitoring is necessary to clearly demonstrate successful closure has been achieved and to provide an early indication of non-conformance to targets and closure criteria and whether an evaluation of management measures is required.

The rehabilitation measures for closure will be reviewed based on knowledge obtained from trials, monitoring performance of existing rehabilitation and site-specific information of material characterisation and performance.

Monitoring and Maintenance Measures

Specific monitoring measures for closure will be reviewed as part of the closure planning process. Many of the closure monitoring measures are expected to be a continuation of the EMP (Appendix A) and will be appropriately adjusted to reflect the closure status of the Proposal.

Final monitoring measures will be developed in consultation with key stakeholders to ensure that they will appropriately record the key aspects to track progress against the completion criteria.

Table 37: Closure Monitoring Measures

| Aspect | Measure |
|---------------------------------|--|
| Water | Establishment, maintenance, monitoring and reporting of groundwater and surface water monitoring against closure targets. |
| Landforms and landscape | Establishment, maintenance, monitoring and reporting of landform and stability and erosion monitoring sites against closure targets. |
| Rehabilitation and revegetation | Establishment, maintenance, monitoring and reporting of vegetation monitoring sites against closure targets. |

Stakeholder Consultation

Stakeholder involvement is critical in developing and implementing the mine closure plan. Consultation with stakeholders prior to the commencement of the closure and decommissioning phase will ensure stakeholder concerns and objectives are built into the final risk assessment and closure strategy. This will minimise the potential for late changes to the closure planning process to occur.

Stakeholders included within the consultation process may include regulators, community and non-government organisations (in particular neighbouring pastoralists) and company management and employees and traditional owners. Stakeholders will be identified for closure during the life of mine and will provide updates on closure developed on an ongoing basis. Once options and schedule for closure is refined a targeted consultation strategy will be developed providing information to stakeholders and address any concerns raised.

13.5.3 Closure Considerations for Specific Aspects of the Proposal

Landforms

Existing and proposed mine landforms for the Proposal consist of permanent and temporary landforms. Temporary landforms will consist of mine overburden, ROM pads, low grade stockpiles and rehabilitation material stockpiles. These areas will be progressively decommissioned and rehabilitated as part of the closure process for the Proposal. Permanent waste landforms will be required as a result of the bulking factor (Section 3.5.9) of material disturbed during mining and where excess material, such as overburden, cannot be backfilled into pits. It is planned that 16 permanent waste landforms will require closure during the life of mine (Figure 71).

The current 17 year mine plan includes a basic design for permanent waste landforms which include the operational and closure parameters specified in Table 38. During life of mine operation the following operational management strategies will apply to landforms:

- permanent waste landforms will be located to avoid blocking of natural water courses in the long term
- permanent waste landforms will be designed to resemble the surrounding topography as closely as practicable
- temporary waste landforms will be located along haulage routes minimise haulage distances
- waste will be hauled to the nearest vacant (mined out) pit or to a temporary or a permanent waste landform as appropriate.

Table 38: Waste Landform Operational and Closure Parameters

| Aspect | Details |
|--|---|
| Operational parameters | |
| Pre-strip | Topsoil stockpiles to be maximum 2 m thick Cleared vegetation to be mulched and stockpiled |
| Ramp gradient | 10% |
| Batter angle | 37° |
| Batter height | 3 benches of 10 m |
| Bulking factor of mine waste | 30% |
| Rehabilitation | Final slope of 15° |
| Rehabilitation parameters | |
| Batters | Final concave slope of approximately 15° |
| Batter (lift) height | Maximum of 10 m lift heights |
| Berms/benches | Minimum of 18-22 m wide at the floor |
| Drainage | Flat benches, internally draining |
| Upper waste landform surface | Surfaces are bunded, internally draining and exhibits areas of growth |
| Crest bunds on upper surface and on berms of final waste landforms | Compacted with a minimum of 2 m height |
| Rock armour | Batters to be rock armoured |
| Topsoil and/or vegetation | Mulch areas identified during onsite investigations |
| Deep ripping | All compacted surfaces |
| Seeding | Seed with local provenance species as required |

The outcomes of the investigative tasks undertaken during the life of mine to mitigate risks associated with final landform will help refine the final rehabilitation strategy for waste landforms. However, at this initial stage, with limited available information, rehabilitation of waste landforms will likely involve:

- re-establish overland flows in the natural drainage lines or within permanent engineered diversions
- completion and sealing in pit dewater bores
- progressively batter permanent waste landform slopes and contours to final closure design as refined by subsequent trials or as specified above in Table 38.

Monitoring of waste landforms will be undertaken during operations and post closure, to ensure the development of stable surfaces is achieved and rehabilitated areas are self sustaining. Monitoring and maintenance of surface water diversions will also be undertaken to ensure erosion and potential impacts on vegetation downstream are appropriately managed.

Surface Water

Alterations to surface water flows within the Proposal area will be required to allow for safe mining. Modifications to major flow paths will be required for periods of up to a few years to allow for changes in landforms, pits, stockpiles and waste landforms. During mine operation, the impact of mining to the surface water regime will be minimised through the progressive backfilling to reduce the pit and stockpile areas that are active. The impacts to surface water flows and drainage during mine operation are detailed in Section 7.5. The management of the potential impacts on surface water from this Proposal are included in Section 7.7 and are also addressed in the Surface Water Management Plan in the EMP (Appendix A).

The potential risks to closure resulting from impacts of the Proposal to surface water are related to landscape, surface water drainage systems, downstream flora communities and potentially cultural and heritage areas. The risks identified at these early closure planning stages include:

- the potential for creating water starvation in downstream environments particularly within Mulga and eucalypt woodland communities
- increased sediment flow into established channels, nearby water bodies and subsequently to the Fortescue Marsh.

The outcomes of investigative tasks to mitigate risk will help refine the final rehabilitation closure strategy for drainage systems. However, based on the current level of understanding the rehabilitation process will likely involve:

- drainage systems to be re-instated according to cross-sectional and long sectional profiles
- replacement of creek profile using low permeable layers at surface
- spreading a layer of riprap or rock sized to match the original creek bedload
- progressive seeding of disturbed areas with local provenance species.

Monitoring of surface water flows in downstream creek lines will be undertaken during operations. Following closure, monitoring of creek flows for transported sediment load and the development of stable and re-established ecosystems will be undertaken to determine the success of the rehabilitation measures and to ensure that surface water systems are stable and are viable in the long term.

Groundwater

Alteration to the groundwater regime within the Proposal area will be required to access the ore for mining. Dewatering of up to 100 GL/yr will be required, with approximately 11 GL/yr of this to be used for ore processing and dust suppression onsite and the remainder injected. The impacts to groundwater regimes and dependent ecosystems during mine operation are detailed in Section 6.5 and 8.5. The management of the potential impacts on groundwater from this Proposal are detailed in Section 6.7 and are also addressed in the Groundwater Management Plan in the EMP (Appendix A).

Hydrogeological modelling undertaken by Fortescue (2010) for this Proposal predicts that groundwater level recovery occurs following the completion of mining and dewatering. The modelling also indicates that water levels will recover to within 2 m of the original water level locally around some mine pits after approximately 20 years recovery under average rainfall conditions. Water levels adjacent to the marsh recover rapidly in response to marsh flooding events (FMG 2010).

In-pit Tailings Storage Facilities (in-pit TSFs)

The description of in-pit TSF management is adapted from Coffey (2010) unless otherwise stated within this section. The study is included within Appendix H.

The in-pit method of tailings disposal has been adopted at Cloudbreak. The in-pit TSF method involves the controlled deposition of tailings into partially or completely mined out pits. Water is also recovered from the pits prior to deposition in order to maximise density of the deposited tailings. Up to 6 Mtpa of tailings will be disposed of in in-pit TSFs as part of this Proposal. The waste produced will be approximately 15% of the ROM ore fed into the OPF and comprise two components, termed fine and coarse residue. The 'fine' and 'coarse' residue are combined in the thickeners, which is then pumped as a dense residue stream at approximately 50-60% solids.

Tailings will be discharged above the water table, in mined out pits, as slurry and deposited in discrete layers from multiple discharge points. Discharge points will be regularly rotated to ensure an even development of tailings beach. Tailings will be dried between each successive deposition to allow water to drain towards a decant pump in the pit. There may be concurrent mining activity and tailings deposition for any given pit. This will be achieved by construction of in-pit mine waste embankments to separate the tailings storage from the active and future mining areas.

There will be two basic embankment designs (Figure 14). The first design comprises compacted fill sourced from waste dumps proximate to the pit. The second design has a downstream mine waste zone dumped in the pit during mining operations, with a nominal 15 m wide compacted upstream zone. The embankment geometry for the two designs (Figure 14) is based primarily on considerations of stability, safety and ease of construction. Minimum batter slopes of 1(vertical):1.5(horizontal) have been chosen based on the results of embankment seepage and stability modelling, with flatter upstream batter slopes of 1(vertical):2(horizontal) to be adopted where construction of an upstream compacted zone is anticipated. The design crest width will accommodate large construction equipment, which ranges from 35 m to 57 m based on current Cloudbreak operations. The embankment construction method adopted will vary depending upon the size of the pit, tailings storage requirements and the scheduling of mine waste movement.

In the later stages of mining, when saline ore is being mined, the tailings will be saline. There is currently not enough data available regarding expected characteristics of saline tailings to make accurate assumptions. The predicted quantity of saline ore tailings will be between 5 to 10% of the total tailings, therefore encapsulation of the saline tailings between non-saline tailings layers would be a highly effective option for disposal. Encapsulation would minimise the potential for the saline material (salt) to either leach out through the base over time and contaminate groundwater or rise to the surface by capillary movement and affect cover materials.

The potential impact of saline seepage to groundwater will be assessed when additional information is available on the character of the hypersaline tailings and the expected configuration of the in-pit TSF which would receive them. Additional measures to mitigate saline seepage may be required such as underdrainage system construction and operation and/or saline seepage collection via dewatering wells.

The timing of TSF rehabilitation works will largely depend upon tailings drying and consolidation. The TSFs will be progressively rehabilitated after they have been filled, along with the associated mining areas. During the initial start-up phase of a mining area, overburden will be placed off path at a permanent storage area where the topsoil will be stockpiled. Following the initial start-up phase, overburden will be returned to the mining void and the final landform will take into consideration pre-mining landform.

The investigations undertaken over the life of mine to mitigate potential risks to closure will assist to refine the final rehabilitation closure strategy for in-pit TSFs and backfilled pits. Based on the current available information the closure planning and rehabilitation of in-pit TSFs will likely involve:

- sealing of all in-pit dewatering bores after void excavation and prior to tailings disposal in order to prevent saline mixing of the hydrological regime post closure
- allowing for the consolidation and drying of rejects material to achieve geotechnically stable landform

- covering of in-pit TSFs and backfilled pits with a minimum 2 m of waste rock to establish a stable and appropriate water-shedding surface
- deep ripping of all compacted surfaces
- progressive seeding with provenance species.

The monitoring program of in-pit TSFs will be undertaken during the progressive filling of pits and post closure. Monitoring will target the potential seepage from unconsolidated tailings, the stability of in-pit TSFs and surface water diversions around these areas.

Heavy Industrial Infrastructure

Heavy industrial infrastructure at the Proposal area includes a desalinisation plant, conveyor, ore processing facility, desanding plant, powerhouse, road base crusher, bulk fuel storage area, tailings infrastructure, workshops and explosives magazine. As part of the decommissioning plan this infrastructure will be progressively removed from the Proposal area with the disturbed areas appropriately rehabilitated and/or decontaminated. The extent of rehabilitation required for these areas will be determined through investigations undertaken during the life of mine.

The outcomes of the above investigative strategies will help refine the closure strategy for heavy industrial infrastructure. Based on the current level of understanding, rehabilitation of heavy industrial infrastructure will involve:

- removal of existing infrastructure including OPF, conveyor, workshops, concrete pads, buried pipes, buildings, infrastructure, workshops etc, as detailed by the decommissioning plan
- containment of any remaining inert scrap materials which are not suitable for sale or recycling within waste landforms
- removal of all saline or hydrocarbon contaminated soils for bioremediation identified/recorded during life of mine operations
- re-contouring of the landscape to restore natural drainage
- spreading of available growth medium (topsoil and or vegetation mulch)
- deep ripping of all compacted surfaces
- seeding with local provenance species.

Groundwater Infrastructure

Groundwater infrastructure associated with the Proposal includes dewatering bores, saline and non-saline re-injection borefields, groundwater monitoring bores and water distribution infrastructure. The groundwater management system comprises of dewatering bores, injection bores and pipelines. The ongoing operation and maintenance of the groundwater management system at the Proposal area will be conducted in accordance with the groundwater bore management plan and groundwater operating strategy prepared for life of mine.

The outcomes of ongoing investigative studies and tasks to mitigate risk will refine the rehabilitation closure strategy for groundwater infrastructure used for the Proposal. Based on existing information available the decommissioning of groundwater infrastructure and rehabilitation of these areas will likely involve:

- the progressive removal of groundwater infrastructure including bores, pipelines, transfer pumps
- capping, sealing and grouting of all bores in line with the National Minimum Bore Specifications Committee Minimum construction requirements for water bores in Australia (NMBSC 2003)
- removal of all salinity affected soil for remediation or containment within waste landform
- backfilling of sumps, trenches and bunds with recontouring to restore natural drainage
- deep ripping of all compacted surfaces, including access tracks, laydown yards and drill pads
- progressive seeding with local provenance species.

Light Industrial Infrastructure

Light industrial infrastructure includes elements such as contractor workshops, compounds, site offices, accommodation with support infrastructure, crib hits and toilets, sewage/waste water treatment, potable water treatment plants, security gatehouses, landfills, telecommunication towers, water containment infrastructure and backup power generation systems (Figure 73). As part of the decommissioning plan this infrastructure will be progressively removed from the Proposal area with the disturbed areas appropriately rehabilitated and/or decontaminated, with materials to be disposed offsite in an appropriate facility. The extent of rehabilitation required for these areas will be determined through investigations undertaken during the life of mine.

Sealed Roads

Three major road types will be constructed at the Proposal site, which include general traffic roads, haul roads and access tracks. Decommissioning of roads will require the removal of all bitumen from sealed roads and disposal at an appropriate location. Roadways will be appropriately rehabilitated, that is deep ripped, spread with topsoil and seeded. Where roads intersect natural drainage lines these are to be rehabilitated according to the appropriate surface water requirements.

13.6 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

The Proposal is not likely to result in significant environmental impact following closure when management measures are considered. Ongoing investigations and monitoring undertaken during the life of mine will refine the management measures required to achieve the long term objectives of mine closure and in accordance with EPA's closure objective. This will include implementation of the existing CMCP to achieve documented objectives and monitoring to check implementation and measure outcomes.

The key likely long-term outcomes for closure are:

- 1) Final landforms will have stabilised slopes of appropriate gradient and covered by vegetation re-established from respread topsoil and/or seed of local provenance.
- 2) The groundwater table will recover to a level and quality to that of pre-mining.
- 3) Altered surface water regimes will be stable and re-vegetated with stable self-sustaining ecosystems.
- 4) All areas disturbed for mining and infrastructure are rehabilitated following decommissioning and meet specified final land use criteria.

The management measures to appropriately decommission, decontaminate and rehabilitate disturbed areas are in place to mitigate the potential risks to final mine closure. During life of mine operations, investigations and the adaptive management approach will ensure that risks to closure are detected early and are addressed so as to meet the EPA's closure objective.

Fortescue is currently engaging with stakeholders, incorporating feedback into the ongoing closure planning process. Stakeholder input is integral throughout the life of mine to ensure their requirements are considered and support the closure planning process.

The long term outcomes for closure are considered to be acceptable according to the EPA's closure objective.

14. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE IMPACT ASSESSMENT

The Proposal has the potential to affect the following Matters of NES; (DEWHA 2010):

- Threatened species (only fauna)
- Migratory species.

The EPBC Act objectives are to:

- provide for the protection of the environment, especially Matters of NES
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources
- control the international movement of wildlife, wildlife specimens and products made or derived from wildlife.

14.1 RELEVANT ENVIRONMENT OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

14.1.1 Australian Government Protection

The Australian Government EPBC Act protects species listed under Schedule 1 of the Act. In 1974, Australia became a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, an official list of endangered species was prepared and is regularly updated. This listing is administrated through the EPBC Act. The current list differs from the various State lists; however, some species are common to both.

The EPBC Act aims to prevent significant impacts occurring to Matters of NES, including threatened species through assessment of proposed actions against the *Matters of National Environmental Significance: Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2009).

14.1.2 International Agreements

Australia is party to the Japan-Australia (JAMBA), China-Australia (CAMBA) and Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements. Most of the birds listed in these agreements are associated with saline wetlands of coastal shorelines and have little relevance to the Proposal area; however, some migratory birds not associated with water are also listed on these international treaties.

14.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the Proposal that may potentially affect Matters of NES, not considering mitigation efforts, include:

- **vegetation clearing** for development within the mining areas and installation of water conveyance infrastructure will directly remove fauna habitat
- **trenching for burial of some pipelines** may result in the loss/injury of individual fauna
- **physical presence of linear infrastructure** such as roads and pipelines may disrupt fauna linkages
- **redistribution of surface water flows** around the mine and its infrastructure, may alter fauna habitat
- **dewatering and injection activities** may affect groundwater-dependent vegetation and affect the value of significant fauna habitat
- **vehicle movements during construction and operation** may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes.

14.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

Based on previous surveys, database and literature searches from within 50 km of the survey area, six Threatened fauna species and seven Migratory bird species listed under the EPBC Act may occur in the Proposal area (Table 39). Several of these species have been recorded within or adjacent to the Proposal area during previous fauna surveys (Table 39).

A desktop study undertaken by Ecologia (2010a) summarises all the available survey data and information available within the Chichester area of Fortescue's projects and within Ecologia databases (which includes results of numerous Level 1 and Level 2 surveys within 50 km of the Proposal area). The following description of the likelihood of species is adapted from Ecologia (2010a) unless otherwise stated. Copies of historical and current surveys that include the Cloudbreak survey area ¹⁴ can be found in Appendix C and summarised in Section 9.3.1.

¹⁴ The Cloudbreak survey area is the area covered by the Ecologia (2011a) survey, as shown in Figure 60. This is also the extent of fauna habitat mapping for Cloudbreak.

Table 39: Summary of Potential Presence of Conservation Significant Species

| Species | Status Under Commonwealth EPBC Act | Likely Occurrence within Proposal Area |
|---|------------------------------------|---|
| Night Parrot (<i>Pezoporus occidentalis</i>) | Endangered | Recorded from Minga Well and likely to occur in the Samphire and Spinifex country of the Fortescue Marsh. |
| Northern Quoll (<i>Dasyurus hallucatus</i>) | Endangered | Secondary evidence of presence, some suitable habitat possible in rocky areas. |
| Pilbara Olive Python (<i>Liasis olivaceus barroni</i>) | Vulnerable | May be present within the rocky areas in the north of the Proposal area. |
| Crest-Tailed Mulgara ¹⁵ (<i>Dasymercus cristicauda</i>) | Vulnerable | May occur within the Proposal area. Potential burrows in Proposal area observed but no evidence of individuals. Small amount of suitable habitat within the Proposal area. |
| Greater Bilby (<i>Macrotis lagotis</i>) | Vulnerable | Records of individuals and active burrows within and surrounding the Proposal area. Areas of suitable habitat present along Fortescue Marsh and in Mulga woodland. |
| Orange Leaf-nosed bat (<i>Rhinonictis aurantius</i>) | Vulnerable | Recorded at Thieves Well. No suitable roosting habitat but will occasionally forage within the Proposal area. |
| Fork-tailed Swift (<i>Apus pacificus</i>) | Migratory | Highly nomadic aerial species. Will occasionally overfly Proposal area but will not utilise it directly. |
| Rainbow Bee-eater (<i>Merops ornatus</i>) | Migratory | Recorded within Proposal area. Suitable habitat for hunting and breeding. |
| White-bellied Sea-eagle (<i>Haliaeetus leucogaster</i>) | Migratory | Recorded at Fortescue Marsh. Uncommon in area, although suitable habitat present along the marsh where water present. Unlikely to be suitable habitat within the Proposal area. |
| Eastern Great Egret (<i>Ardea modesta</i>) | Migratory | Suitable hunting habitat when surface water present in Fortescue Marsh and some potential habitat along creek lines within the Proposal area. |
| Wood Sandpiper (<i>Tringa glareola</i>) | Migratory | Recorded at Fortescue Marsh. Suitable habitat present in marsh especially after rain. Some potential habitat along creek lines within the Proposal area. |
| Common Greenshank (<i>Tringa nebularia</i>) | Migratory | Recorded at Fortescue Marsh. Suitable habitat present in marsh especially after rain. Some potential habitat along creek lines within the Proposal area. |
| Red-necked Stint (<i>Calidris ruficollis</i>) | Migratory | Few records, but suitable habitat present in marsh especially after rain. Some potential habitat along creek lines within the Proposal area. |
| Cattle Egret (<i>Ardea ibis</i>) | Migratory | May occur in the vicinity of Fortescue Marsh. |
| Oriental Plover (<i>Charadrius veredus</i>) | Migratory | May occur in the Proposal area. |

¹⁵ Mulgara species terminology is complex. Refer Section 14.3.4 for details.

14.3.1 Night Parrot (*Pezoporus occidentalis*) - Endangered

The Night Parrot (*Pezoporus occidentalis*) is listed as Endangered under the EPBC Act.

The species is a medium-sized parrot measuring 22 to 25 cm in length, with a wing span of approximately 44 to 46 cm, predominately bright green in colour with black and yellow bars, spots and streaks over much of the body, bright yellow colouring on the belly and vent, and black colouring on the upper surfaces of the periphery of the wings and tail (SEWPAC 2011).

The Night Parrot is secretive and is usually assumed to be nocturnal (Blyth 1996). Movement patterns are unknown but it is presumed by some authors that the Night Parrot is nomadic (SEWPAC 2011). It is thought that this reclusive species may be ground-dwelling and have the ability to live away from water sources; possibly returning to water sources during hot, dry conditions (Bamford 2010a).

The distribution of the species is poorly understood however, historical evidence indicates that Night Parrots were distributed over much of semi-arid and arid Australia (Garnett and Crowley 2000). The Night Parrot is known from only 23 museum specimens and a small number of confirmed sightings since the late 1800s (SEWPAC 2011, Figure 74). The most recent confirmed sighting was made in 2005 on Mulga Downs Station in close proximity to the Fortescue Marsh (Davis and Metcalf 2008).

Over the past 15 to 20 years, a number of dedicated searches have failed to identify a single extant population of the species (SEWPAC 2011). The age at sexual maturity and life expectancy of the Night Parrot are not known. The diet and foraging ecology is also largely unknown, although the limited available information suggests the species preference is to feed on the seeds of grasses, herbs and soft grasses (SEWPAC 2011). The presence of soil in the upper mandible of museum species also suggests that they may dig for roots or tubers (Higgins 1999).

The small number of confirmed and verifiable records in Australia and the Pilbara makes it difficult to determine population trends with any accuracy (SEWPAC 2011). The Night Parrot's population is currently listed as "unknown" on the IUCN Red List of Threatened Species (BirdLife International 2009), as there is a lack of data currently available on the species. Given the decline in reporting rates, accounts of local and regional extinctions, and the failure of a number of recent targeted surveys, it is thought that the total population size of the Night Parrot has declined since the late 1800s (SEWPAC 2011). It is likely that the species is now extinct in some parts of its former range and it is speculated that it now only occurs in five subpopulations in Australia, the largest of which is estimated to consist of 20 breeding birds (SEWPAC 2011) – the actual locations of these speculative subpopulations has not been determined (i.e. there are no known subpopulations within, or near, the area of the proposed action).

Habitat preference

Based on accepted records, the habitat of the Night Parrot consists of *Triodia* grasslands in stony or sandy environments, and Samphire and chenopod shrublands on floodplains, claypans, and on the margins of salt lakes, creeks or other sources of water (SEWPAC 2011, Bamford 2005). The last recording of the species was at the permanent water source of Minga Well which is within Mulga habitat and the species may also utilise this habitat, although this is not expected to be preferred habitat. The occurrence of the Night Parrot at Minga Well was most likely due to the presence of water in the area during a period of drought in the Pilbara (Ecologia 2011a).

Pilbara wide regional mapping of potential habitat for this species has not been undertaken as there is limited information on Night Parrot habitat. Regional sightings of the Parrot are limited to the single sighting at Minga well as shown on Figure 74.

The chenopod shrubland within and surrounding the Fortescue Marsh provides good conditions for the species and it should be considered as likely to occur, on at least an occasional basis, in these habitats within the survey area (Ecologia 2010a). Figure 75 shows the extent of potentially suitable habitat within the Cloudbreak survey area. The survey area contained 3768 ha of predicted preferred night parrot habitat.

The most likely movement of individuals will be within the dense Spinifex and Samphire in the vicinity of the marsh as individuals move to areas with a food source (e.g. seeding spinifex). Some movements may also occur during drought conditions between their typical habitat within and surrounding the Fortescue Marsh, and any nearby water sources such as Minga Well.

The small number of confirmed or verifiable records makes it difficult to determine whether any Night Parrot populations occur within reserves (SEWPAC 2011).

Results of targeted fauna surveys and monitoring programs

After a series of unconfirmed sightings over several decades suggested the Night Parrot still survived in areas in the vicinity of the Fortescue Marsh, the Night Parrot was reliably detected at Minga Well on Mulga Downs Station in April 2005 during surveys commissioned by Fortescue for the Environmental Impact Assessment of the approved Cloudbreak Mine. Eight Night Parrot surveys have since been conducted using a range of techniques and despite a high survey effort with numerous targeted surveys conducted within the Cloudbreak survey area no further individuals have been recorded (Table 40). The survey conducted in December 2009 (Bamford 2010a) recorded a call and sighting of an unidentified bird near Cooke's Pool on the Fortescue Marsh. The bird had the potential to be a Night Parrot given the characteristics of the call and size of the bird, however, the sighting was made at dusk in low light conditions making it impossible to determine colour or markings of the bird. The 2010 Night Parrot survey did not observe any known or possible Night Parrots (Bamford 2011) and no individuals or calls were recorded during 13 hours of targeted searches for this species by Ecologia (2011a).

Night Parrot surveys will continue annually to research the potential occurrence of Night Parrots in the vicinity of Cloudbreak Mine.

Table 40 Summary of survey effort for Night Parrot in the Cloudbreak Survey Area

| Survey | Person Days in field | Person Hours | Camera Trap Nights | Night Parrot Observations |
|----------------------------|----------------------|-----------------|--------------------|---|
| 2005 – 2007 (Bamford 2009) | 250 | - | - | No Night Parrot detected Two calls of interest noted |
| 2008 (Bamford 2009) | 30 | 99 | - | No Night Parrot detected |
| 2009 (Bamford 2010a) | - | 125 | 127 | No Night Parrot detected Unidentified bird flushed at night and called |
| 2010 (Bamford 2011) | - | 5 | 686 | No Night Parrot detected |
| TOTAL Survey Effort | > 280 | > 229 | 299 | Nil |

Threats

The lack of information available on the Night Parrot makes it difficult to determine the cause or causes of the apparent decline in population size. There is no direct evidence to link any threatening process to the apparent decline.

An interim recovery plan for the Night Parrot in Western Australia developed by Blyth (1996) identified threatening processes including:

- predation by cats and foxes
- altered fire regimes
- grazing by stock and rabbits
- reduced availability of water due to over-use by camels
- competition from introduced herbivores for, and degrading effects upon, critical areas of above-average nutrients and moisture in the arid zone, especially during times of drought
- the degrading effect by hard hoofed animals around watering points.

There is little information on the response of the Night Parrot to disturbance but there has been one account of a Night Parrot apparently attracted into a shed by a bright light (Higgins 1999).

Conservation programs in the Pilbara

No specific conservation programmes currently exist for the Night Parrot. Too little is known about the species to be able to predict where it will occur, or to be able to search successfully for it.

DEC conduct broad scale pest animal control programs on an annual basis which include targeting donkeys and other feral herbivores in the eastern Pilbara as well as the eastern Chichester Range (Rummery C [DEC] 2010, pers. comm). In addition DEC are also developing up a pest animal program for the Fortescue Marsh area which will include fox baiting in the area and are engaging in discussions to develop these 1080 baiting programs to protect threatened species (Rummery C [DEC] 2010, pers. comm).

14.3.2 Northern Quoll (*Dasyurus hallucatus*) – Endangered

The Northern Quoll is listed as Endangered under the EPBC Act.

The Northern Quoll is a marsupial of approximately 300 to 1100 g in weight, with a distinctive dark body marked with white spots. The species is a key predator in the dry savannah landscapes in northern Australia consuming a wide range of prey including invertebrates such as beetles, grasshoppers, spiders, scorpions and centipedes, and vertebrates such as the Northern Brown Bandicoot, the Common Brushtail Possum, rats, Sugar Gliders, insectivorous bats, quails, bird eggs, snakes and frogs. They are also known to eat fruit and nectar, carrion and human refuse (DEWHA 2009).

Northern Quolls are short-lived, with females living up to three years but the majority of males undergoing a ‘die-off’ (characteristic of some carnivorous marsupials) after their first mating season, with few living more than a year (Oakwood 2008).

During the non-breeding season, home ranges are about 35 ha, but this increases to about 100 ha for males in the breeding season (Oakwood 2008).

The Northern Quoll is distributed across tropical northern Australia, from the Kimberley in Western Australia to south-east Queensland, with a disjunct population in the Pilbara of Western Australia (Oakwood 2008). A 75% reduction in habitat range occurred during the 20th century, so that the species is now restricted to the Pilbara and north Kimberley in Western Australia and a few discrete populations across the Northern Territory and eastern Queensland (Braithwaite and Griffiths 1994). A map showing current recorded sightings and habitat in the Pilbara region is contained in Figure 76.

The overall population trend (i.e. Australia wide) for the Northern Quoll is listed in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species as “decreasing” (Oakwood 2008).

For the Pilbara region, Northern Quoll populations have been “declining at least since the 1980s, through a time when altered fire regimes plus habitat degradation through over-grazing have occurred, although a causal link has not been established” (Hill and Ward 2009).

Given the annual die off of male Northern Quolls, there is a need for annual recruitment of males to sustain the Northern Quoll population. Therefore the species is particularly susceptible to impacts including drought and large fires which may reduce numbers and decrease the likelihood of successful breeding. Average annual rainfall in the area is approximately 300 to 400 mm and is characterised by frequent, low-intensity events related to localised thunderstorms and tropical upper air disturbances, as well as occasional annual or near annual high-intensity events associated with tropical cyclones (BoM 2010). In the 18 months until January 2011, no cyclones or large rainfall events have occurred and this appears to have reduced animal numbers in the Pilbara (Bamford 2010b).

Habitat preference

Across their entire range (i.e. northern Australia) Northern Quolls live in a reasonably wide range of habitats including rocky hills and escarpments, eucalypt forests and woodlands, rainforests and areas of human settlement (Oakwood 2008). Northern Quolls are both terrestrial and arboreal and use a variety of den sites including rock crevices, tree hollows, logs, termite mounds, house roofs and goanna burrows (Oakwood 2008). The draft recovery plan for the Northern Quoll (prepared by the Northern Territory, Western Australian, Queensland and Commonwealth environment departments) reiterates that rocky areas provide prime habitat for Northern Quolls (Hill and Ward 2009).

In areas of human settlement, Northern Quolls appear to adjust readily to human presence and infrastructure, with some residing in houses and mine camps (Bamford 2010b, Woinarski *et al.* 2008).

Within the Pilbara, areas that have the highest potential to contain resident Northern Quolls are along gullies and creek lines and around rocky or stony scree slopes, rocky boulder fields and rocky ranges. The association of the Northern Quoll with rocky habitats in the Pilbara is likely to be driven by this species' need for suitable den sites, as woodlands containing tree hollows of suitable size are very limited in the region. Rocky habitat types are widespread and common across the Pilbara, but in terms of area represent a small portion of the landscape.

Rocky and riparian habitat types suitable for Northern Quoll are associated with 31 of the 101 Land Systems of the Pilbara (Figure 76). These land systems cover a total of 120 301 km² within the Pilbara (63% of land area). Six of these land systems (Rocklea, Macroy, Robel, Capricorn, Wona and River) which comprise approximately three quarters of Northern Quoll records for the Pilbara regions (Biota 2005). These six land systems contain preferred quoll habitats of rocky hills, mesa, plateaux, larger open drainages and granite boulder fields (Biota 2005). These land systems comprise a total of 44 951 km² within the Pilbara (23.37 % of land area).

The Cloudbreak survey area contains approximately 32 ha of suitable habitat for Northern Quoll. This is approximately equivalent to the home range of one Northern Quoll in the non-breeding season. Any Northern Quolls present would occupy home ranges in these small areas of suitable habitat identified in the north of the Proposal area. Females are likely to stay within the immediate vicinity of those areas, foraging each night along rocky breakaways and escarpments. Males may move about between widely separated areas of suitable foraging habitat, especially between May and July, as they visit females during the breeding season. Quolls are not known to follow particular movement corridors, with roving males having been captured from a wide variety of habitats however the majority of individuals can be expected to move along escarpment edges, possibly venturing along wooded creek lines in areas with suitable cover (Ecologia pers. comm. 2011).

Results of targeted fauna surveys and monitoring programs

There are very historical few records of Northern Quoll from the southern Chichester region, with one single record from the survey area near the Fortescue Marsh in 1980. Northern Quoll scats have been recorded from rocky areas within the Cloudbreak Survey Area (ATA 2006a and 2006b); Figure 77); however, there are only limited areas of rocky escarpments that may provide suitable denning habitat for Northern Quoll. During the Ecologia (2011a) survey, a motion camera was set up in potential den habitat for 36 hours but did not record any Northern Quoll activity (Table 41).

Due to the limited availability of habitat, it is expected that few, if any, Northern Quolls are resident within the Proposal area. However individuals, especially males, may occasionally move through the Proposal area in search of food, water or females.

Table 41: Summary of survey effort for Northern Quoll in the Cloudbreak Survey Area.

| Survey | Elliot Trap Nights | Camera Trap nights | Northern Quoll Observations |
|----------------------------|--------------------|--------------------|--|
| 2004 (Biota 2005) (a) | 400 | - | No Northern Quoll recorded in proposal area |
| 2006 (ATA 2006a and 2006b) | - | - | Three scats recorded on site during inspection of suitable habitat |
| 2010 (Ecologia 2011a) | - | 36 | Not recorded |
| TOTAL Survey Effort | 400 | 36 | Three scats recorded on site |

(a) The Biota (2005) survey covered a broad area including the Cloudbreak Survey Area.

Threats

The major threats to the Northern Quoll listed in the *National Recovery Plan for the Northern Quoll* (Hill and Ward 2009) relevant to the Pilbara are:

- feral predators
- inappropriate fire regimes
- habitat degradation (particularly by stock and large feral herbivores).

The major threats to the Northern Quoll listed by the IUCN, relevant to the Pilbara (Oakwood 2008) were:

- livestock farming and ranching
- natural system modifications (fire and fire suppression)
- invasive and other problematic species and genes (invasive non-native/alien species).

The Pilbara population is considered important because it is the only large area of the species' range which is currently free of Cane Toads and not threatened by their imminent arrival. Toads have severely decreased the abundance and distribution of the Northern Quoll through poisoning.

Feral cats and dingoes (*Canis lupus*) may predate directly on Northern Quolls (Jones *et al* 2003). Northern Quolls appear to be susceptible to predation if habitat refuges and shelters are removed or reduced (Jones *et al* 2003). There is also some evidence to suggest that Northern Quoll populations decline when understorey vegetation is removed or reduced by fire or grazing (Jones *et al* 2003).

Conservation programs in the Pilbara

The main conservation effort for Northern Quolls in Western Australia involves the preparation and implementation of Cane Toad management measures by the DEC. The Cane Toad Strategy for Western Australia: 2009-2019 (DEC 2009b) includes:

- strengthening toad quarantine and abatement measures
- identifying potential refuge areas for native fauna potentially affected by cane toads
- identifying high value biodiversity assets and potential locations for targeted conservation programs.

State government funding has also been provided to the Kimberley Toad Busters, to prevent the spread of toads through the Kimberley and into the Pilbara.

DEC also undertake broad scale pest animal control programs on an annual basis which include targeting donkeys and other feral herbivores in the eastern Pilbara as well as the eastern Chichester Ranges (Rummary C [DEC] 2010, pers. comm). In addition DEC are also developing up a pest animal program for the Fortescue Marsh area which will include fox baiting in the area and are engaging in discussions to develop these 1080 baiting programs to protect threatened species (Rummary C [DEC] 2010, pers. comm).

Outside the Pilbara, translocations of mainland Northern Quolls to islands have been trialled to secure and quarantine quoll populations, particularly from the cane toad (Rankmore et al 2008).

14.3.3 Greater Bilby (*Macrotis lagotis*) – Vulnerable

The Greater Bilby (*Macrotis lagotis*) is listed as Vulnerable under the EPBC Act. It is an omnivorous, medium sized ground mammal, ranging in weight from 1.0 to 2.5 kilograms (kg). The species is nocturnal and constructs a substantial deep burrow system up to 3 m in length (Flannery 1990). The Bilby is generally a solitary animal and can breed throughout the year (Pavey 2006a).

The Greater Bilby forages at night, excavating prey including termites, ants, beetles, insect larvae and spiders from the soil and creating holes up to 25 cm in depth. The species has been documented as showing temporary home ranges and relatively rapid changes in distribution in response to variation in habitat resources (Johnson 1995). Males, females and juveniles may occupy overlapping home ranges and in optimal habitat can have a density of 12 to 16 individuals per km². The species is highly mobile and can have large foraging ranges. Adult females have been known to move up to 1.5 km between burrows on consecutive days, and adult males regularly move 2 to 3 km and up to 5 km between burrows on consecutive days (SEWPAC 2011). Because of their mobility, it is common to find inactive burrows (Bamford 2010b).

Bilby numbers are thought to be in significant decline in the Pilbara (Bamford 2010b), and there exists only a few known scattered populations within the region with records including numerous locations on the Abydos Plains (How *et al.* 1991), and along the Fortescue rail corridor from Port Hedland to Cloudbreak (ATA 2007) predominantly on red sandy soils in spinifex. However, it is possible that they are more widespread and abundant in the Pilbara than is generally accepted because of a lack of survey effort in the region (Bamford 2010b). Figure 78 shows the extent of recordings for the Greater Bilby in the Pilbara region.

Habitat preference

At the time of European settlement, the Greater Bilby occupied a wide range of habitats throughout Australia, from the dry interior to temperate coastal regions. Today most of the area occupied by the species probably represents the least favourable portions of its former range and the species is thought to be restricted to three major habitat types including open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock (Spinifex) grassland in plains and alluvial areas (Pavey 2006a). This may also be due to the high temperatures in these regions being not well tolerated by foxes (Southgate *et al* 2007). All environments where Greater Bilbies occur have a soil that will support burrow construction, such as firm sand or sandy-loam.

In limited parts of the Greater Bilby's range, fire may be an important factor in improving the habitat value for the species. The occurrence of the Greater Bilby is associated with close proximity to recently burnt (i.e. < 1 year) habitat (Southgate *et al* 2007). The presence of the Greater Bilby is strongly associated with substrate type (sandy or sandy-loam), mean annual rainfall and the presence of Dingoes in the area as they suppress the abundance of foxes and possibly also feral cats (Southgate *et al* 2007).

Spinifex on sandplains is very suitable habitat for the Greater Bilby and dominates seven Pilbara Land Systems, being Boolgeeda, Divide, Giralalia, Gregory, Little Sandy, Nita and Uaroo, which make up a total of 65 676 km² or 34% of the Pilbara (Figure 78). Another 35 Land Systems (49 617 km² or 26 % of the Pilbara) with more stony or gravelly plains are considered to be moderately suitable habitat.

Preferred potential habitat for the Greater Bilby within the Cloudbreak survey area may be contained within the Mulga woodland, with areas of sandy or sandy-loam soil along the edges of the Fortescue Marsh also providing suitable habitat (Ecologia 2010a). Figure 79 shows the potential areas of habitat for this species. The Cloudbreak survey area contains 3768 ha considered suitable for Bilbies and 28 096 ha that may contain patches of habitat suitable for Bilbies.

The Bilby's movement patterns fluctuate in response to the changing availability of food and their home ranges are usually temporary in location (Johnson 2008). Bilbies shelter within burrows during the day and may move up to 5 km each night in search of food (Pavey 2006b). A typical short-term home range varies from 1.1 to 3.16 km² and may contain up to 12 burrows (Pavey 2006a). Within the Proposal area, Bilbies may move throughout the hummock grassland fringing the Fortescue Marsh, as well as Mulga woodland and Snakewood habitats in search of food. This species does not follow easily delineated movement corridors, as it moves between several burrows and forages widely for a variety of food sources each night.

Greater Bilbies are present in the Gibson Desert Nature Reserve, Rudall River National Park and the proposed Percival Lakes Nature Reserve in Western Australia (Burbidge and Pearson 1989). The last two sites are located within the Great Sandy Desert. The Greater Bilby has also been reintroduced at various sites in Western Australia, such as Dryandra Woodland and Peron Peninsula (Pavey 2006a).

Results of targeted fauna surveys and monitoring programs

A Bilby was recorded from near Kardardarrie Well, 8 km west of the Cloudbreak survey area in 2004 (Biota 2005) and a dead individual was recorded from Mulga Downs Station in 1997 (Bamford 2005a, Biota 2005, DEC database). Both these recordings are outside the Proposal area. No individuals or recently active burrows of the Bilby were recorded during the Ecologia (2011a) survey. One potential burrow was recorded (50K 721370E 7531310N; Figure 79) but no signs of recent activity was present. A motion camera was set up in front of the burrow for 36 hours and no Bilby activity was recorded, confirming its inactivity (Table 42). Recently used burrows were also identified near Cockeye Bore to the east of the Proposal area during the Bamford (2005a) survey in an area of Spinifex and chenopod shrubland on loam soil (Figure 79). The burrows were in an area of a few hectares and there were some older burrows in similar habitat within a few hundred metres. Similar habitat has been surveyed in the region without other burrows being found, so it would appear that Bilbies in the area are widely dispersed but that other colonies may be present (Bamford 2005a). Numerous diggings have also been recorded from across the survey area; potentially from Bilbies although this has not been confirmed (Ecologia 2010a).

Bilbies most likely occur in the Proposal area, on at least an occasional basis, wherever soils allow them to construct burrows such as areas of sandy or sandy-loam in hummock grassland, Mulga woodland and areas along the edge of the Fortescue Marsh.

Table 42: Summary of survey effort for Greater Bilby in the Cloudbreak Survey Area

| Survey | Elliot Trap Nights | Camera Trap Nights | Greater Bilby Observations |
|--------------------------------|--------------------|--------------------|---------------------------------|
| 2004 (Biota 2005) (a) | 400 | - | One individual collected |
| 2010 (Ecologia 2011a) | - | 36 | Not recorded |
| TOTAL Survey Effort | 400 | 36 | One individual collected |

(a) The Biota (2005) survey covered a broad area including the Cloudbreak Survey Area.

Threats

The Greater Bilby population is small; making it sensitive to the loss of small numbers of individuals. Habitat destruction due to agricultural activities, and competition (rabbit, stock) and predation (foxes, feral cats and dingos) from introduced animals are thought to be the principal factors for the decline of this species across the country. In addition, fire has been suggested as an important factor in maintaining habitat diversity for this species (Johnson 1995) and an absence of a suitable burning regime in Spinifex dominated landscape may also affect the abundance and distribution of the Greater Bilby (Bamford 2010b).

Greater Bilby, particularly juveniles, are susceptible to predation in disturbed environments, and are vulnerable to vehicle collisions at night (Bamford 2010b). Their vulnerability to roadkill may in part be due to their habit of using the edges of roads for access (Bamford 2010b).

Conservation programs in the Pilbara

The National Recovery Plan for the Greater Bilby was developed in 2006 (Pavey 2006a) to achieve three major objectives: improve and at least maintain the national conservation status of the Greater Bilby over the duration of the Plan (still current and reviewed every five years); achieve an accurate assessment of distribution and trends; and successfully reduce the impacts of key threatening processes.

There are a number of Australia wide conservation programmes and research initiatives for the Greater Bilby (SEWPAC 2011). However, in the Pilbara there are no known conservation programs specifically for the species. The closest such program to the Pilbara is located at Francois Peron National Park (Gascoyne) managed by the Department of Environment and Conservation (DEC) where the Greater Bilby has successfully been re-introduced to the Peron Peninsula. In October 2010, the DEC announced that conservation efforts in the Pilbara would receive a significant funding boost focusing on pest animal control, including completion of a fence on the southern boundary of the Cane River- Mt Minnie Conservation Park, as part of a broader program to reduce the impact of pest and feral animals in the area (Rummary C [DEC] 2010, pers. comm). These efforts will benefit the conservation of the Greater Bilby in the Pilbara.

DEC also undertake broad scale pest animal control programs on an annual basis which include targeting donkeys and other feral herbivores in the eastern Pilbara as well as the eastern Chichester Ranges (Rummary C [DEC] 2010, pers. comm). In addition DEC are also developing up a pest animal program for the Fortescue Marsh area which will include fox baiting in the area and are engaging in discussions to develop these 1080 baiting programs to protect threatened species (Rummary C [DEC] 2010, pers. comm).

14.3.4 Mulgara (*Dasyercus cristicauda* / *Dasyercus blythi*) – Vulnerable

Mulgara are carnivorous marsupials with a body mass of over 100 g, head and body length of 15 to 20 centimetres (cm) and tail length of approximately 9 cm. Males are significantly larger than females (Masters *et al* 2003). The back is sandy brown, belly greyish-white and the short tail enlarged and reddish near the body, tapering quickly to a point.

Two species of 'Mulgara' are currently recognised including the Brush-tailed Mulgara (*Dasyercus blythi*) and the Crest-tailed Mulgara (*D. cristicauda*). Only the Crest-tailed Mulgara is listed under the EPBC Act. Both species have wide and possibly overlapping distributions in arid Australia, but are considered likely to utilise different parts of the environment on a local scale when they are recorded in the same area. Evidence of the two species such as scats and burrows are indistinguishable in the field.

The recognition of two Mulgara species has been recent and the identity of museum specimens has yet to be re-checked before the true range limits of both can be determined (Woolley 2005, 2008a). Mulgara records and specimens from prior to 2005 are mostly listed as *D. cristicauda*, but many may be *D. blythi*. Only *D. blythi* is considered to occur in the Pilbara (Heidrich A [Ecologia] 2011, pers. comm. 1 March; Bamford M [Bamford Consulting Ecologists] 2011, pers. comm. 28 February.).

The Crest-tailed Mulgara (*D. cristicauda*) is listed as Vulnerable under the Commonwealth EPBC Act and as Schedule 1 (ranked as Vulnerable) under the WA Wildlife Conservation Act, although this Act has not been updated since the species have been split into two. The Brush-tailed Mulgara (*D. blythi*) is listed as a Priority species (ranked as Priority 4) by the Western Australian DEC. As SEWPAC has not reassessed the status of Mulgara since the species was split into Brush-tailed and Crest-tailed species, the two species are considered under the EPBC Act to be *D. cristicauda* and therefore 'Vulnerable'.

IUCN Red List of Threatened Species lists both the Brush-tailed and Crest-tailed Mulgara as of "Least Concern" (Woolley 2008b). Neither species is considered threatened in this list (Critically Endangered, Endangered, Vulnerable or Near Threatened) because of their wide distribution, presumed large population, and because neither is considered to be currently in population decline at a level that would support listing in a threatened category.

The population density of Brush-tailed Mulgara (and presumably Crest-tailed Mulgara) fluctuates based on long-term climatic conditions (Gibson and Cole 1992). There is also an annual population fluctuation, with numbers declining during the breeding season (June to October, when most males experience post-breeding mortality) and increasing following the spring influx of juveniles (Masters 1993, 1997, 1998).

Mulgara abundance in some areas is positively associated with rainfall in the previous 12 to 24 months (Gibson and Cole 1992, Masters 1998, Dickman *et al* 2001, Letnic and Dickman 2005). Thompson and Thompson (2008) state that: "recent burning of the spinifex does not seem to be sufficient to shift Mulgara out of an area". However, Bamford Consulting Ecologists found lower densities in areas burnt three years previously compared with areas unburnt for greater than 10 years south-east of Meekatharra (Bamford 2010b).

The population trend for the Brush-tailed Mulgara is listed in the IUCN Red List of Threatened Species as "unknown" (Woolley 2008b), and that of the Crest-tailed Mulgara as "stable" (Woolley 2000c). In a draft recovery plan for the Ampurta *D. hillieri*, Masters (2003) stated there have been no recent declines, as the species appears to be relatively secure within its present range.

Habitat Preference

Mulgara are considered solitary with a home range of 1.4 to 14 ha (Manson 1994, Masters 2003). Mulgara are generally sedentary with high site fidelity and a low propensity for dispersal once a home range has been established (Masters 1998). Spinifex grasslands on sandy or soft-soil substrates are preferred habitats (Woolley 2008a). The reported distribution of Mulgara (covering both species) in Western Australia includes much of the inland spinifex-covered sandy desert and spinifex vegetated areas in the Pilbara, Murchison and northern goldfields (Gibson and Cole 1992, Masters 2003, Masters *et al* 2003, Thompson and Thompson 2008).

Mulgara records from the Pilbara are mainly in the north and east where the soils are sandy. Within their range, the distribution of Mulgara is patchy and it is most frequently confined to mature, spinifex-dominated vegetation on sandy soils. CALM (2002) commented that Mulgara can be found in spinifex on sandy substrates in the Pilbara bioregions of Chichester (PIL 1) and Roebourne (PIL 4), including possibly isolated pockets along the Fortescue Valley (PIL 2). Spinifex on sandplains is very suitable habitat for Mulgara and dominates six Pilbara Land Systems, being Divide, Giralia, Gregory, Little Sandy, Nita and Uaroo, which make up a total of 38 653 km² or 20% of the Pilbara (Figure 80). Another 15 Land Systems (66 298 km² or 34% of the Pilbara) are considered to be moderately suitable habitat as they contain spinifex areas but with less favourable soil types (Figure 80).

If Mulgara occur within the Proposal area they are most likely to reside within the spinifex hummock grasslands that border the Fortescue Marsh. The Cloudbreak survey area contains 3768 ha of potential Mulgara habitat (Figure 81).

Brush-tailed Mulgara are largely sedentary within a home range that can be up to 10 ha for females and 25 ha for males (Masters 2003; Koertner *et al.* 2007). Home ranges overlap between individuals of both sexes and each animal may use several burrows, sometimes sharing with several others (Koertner *et al.* 2007). Once a Mulgara has established a home range, it exhibits high site fidelity and a low propensity for dispersal (Masters 2003).

Results of targeted fauna surveys and monitoring programs

It is currently uncertain whether Brush-tailed Mulgara occur within the Proposal area, however targeted searches for the Brush-tailed Mulgara resulted in no positive records of either individuals or secondary evidence (burrows) of this species (Ecologia 2011a) (Table 43.) Potential burrows have been previously observed within the mine footprint, however there is little suitable habitat and few local records of the species.

Table 43: Summary of survey effort for Mulgara in the Cloudbreak Survey Area

| Survey | Elliot Trap Nights | Targeted search hours | Mulgara Observations |
|----------------------------|--------------------|-----------------------|---|
| 2004 (Biota 2005) (a) | 400 | - | No Mulgara recorded in proposal area and immediate surroundings Diggings, scats and tracks recorded >90 km to the East |
| 2010 (Ecologia 2011a) | - | 7.25 | No Mulgara recorded |
| TOTAL Survey Effort | 400 | 7.25 | Nil in proposal area and immediate surroundings |

(a) The Biota (2005) survey covered a broad area including the Cloudbreak Survey Area.

Threats

The IUCN does not list any known major threats to either of the Mulgara species (Woolley 2008b, 2008c).

Mulgara habitat has been adversely affected through grazing by introduced species (e.g. camels [*Camelus dromedarius*], rabbits [*Oryctolagus cuniculus*], cattle [*Bos taurus*]), and changes to the fire regime, however Masters *et al* (2003) considered losses in spinifex cover are unlikely to affect *D. cristicauda* provided at least 15% cover is maintained. It is possible that predation by introduced feral cats (*Felis catus*) and foxes (*Vulpes vulpes*) may threaten this species but this has not been verified to date.

There is no specific information on the response of Mulgara to disturbance such as light and noise, but active burrows have been found on pastoral stations within a few kilometres of the homestead and within a few hundred metres of windmills and stock watering points (Bamford 2010b).

Conservation programs in the Pilbara

At present there is no specific conservation programme for Mulgara in Western Australia, although there is a draft plan for the related Ampurta *Dasycercus hillieri* (Masters 2003). There is a National Recovery Action Plan for Australian Monotremes and Marsupials which includes strategies for habitat protection on other state lands and further research into the species ecology (Maxwell *et al* 1996).

DEC also undertake broad scale pest animal control programs on an annual basis which include targeting donkeys and other feral herbivores in the eastern Pilbara as well as the eastern Chichester Ranges (Rummary C [DEC] 2010, pers. comm). In addition DEC are also developing up a pest animal program for the Fortescue Marsh area which will include fox baiting in the area and are engaging in discussions to develop these 1080 baiting programs to protect threatened species (Rummary C [DEC] 2010, pers. comm).

14.3.5 Pilbara Leaf-nosed Bat (*Rhinonictoris aurantia*) - Vulnerable

The Pilbara Leaf-nosed Bat (*Rhinonictoris aurantia*) is the Pilbara form of the Orange Leaf-nosed Bat and is listed as Vulnerable under the EPBC Act. It is a moderate-sized bat with short fur, relatively small ears and a fleshy nose-leaf structure surrounding the nostrils. The bat is nocturnal and carnivorous and is thought to feed primarily on moths, beetles and opportunistically on termites, emerging from its daytime roost to forage for prey after dusk. In general the Pilbara Leaf-nosed Bat has a poor ability to maintain its heat and water balance (Baudinette *et al.* 2000) and is therefore dependent on warm and humid environmental conditions. The Pilbara Leaf-nosed Bat is able to persist within the now arid Pilbara environment by choosing humid and warm day roosts (e.g. deep caves).

The species is limited to the Pilbara and Gascoyne regions. Colonies of the Pilbara Leaf-nosed Bat are found in three distinct areas: in the mines of the eastern Pilbara; scattered throughout the Hamersley Range in smaller colonies; and in sandstone formations south of the Hamersley Range in a small number of significant colonies (Armstrong 2001). This includes the six confirmed roosts of Bamboo Creek Mine, Copper Hills Mine, Klondyke Queen Mine, Lalla Rookh Mine and one cave in Barlee Range; and eight other likely permanent occurrences (SEWPAC 2011) (Figure 82).

A major component of the Pilbara Leaf-nosed Bat population, from both a demographic and genetic perspective, occurs in Barlee Range Nature Reserve, Western Australia. No roost has been confirmed in any other reserve system in the region (SEWPAC 2011). The remainder of known roosts and observations of bats in flight or specimens collected occur on mining and pastoral leases. Apart from being protected in Barlee Range Nature Reserve, there is no active management of the species (SEWPAC 2011).

Habitat preference

As with all cave-roosting bats, the Pilbara Leaf-nosed Bat has separate diurnal and nocturnal habitats - the roost and foraging sites. Dry season roosting sites for the Pilbara Leaf-nosed Bat are restricted to caves and mine adits (horizontal shafts) with stable, warm and humid microclimates because of its poor ability to thermoregulate and retain water (SEWPAC 2011). The roost is usually over pools of water, or deep in an area that maintains elevated temperature and humidity. Thus, the roosting site is often at depth in mines; in small crevices within caves, usually those ascending between sedimentary rock layers; and with associated groundwater seeps (SEWPAC 2011). In the Pilbara few actual roost clusters have been observed, perhaps the only one being that in the Comet mine (in Marble Bar) prior to 1992 (Armstrong 2001). Simple vertical shafts are not used by Pilbara Leaf-nosed Bats and shallow caves beneath mesa bluffs are also unlikely roost sites (Armstrong 2001).

Roosting habitat for Pilbara Leaf-nosed Bat is limited to areas that are likely to contain suitable caves. These may occur in hills and ranges, plateaux, mesa, breakaways, or fields or along river gorges. It is considered that 16 of the Pilbara Land System units are suitable habitat for Pilbara Leaf-nosed Bat. A total of 83 320 km² or 43 % the Pilbara may contain suitable roosting habitat for this species (Figure 82).

Foraging habitat is diverse owing to the wide distribution of the Pilbara Leaf-nosed Bat; however in the Pilbara it has been observed in the following habitats (SEWPAC 2011):

- *Triodia* hummock grasslands covering low rolling hills and shallow gullies with scattered *Eucalyptus camaldulensis* along the creeks
- over small watercourses amongst granite boulder terrain and around nearby koppies (small hills rising up from the Spinifex grasslands)
- over pools and low shrubs in ironstone gorges
- over low shrubs and around pools in gravelly watercourses with *Melaleuca leucodendron*, such as in Barlee Range Nature Reserve.

Figure 83 shows the potential areas of foraging habitat (14 114 ha) for this species within the Cloudbreak survey area.

The limiting factor for Pilbara Leaf-nosed bat numbers is therefore considered to be roosting habitat.

Results of targeted fauna surveys and monitoring programs

The Pilbara Leaf-Nosed Bat has been recorded once at Thieves Well. The species may occasionally forage within the Proposal area. No suitable roosting habitat for Pilbara Leaf-nosed bats has been found in the Cloudbreak survey area (Ecologia 2011a). A summary of survey effort for the Pilbara Leaf-nosed Bat can be found in Table 44.

Table 44: Summary of survey effort for Pilbara Leaf-nosed Bat in the Cloudbreak Survey Area

| Survey | Anabat sequences recorded | Survey hours | Survey days | Pilbara Leaf-nosed Bat Observations |
|----------------------------------|---------------------------|--------------|-------------|--|
| 2004 (Biota 2005) (a) | 12 | - | - | No Pilbara Leaf-nosed Bat recordings |
| 2010 (Metcalf and Bamford, 2010) | - | - | 10 | No Pilbara Leaf-nosed Bat recordings |
| 2010 (Ecologia 2011a) | - | 57.5 | - | No Pilbara Leaf-nosed Bat recordings |
| TOTAL Survey Effort | 991 | 57.5 | 10 | Nil in Proposal area, or wider Chichester Operations area |

(a) The Biota (2005) survey covered a broad area including the Cloudbreak Survey Area.

Threats

Data suggest that most roost populations of the Pilbara Leaf-nosed Bat are stable, although accurate estimations of population sizes are difficult to achieve (SEWPAC 2011). There may be fluctuations in the occupancy and numbers within a roost cave or mine as a result of disturbance and subsequent relocation.

The major threats to the Pilbara Leaf-nosed Bat (SEWPAC 2011) are:

- heat and water loss due to the species poor ability to thermoregulate and retain water
- habitat disturbance and destruction (mine collapse, flooding of mine roosts, mine development, blasting in adjacent mine workings; human entry of roosts, infill of mine shafts during mine rehabilitation)
- natural predators (snakes, Ghost Bat)
- collisions with vehicles.

The Pilbara Leaf-nosed Bat is also particularly sensitive to human intrusion (SEWPAC 2011), and so may be forced to migrate from an area if noise and vibration disturbances are significant.

Conservation programs in the Pilbara

At present there is no specific conservation programme for the Pilbara Leaf-nosed Bat in Western Australia. There are a number of proposed conservation programmes, initiatives and research directives for the management of the Pilbara Leaf-nosed Bat, but these have yet to be initiated (Bamford 2010b). However, a population of this species is protected in the Barlee Range Nature Reserve.

14.3.6 Pilbara Olive Python (*Liasis olivaceus barroni*) – Vulnerable

The Olive Python (Pilbara subspecies) (*Liasis olivaceus barroni*) is a dull olive-brown to pale fawn or rich brown python with a white/cream belly and an average length of 2.5 m, but has been recorded at lengths up to 4 m. The Olive Python is listed as Vulnerable under the EPBC Act and is restricted to ranges within the Pilbara region, north-western Western Australia, such as the Hamersley Range, and islands of the Dampier Archipelago.

There are 17 locations within the Pilbara where the Olive Python is known to occur with populations occurring at Pannawonica, Millstream, Tom Price and Burrup Peninsula (Pearson 1993). Some authors including Kendrick (2001) have reported that the species is common and wide spread in the Pilbara and that it should not be listed as threatened or declining. More broadly the species is considered stable and in sizable numbers at some known sites however population size estimates are difficult to make given the species cryptic nature and the lack of reliable trapping and census data (SEWPAC 2011).

Due to a lack of research, it is currently unclear how Pilbara Olive Python populations respond to disturbance. While there are no quantitative measures of the resilience and re-establishment of a population following a disturbance, the species has been recorded utilising man-made water sources and structures.

Habitat preference

Olive Pythons are usually found in rocky areas or gorges, especially in rocky habitat associated with water courses however, they may also be found in hollow logs or burrows beneath rocks (SEWPAC 2011). The species is an adept swimmer, often hunting in water and feeding on a variety of vertebrates including wallabies, fruit bats, ducks and pigeons. Individuals will usually spend the cooler months sheltering in caves and rock crevices and in the warmer months will move widely but usually in close proximity to water and rock outcrops (Ecologia 2010a). A large portion of the Olive Python habitat is conserved in Karijini National Park. Recordings for the Olive Python in the Pilbara are included in Figure 84.

A total of thirty Pilbara Land Systems are considered to include suitable habitat for the Olive Python. These land systems have a total area of 97 188 km² or 51 % of the Pilbara area (Figure 84).

Results of targeted fauna surveys and monitoring programs

Pilbara Olive Python has never been recorded at Cloudbreak (Ecologia 2011a) (Table 45). Ecologia (2011) consider that there is a low likelihood of Pilbara Olive Python occurring in the Cloudbreak survey area, as the habitat is generally not suitable for this species due to the lack of rocky areas associated with permanent water bodies in the area.

Table 45: Summary of survey effort for Pilbara Olive Python in the Cloudbreak Survey Area

| Year | Survey | Pilbara Olive Python Observations |
|--------------------------------|----------------------------|--|
| 2004 (Biota 2005) (a) | No targeted surveys | No Pilbara Olive Python recorded |
| 2010 (Ecologia 2011a) | No targeted surveys | Nil in proposal area and immediate surroundings |
| TOTAL Survey Effort | No targeted surveys | Nil in proposal area and immediate surroundings |

(a) The Biota (2005) survey covered a broad area including the Cloudbreak Survey Area.

Threats

Predation by feral cats and foxes, especially on juveniles is considered to be the single greatest threat to the Olive Python, followed by the predation of food sources (quolls and rock wallabies) by foxes, major fires and the destruction of habitat by gas and mining developments (SEWPAC 2011). Given the species limited range and restricted habitat, the Olive Python may also be vulnerable to disturbance through increasing numbers of tourists using water holes and some individuals have been deliberately killed when mistaken for venomous snakes.

Mining developments have the potential to affect habitat, alter prey availability and increase deaths through vehicle collisions. Additional water bodies such as dams and sewage ponds, associated with mining or development however, appear to benefit the snake and provide extra habitat where none existed before (SEWPAC 2011).

Conservation programs in the Pilbara

Kendrick and McKenzie (2001) suggested that no recovery plan is required for the Pilbara Olive Python as the species is considered common, widespread and not in population decline.

The Threatened Species Scientific Committee (TSSC 2008) compiled conservation advice for the Pilbara Olive Python, which outlined priority research and actions to assist in the protection of this species. It is not known if any of the actions described in the advice have been implemented to date.

DEC are also developing up a pest animal program for the Fortescue Marsh area which will include fox baiting in the area and are engaging in discussions to develop these 1080 baiting programs to protect threatened species (Rummery C [DEC] 2010, pers. comm).

14.3.7 Eastern Great Egret (*Ardea modesta*) - Migratory

The Eastern Great Egret (*Ardea modesta*) is a listed migratory bird under the EPBC Act. The Eastern Great Egret was recently elevated to full species status (SEWPAC 2011).

Eastern Great Egrets are widespread in Australia occurring in all states/territories of mainland Australia and in Tasmania. The area of occupancy in Australia is estimated at 408 400 km². The species occur across a large part of Western Australia, including the south-west, Kimberley and Pilbara (Johnstone and Storr 1998). The Great Egret is common to very common in the well-watered Kimberley flatlands, and scarce to moderately common elsewhere within its range (Johnstone and Storr 1998).

Habitat preference

The Eastern Great Egret mainly inhabits shallow water bodies; both fresh (lakes, lagoons, swamps and floodwaters) and saline (mangrove creeks, estuaries and tidal pools) (Johnstone and Storr 1998).

The Eastern Great Egret breeds in colonies, and often in association with cormorants, ibises and other egrets (Birds in Backyards 2011). Nests are built as a rough, loose, shallow platform. Four eggs are laid in summer in the Kimberley and during the spring in regions further south (Johnstone and Storr 1998). Their diet consists predominantly of small fish and crustaceans. They breed colonially in trees standing in water around wooded swamps and river pools, 4-13 m above water (Morcombe 2000).

It is thought that the Fortescue Marsh contains one of two known breeding localities for the Eastern Great Egret in north-west Australia, the other being Carnarvon (SEWPAC 2011). However, these are likely to be minor breeding sites with the largest breeding colonies, and greatest concentration of breeding colonies located in near coastal regions of the Northern Territory (SEWPAC 2011).

While specific habitat mapping is not available for this species at a regional scale, locations of sightings in the Pilbara can be found in Figure 85.

Suitable hunting habitat when surface water present in Fortescue Marsh and some potential habitat along creek lines within the Proposal area (Ecologia 2011a). Figure 94 shows the area of habitat within the survey area that is considered to be suitable habitat for the Egret and other migratory wading birds when water is present. Within the survey area, 8032 ha is considered to be suitable habitat for The Eastern Great Egret when water is present.

Flooding of the whole Fortescue Marsh area occurs as a result of larger rainfall events over the 26 000 km² catchment. Flooding of the Fortescue Marsh is generally associated with large rainfall events (>100 mm/month), usually due to cyclonic events (Worley Parsons 2011). Broad scale flooding occurs on a frequency of about one year in ten, with inundation persisting for three to six months (SEWPAC, website, accessed 13 October 2010).

Results of targeted fauna surveys and monitoring programs

The Eastern Great Egret has been recorded from within the Cloudbreak survey area, Roy Hill and along Fortescue River east of the survey area (Table 46, Ecologia 2011a).

Table 46: Summary of survey effort for Eastern Great Egret in the Cloudbreak Survey Area

| Year | Survey | Eastern Great Egret Observations |
|--------------------------------|--|---|
| 2005 (March; June – July) | Fauna Survey, Biota (a) | 1 sighting of one individual flying over a creek line, approximately 30 km East of study area |
| 2005 (May) | Night Parrot Survey Bamford Consulting Ecologists | None recorded |
| 2006 | Night Parrot Survey Bamford Consulting Ecologists | 1 sighting recorded along Nullagine Rd |
| 2007 | Night Parrot Survey Bamford Consulting Ecologists | None recorded |
| 2008 | Night Parrot Survey Bamford Consulting Ecologists | None recorded |
| 2009 | Night Parrot Survey Bamford Consulting Ecologists | 2 sightings, Nullagine Rd and Roy Hill Pool west |
| 2010 | Night Parrot Survey Bamford Consulting Ecologists | None recorded |
| 2010 | Level 2 Terrestrial Fauna Survey ,Ecologia | None Recorded |
| TOTAL Survey Effort | 8 Surveys | 4 sightings |

(a) The Biota (2005) survey covered a broad area including the Cloudbreak Survey Area.

Threats

Threats to the Eastern Great Egret include:

- loss or degradation of foraging and breeding habitat through alteration of water flows
- drainage and/ or clearing of wetlands for development
- frequent burning of wetland vegetation used as nest sites
- salinisation and invasion by exotic plants or fishes (SEWPAC 2011).

Maintaining suitable wetland conditions is the most important issue for conservation of this species (SEWPAC 2011).

14.3.8 Other Migratory Birds

The following section contains information on the remainder of the Migratory birds identified in the EPBC Protected Matters Search and the terrestrial vertebrate fauna desktop assessment conducted for the Proposal area in 2010 (Ecologia, 2010). DEC NatureMap database was accessed to identify known recordings of the each migratory bird in Western Australia (DEC 2007b).

- Rainbow Bee-eater (*Merops ornatus*) – Migratory

The Rainbow Bee-eater is scarce to common throughout much of Western Australia, except for the arid interior. While habitat mapping is not available for this species at a regional scale, locations of sightings of this species in the Pilbara can be found in Figure 86.

- Cattle Egret (*Ardea ibis*) – Migratory wader

The Cattle Egret is widespread and common in Australia and its breeding sites in Australia are known to occur predominantly on the east coast. The species was originally native to Africa, south-west Europe and Asia but has undergone a significant range expansion and is now found throughout South and Central America and the United States of America (SEWPAC 2011). Locations of sightings of this species in the Pilbara can be found in Figure 87.

- Oriental Plover (*Charadrius veredus*) – Migratory wader

The Oriental Plover is a non-breeding visitor to Australia which commonly occurs in coastal and inland areas in northern Australia. Most records of the species are from the north-west coast of Western Australia (SEWPAC 2011). While habitat mapping is not available for this species at a regional scale, locations of sightings of this species in the Pilbara can be found in Figure 88.

- Fork-tailed Swift (*Apus pacificus*) - Migratory

The Fork-tailed Swift is a relatively common trans-equatorial migrant from October to April throughout mainland Australia. Fork-tailed Swifts are a highly nomadic aerial species and can travel large distances. Locations of sightings of this species in the Pilbara can be found in Figure 89.

- White-bellied Sea-eagle (*Haliaeetus leucogaster*) - Migratory wader

The White-bellied Sea-eagle occurs in coastal and near coastal areas across Australia, inhabiting most types of habitats except closed forest. Locations of sightings of this species in the Pilbara can be found in Figure 90.

- Wood Sandpiper (*Tringa glareola*) - Migratory wader

The Wood Sandpiper is a trans-equatorial migrant, spending the non-breeding months in Africa, south Asia and Australia. Locations of sightings of this species in the Pilbara can be found in Figure 91.

- Common Greenshank (*Tringa nebularia*) - Migratory wader

The Common Greenshank is a non-breeding visitor to well-watered regions of Australia that can be observed in all months. Locations of sightings of this species in the Pilbara can be found in Figure 92.

- Red-necked Stint (*Calidris ruficollis*) – Migratory wader

Red-necked Stints are a non-breeding migrant, arriving from Siberia and Alaska in October and returning in March. Locations of sightings of this species in the Pilbara can be found in Figure 93.

Habitat preference, results of targeted surveys and monitoring programs

- Rainbow Bee-eater (*Merops ornatus*) – Migratory

The Rainbow Bee-eater occupies open country, most vegetation types and dunes, banks. It has been recorded from almost all surveys within and surrounding the Proposal area.

- Cattle Egret (*Ardea ibis*) – Migratory

The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare (SEWPAC 2011). The Cattle Egret has not been recorded within the Cloudbreak survey area.

- Oriental Plover (*Charadrius veredus*) – Migratory

Oriental Plovers utilise coastal habitats such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands, before dispersing further inland. Thereafter they usually inhabit flat, open, semi-arid or arid grasslands, where the grass is short and sparse, and interspersed with hard, bare ground (SEWPAC 2011). It has not been recorded within the Cloudbreak survey area.

- Fork-tailed Swift (*Apus pacificus*) - Migratory

The species is almost entirely aerial, particularly associated with storm fronts. As a result of this, the Fork-tailed Swifts are likely to occasionally forage in the sky above the survey area, however they will not utilise habitats within the Proposal area directly. It has not been recorded within the Cloudbreak survey area.

- White-bellied Sea-eagle (*Haliaeetus leucogaster*) - Migratory

The White-bellied Sea-eagle has been recorded near the Proposal area. The species is uncommon as far inland as the Fortescue Marsh, but will occasionally hunt in the area, particularly when water is present.

- Wood Sandpiper (*Tringa glareola*) - Migratory

The species preferred habitat consists of freshwater swamps, river pools, claypans and salt lakes. It has been recorded foraging along pools on the Fortescue Marsh near the Proposal area. It is likely to forage along creeks and the Fortescue Marsh when wet.

- Common Greenshank (*Tringa nebularia*) - Migratory

The Common Greenshank can be found in shallow freshwaters (e.g. claypans, swamps, river pools) and salt waters (e.g. estuaries, Samphire flats, reef flats). The species has been recorded foraging along pools on the Fortescue Marsh near the Proposal area. It is likely to forage along creeks and the Fortescue Marsh when wet.

- Red-necked Stint (*Calidris ruficollis*) - Migratory

The species is a primarily coastal one, occurring on the edge of sheltered estuaries, beaches and salt lakes. The Red-necked Stint may occasionally forage near the Proposal area during spring/summer along creeks and the Fortescue Marsh when wet. It has not been recorded within the Cloudbreak survey area.

The areas of potential habitat for Migratory Waders within the Cloudbreak Survey are shown in Figure 94.

Threats

Threats to the Migratory species listed above include:

- habitat loss or degradation
- predation by feral animals
- disturbance of breeding pairs
- increase in disturbance through recreational activities (SEWPAC 2011).

The Rainbow bee-eater has one specific identified threat which is the introduced Cane Toad (*Bufo marinus*). Cane Toads reduce the breeding success and productivity of the Rainbow Bee-eater by feeding on eggs and especially nestlings, and usurping and occupying nesting burrows (SEWPAC 2011).

14.4 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

14.4.1 Habitat loss, edge effects and fragmentation

Vegetation will be progressively removed from sections of the Proposal area during construction of mining infrastructure and during mining. Up to 12 600 ha of vegetation will be disturbed for the Proposal. Maximum disturbance amounts for each habitat type of the EPBC listed species have been calculated by assessing the amount of each habitat that exists within a broad mining area (maximum mine disturbance area) of 17 000 ha and broad injection infrastructure corridors of 40 m width (actual clearing width 20 m) within which the total clearing of up to 12 600 ha will occur (Table 47).

Table 47: Maximum Direct Disturbance of Habitats within the Cloudbreak Survey Area by the Proposal

| Species | Habitat in Survey Area (ha) | Habitat in Maximum Mine Disturbance Area (excludes Approved Footprint) | | Habitat in Maximum Mine Disturbance Area (includes Approved Footprint) | |
|--|--------------------------------|--|------|--|------|
| | | (ha) | % | (ha) | % |
| Night Parrot – preferred habitat | 3768 | 8 | 0.2% | 8 | 0.2% |
| Northern Quoll – preferred habitat | 32 | 27 | 84% | 27 | 84% |
| Greater Bilby - area with patches of potential habitat | 28 096 | 10 911 | 39% | 14 929 | 53% |
| Greater Bilby - potential habitat | 3768 | 8 | 0.2% | 8 | 0.2% |
| Mulgara | 3768 | 8 | 0.2% | 8 | 0.2% |
| Pilbara Leaf-nosed bat – potential foraging habitat only | 14 114 | 6915 | 49% | 8322 | 59% |
| Eastern Great Egret and other migratory waders | 16 063 | 1142 | 7% | 1751 | 11% |

Edge effects refer to the consequences of a boundary between vegetation/habitat and a disturbed area, which may result in increased weed invasion into habitat areas, and affect habitat quality adjacent to the disturbance.

Habitat fragmentation effects can divide populations into isolated groups. Fragmentation may occur due to clearing where the continuity of habitat is reduced. Linear infrastructure also has the potential to fragment habitat by dividing the landscape.

Installation of roads and pipelines for injection infrastructure has the potential to fragment habitat by providing barriers for fauna movement as well as risk of stress, injury or fatality during construction where trenches are required. Pipelines will be installed above ground to minimise disturbance associated with this temporary infrastructure. To avoid creating a barrier to fauna movement, pipelines will be raised or buried at approximately 75 m intervals to allow for vehicle access, surface sheet-flow and fauna movement.

The sections of pipelines to be buried below creek lines or to allow vehicle access will be short and ramps will be provided in any trenches left open overnight to allow fauna to egress if they fall in. Trenches will also be inspected each morning and any trapped fauna removed and translocated.

Night Parrot

Based on the predicted preferred habitat for the species, the chenopod shrubland and hummock grassland within and surrounding the Fortescue Marsh provides good conditions for the species and it should be considered as likely to occur, on at least an occasional basis, in these areas. A maximum of 8 ha (0.2% of the extent mapped in the Cloudbreak survey area) of these habitat types will be cleared for the Proposal for the installation of injection infrastructure. *Triodia* communities are widely distributed throughout the area (and the Pilbara) and Samphire and chenopod shrublands are also represented extensively in the area within and on the fringes of the Fortescue Marsh. Consequently, if the Night Parrot is present in the area, it will not be directly affected by the small amount of habitat clearing. This level of habitat clearance is not expected to cause fragmentation or significant edge effects.

Changes to groundwater levels as a result of dewatering are also unlikely to affect a significant area of this potential habitat (Section 8.5.2 and 14.4.4).

Night Parrot surveys will continue annually to research the potential occurrence of Night Parrots in the vicinity of Cloudbreak Mine.

Northern Quoll

Due to the limited availability of habitat, it is not expected that many, if any, Northern Quolls are resident within the Proposal area. However individuals, especially males, may occasionally move through the Proposal area in search of food, water or females.

Habitat availability, associated with the rocky escarpments in the Chichester Range foothills in the Proposal area is limited. Only 32 ha of the Cloudbreak survey area were considered to be potential habitat for Northern Quoll. A total of 27 ha of this is within the maximum mine disturbance area, (Figure 77, Table 30). However, the rocky escarpments are not within or near the actual mine pit areas, processing facilities or waste dumps and as such Fortescue commits to avoiding any clearing within the rocky escarpment habitat type and thereby avoiding any direct disturbance of preferred habitat for this species.

Greater Bilby

Greater Bilbies occur in a variety of habitats, including Spinifex grassland, *Acacia* shrubland, open woodland, and cracking clays where soil types are suitable for burrowing and foraging (Maxwell *et al.* 1996). The Cloudbreak survey area contains 3768 ha of habitat considered suitable for Greater Bilbies and 28 096 ha that may contain patches of suitable habitat. A total of 8 ha of suitable habitat (0.2% of the mapped extent within the Cloudbreak survey area) and 14 929 ha of the area that may contain patches of suitable habitat (53%) is within the maximum mine disturbance area. Of this, 10 911 ha (39%) is outside the approved footprint (Table 47). The area that may contain patches of suitable habitat is Mulga woodland, which is widespread at a regional level (Figure 63). Based on the proposed clearing amounts and the broad availability of suitable habitat outside of the Proposal area, the Proposal is not expected to result in significant impacts to the Greater Bilby. Most of the suitable habitat is located outside the area proposed to be disturbed, and only less favourable habitat will be disturbed. The clearing associated with the Proposal is unlikely to result in edge effects and fragmentation of an important population, as the area is not generally considered to be ideal habitat when compared regionally.

Mulgara

Mulgara generally prefer sandy areas with moderately dense spinifex with 'runways' between clumps (Ecologia 2010a). The potential habitat areas for Mulgara are predominantly outside the maximum mine disturbance area, with only 8 ha likely to be affected. Fragmentation and edge effects will be small, as the clearing will not be extensive nor will it divide significant areas of habitat. As such, habitat loss, fragmentation and edge effects are unlikely to be a factor for this species.

Pilbara Leaf-nosed Bat

Pilbara Leaf-nosed Bat was not recorded in the Proposal area despite an extensive targeted search for this species. The species is considered unlikely to roost within the area due to a lack of suitable habitat such as warm and humid caves (ATA 2006a). The species may be present in the general area as it forages widely; however, the Proposal area offers no particular resource that would attract them to the area. The Pilbara Leaf-Nosed Bat may forage in the hilly spinifex areas and upper creek lines. Of the total 14 114 ha of potential foraging habitat recorded in the Cloudbreak survey area, 8322 ha (59% of the extent within the Cloudbreak survey area) is within the maximum mine disturbance area. A total of 6915 ha (49%) of this is new disturbance, outside the approved footprint (Table 47).

As roosting habitat is the key limiting resource for this species, and suitable roosting habitat has not been found in the survey area, it is unlikely that the clearing associated with the Proposal will significantly impact this species.

Pilbara Olive Python

The Pilbara Olive Python has not been recorded in or adjacent to the Proposal area. The Pilbara Olive Python has a preference for rocky habitats including ranges and gorges with access to water (Bamford 2005a). The Proposal area does not represent ideal habitat for the Pilbara Olive Python, however this species may traverse the area to gain access to habitat sites which are known to occur outside the Proposal area. The probability of this species to occur is very low in the Proposal area, due to the lack of potential habitat, and is not expected to be significantly affected by the Proposal.

Migratory Birds

A total of nine migratory bird species have the potential to either fly over or forage within and around the Proposal area. Of these species, five have been recorded in or within proximity to the Proposal area. Impacts to migratory waders as a result of the Proposal are considered unlikely to occur due to the distribution of the species and the limited impact expected on the Fortescue Marsh. The area only provides habitat for migratory birds when the area is wet, which may only be a few days per year for the creek lines, but is likely to persist for longer periods in the marsh. Assessment of the potential impacts to each species is discussed further below.

Rainbow Bee-eater

The Rainbow Bee-eater was recorded foraging near Minga Well during the Ecologia (2011a) survey. The species has been recorded from almost all surveys within and surrounding the Cloudbreak survey area (Bamford 2005, Biota 2005, Ecologia internal database, ENV 2008, NatureMap). The Rainbow Bee-eater breeds throughout most of its range and is thought to adapt well to disturbance. Clearing during the breeding season has the potential to destroy nests and chicks of this species. The Rainbow Bee-eater is represented in a wide range of habitats (SEWPAC 2011) including the Proposal area (Figure 68). Given the widespread occurrence of the species in the region and Australia and the range of habitat available, it is considered that the species will not be significantly affected by the Proposal.

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is a non-breeding visitor to Australia which breeds exclusively in Mongolia (SEWPAC 2011). Although this species was not recorded during surveys of the Proposal area, it was abundant during surveys of the Fortescue Stage B Rail Corridor that services Christmas Creek and Cloudbreak mine (Biota 2005). The species is almost entirely aerial and will not be affected by the activities of the Proposal.

Eastern Great Egret

The Eastern Great Egret may breed in the Fortescue Marsh. However, it is considered that the area is likely to be minor breeding sites with the largest breeding colonies, and greatest concentration of breeding colonies located in near coastal regions of the Northern Territory (SEWPAC 2011). A total of 1751 ha of predominantly creek line habitat is within the maximum mine disturbance area. Of this, 1124 ha is outside the approved footprint and is new disturbance. These creek lines only provide habitat when the creek lines are infrequently inundated. Given this and the limited clearing and fragmentation that will occur within the Fortescue Marsh habitat, it is unlikely that the proposal will have a significant effect on this species.

Wood Sandpiper, Common Greenshank, Red-necked Stint, White-bellied Sea-eagle

The Fortescue Marsh and potentially larger creek lines provide suitable habitat for these species when water is typically present within the area. The marsh is likely to be more important habitat than the creek lines. Broad scale marsh flooding may persist for three to six months (SEWPAC 2010a), but creek lines are unlikely to hold water for extended periods.

Cattle Egret

The Cattle Egret is widespread and common in Australia and its breeding sites in Australia are known to occur predominantly on the east coast (SEWPAC 2011). While no records exist of the Cattle Egret occurring in the Proposal area, it is possible that the species occurs in the vicinity. Given the species is common and widespread nature, it is unlikely to be affected by the Proposal.

Oriental Plover

The Oriental Plover is a non-breeding visitor to Australia which commonly occurs in coastal and inland areas in northern Australia. Most records of the species are from the northwest coast of Western Australia (SEWPAC 2011). While no records exist of this species occurring at the Proposal area, it is possible that it occurs in the area. However given that the species does not breed in Australia and noting its widespread distribution, it is unlikely to be affected by the Proposal.

14.4.2 Vertebrate pests

Previous surveys of the Cloudbreak area recorded eight introduced mammalian species, including house mouse (*Mus musculus*), feral cat (*Felis catus*), dog/dingo (*Canis lupis*), rabbit (*Oryctologus cuniculus*), donkey (*Equus asinus*), Camel (*Camelus dromedarius*) and horse (*Equus caballus*) (Fortescue 2010a).

The greatest risk of pest incursion is to the Northern Quoll, Mulgara and Bilby via direct predation by feral foxes and cats (Department of Environment and Heritage, undated publication). Threats to Bilbies also include increased competition for resources by grazing from feral herbivores (NTPAWC 2007a, NTPAWC 2007b).

Vertebrate pests may be attracted to the Proposal area due to the availability of food and shelter. The availability of food in the Proposal area is managed through the appropriate management of putrescible waste at the Cloudbreak Landfill. Fortescue have also been and will continue to implement a feral cat control program in consultation with DEC to assist in alleviating threats to native fauna from predation.

Cane Toads are an emerging pest in the northern parts of Western Australia as they move west from the Northern Territory (DEC, 2009). There is conflicting information as to whether the Cloudbreak area offers suitable habitat for the Cane Toad (*Bufo marinus*), with studies indicating that the area is suitable (Kearney et al, 2008) and unsuitable (Urban et al, 2007) habitat for the Toad. As the temperature range of the area is suitable for Cane Toads, two of the key factors appear to be Toad access to the area and presence of water of a suitable quality for breeding. A number of permanent artificial water bodies of fresh water already exist in the Cloudbreak area in the form of stock bores (Figure 62). Should Cane Toads reach the Proposal area, these are potential breeding areas.

Much of the water abstracted and injected (and hence possibly present in artificial ponding structures) at Cloudbreak will be brackish or saline, with salinities above the 5000 mg/L that is considered to be the limit for toad breeding (Markula, Csurhes and Hannan-Jones, 2010), and as such the Proposal is not expected to significantly increase the availability of potentially suitable cane toad breeding habitat.

14.4.3 Alteration of surface water regimes

Some habitats, particularly Mulga communities that are partially dependent on sheet-flow runoff, may be susceptible to alterations to surface water flow due to the presence of mine infrastructure upstream from these areas. Impacts on Mulga from alteration of surface water flows are discussed in detail in Section 8.5.3. Up to 222 ha of Mulga may be shadowed by mining infrastructure for more than two years. This equates to approximately 0.5% of the total Mulga habitat mapped in the Cloudbreak survey area, which does not significantly add to the proportion of the habitat being directly affected by the Proposal.

Impacts on vegetation from interruptions of surface water sheet flow from water conveyance infrastructure are considered to be insignificant (Section 7.5.1). Dewatering and injection infrastructure has been designed to minimise impact on the natural flow of surface water through actions such as burying the pipeline beneath the beds of waterways and raising the pipeline at regular intervals (approximately every 75 m) to encourage natural drainage and prevent the establishment of ponded water.

Rock spalls shall be used both upstream and downstream of all watercourse crossings to dissipate energy and reduce flows, maintaining the nature flow of surface water to downstream vegetation.

The changes to water volumes entering the marsh and Yintas are not considered to be significant (Section 7.5) and as such the Proposal is not expected to affect species utilising the marsh during flood events.

14.4.4 Alteration of groundwater hydrology

Dewatering and reinjection activities will result in groundwater drawdown and mounding across the Proposal area. This can affect native fauna through the resultant effects on vegetation. Groundwater drawdown can lead to impacts on phreatophytic vegetation that relies on constant access to groundwater to survive, as well as to carry out processes such as flowering and setting seed (Eamus et al. 2006). In contrast, groundwater mounding may result in bringing the water table into the root zone of intolerant plants such as Mulga with consequent effects on vegetation health. Impacts to vegetation from groundwater drawdown and mounding are discussed in detail in Section 8.5.2 and summarised below.

The only vegetation communities known to be groundwater-dependent in the Proposal area are Coolabah (*Eucalyptus victrix*) and River Red Gum (*Eucalyptus camaldulensis*) communities, which tend to be concentrated in the riparian zone around creeks (Section 8.3.2). Modelling predicts that no creek line communities outside the maximum disturbance area are expected to be affected by groundwater drawdown (Figure 57).

Samphires may also be partially groundwater-dependent and may be affected by groundwater drawdown. Samphire vegetation is considered suitable habitat for the Night Parrot and the Fortescue Marsh is important for Migratory bird species. Modelling predicts that up to 13 ha of Samphire may be affected by groundwater drawdown for two or more consecutive years which may affect the water available for the plants' survival. This equates to approximately 0.04% of the local extent (Cloudbreak and Christmas Creek combined survey areas) of this habitat and as such mounding will not significantly affect the availability of Samphire habitat in the local area.

Mulga communities are known to be particularly susceptible to waterlogging and associated salinisation of the root zone. Mulga is considered to contain patches of suitable habitat for Bilby. Up to 18 ha of this habitat is within the groundwater mounding area where groundwater may rise to within the root zone of the Mulga (estimated to be within 3 m below ground level) for two or more consecutive years (this extended period of mounding may result in adverse effects on the health and/or survival of Mulga vegetation in this area – Section 8.5.2).

It is therefore considered that the dewatering and injection associated with the Proposal will not result in significant impacts on Matters of NES.

14.4.5 Noise and disturbance

“Noise and disturbance” has been defined to include any activities or factors that may cause impacts to Matters of NES that are not directly related to habitat loss, edge effects, fragmentation, vertebrate pests or hydrology. This category includes activities associated with mine construction and operations such as noise and vibration, vehicle movement, dust, weed introduction and invasion can affect nearby resident fauna. The noise and vibrations associated with blasting and drilling may encourage some animals to move from the area. An increase in vehicle movement post construction will also increase the frequency of noise and potentially increase the frequency of collisions with trains and service vehicles.

The impacts on the factors of air quality and noise are not expected to be any greater than that assessed for the approved Cloudbreak Mine. As such, these impacts have not been assessed further and can be managed under existing management plans.

Preparation of the site and the passage of vehicles on haul roads and access tracks have the potential to result in the fatality or injury of individuals if they are present within the Proposal area. Greater Bilby, Pilbara Leaf Nosed Bat and Pilbara Olive Python are prone to road fatalities. Their vulnerability to road kill may in part be due to their habit of using the edges of roads for access (Bamford 2010b).

Implementation of speed limits designed to limit the likelihood of fauna road deaths, and restrictions on driving off-road will limit the impact of the Proposal. Isolated deaths of individuals are not expected to affect the conservation status and distribution of any fauna species.

Potential impacts from the spread of weeds through vehicle movement and earthworks, and fire risk are not expected to be any greater than that already assessed for the approved Cloudbreak Mine, hence are not addressed further in this document. These aspects are currently managed under the existing Operation Environmental Management Plan (Fortescue 2008).

14.4.6 Table of Cross References for Matters of NES

Further detail on aspects of the Proposal that may affect Matters of NES can be found in previous sections on the PER. Table 48 provides a cross-reference to the most relevant sections.

Table 48: Table of Cross References for Matters of NES

| Item | Sections in document |
|---|------------------------------------|
| Summary of fauna surveys | Section 9.3.1 |
| Copies of fauna surveys | Appendix C |
| Habitat types | Section 9.3.3 |
| Feral animals | Section 9.3.4 |
| Changes in surface water regime and impact on habitat | Sections 7.3, 7.5, 9.5.3 |
| Changes in groundwater regime and impact on habitat | Sections 6.3, 6.5, 9.5.2 |
| Clearing and impact on habitat | Section 9.5.1 |
| Noise | Section 16 |
| Dust | Section 17 |
| Environmental Management Plan | Appendix A |
| Rehabilitation and mine closure | Section 13, Appendix A, Appendix I |

14.5 CUMULATIVE IMPACTS

The main potential cumulative impact is the combined effect of clearing of habitat potentially utilised by Matters of NES from Cloudbreak, Christmas Creek Mine and Roy Hill Mine. Cumulative impacts of Mulga (potential habitat for the Greater Bilby and Pilbara Leaf-nosed Bat) are discussed in more detail in Section 8.6. Cumulative impacts to creek line habitat (habitat for Migratory birds) and halophytic shrubland (habitat for Night Parrot and Mulgara) are also discussed in Section 8.6. Generally, all habitat types that will be affected by the Proposal occur in other project areas and will have some cumulative impact to the local representation of these habitat types. However, all of these habitats occur in the wider region and cumulative impacts are not expected to have significant impacts on the distribution and abundance of fauna species.

14.6 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

14.6.1 Ground Disturbance

A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value flora and vegetation, including of habitat value such as Mulga and 'habitat' trees, may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered, such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted, further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the proposed 2015 pastoral lease exclusion zone.

14.6.2 Adaptive Management of Groundwater

Impacts to significant fauna habitat such as Mulga Woodland and habitats near the Fortescue Marsh from groundwater mounding and drawdown will be managed under an Adaptive Management Approach (Appendix A). This framework is discussed in more detail in Section 8.7.2. This Framework will assist in monitoring and responding to the potential indirect impacts of changes on groundwater levels on habitat adjacent to the Fortescue Marsh, including the low halophytic (Samphire) shrublands and hummock grasslands that are habitat for the Night Parrot, Greater Bilby and Mulgara.

14.6.3 Environmental Management Plan

Management of potential impacts on fauna from this Proposal are also addressed in Biodiversity Management Plan in the Environmental Management Plan (Appendix A) and includes the following key management actions:

- clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above)
- significant fauna habitat will be spatially identified and where appropriate, demarcated on site
- all lined surface water storage will have fauna egress points
- vehicles speeds will be restricted across the Proposal area
- off road driving or driving on restricted access routes will be prohibited other than for emergency situations

- rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented
- low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards
- lighting will be directed onto construction or operational areas.

Specific management plans have also been developed and implemented for the Night Parrot and Greater Bilby as a requirement of the approved Cloudbreak Project. Annual Night Parrot surveys will continue at Cloudbreak.

14.6.4 Rehabilitation and Mine Closure

The aim of rehabilitation and mine closure is to re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment in line with set closure objectives (Section 13.5, Appendix I). Appropriate management of rehabilitation is a major component of the overall mitigation approach to mining.

Rehabilitated areas will be monitored progressively against rehabilitation criteria to determine whether further action is required to ensure that rehabilitation and closure objectives are achieved. After cessation of mining, monitoring of rehabilitation success will continue for a period as determined through research programs and consultation with DEC. Vegetation monitoring of rehabilitation will occur for at least five years following completion.

Specific monitoring measures for closure will be reviewed as part of the closure planning process. Monitoring is likely to be a combination of methods and may include photographic monitoring, transects and standard plot areas.

These rehabilitation and closure measures will mitigate and reduce the long-term impact of the Proposal upon Matters of NES that utilise the Proposal area.

14.6.5 Threatened Fauna Offset Plan

Fortescue is currently in the process of developing an approach to offsetting the areas of preferred habitat for Matters of NES threatened fauna species that will potentially be affected by Fortescue projects. Fortescue will develop a Threatened Fauna Offset Plan in consultation with SEWPAC and DEC.

The preferred habitat of threatened fauna potentially affected by the Proposal includes:

- 8 ha of suitable habitat for Mulgara
- 8 ha of suitable habitat for Night Parrot
- 8 ha of suitable habitat for the Greater Bilby and 10 911 ha of the area that may contain patches of suitable habitat
- 1142 ha Creekline habitat for Migratory waders.

Fortescue is committed to establishing a conservation reserve of at least 3300 ha in size to offset the above potential impacts by protecting equivalent areas of habitat for these threatened fauna species to meet the expectations of SEWPAC. Fortescue will liaise with SEWPAC and DEC to identify a suitable parcel(s) of land to meet the offset objectives. The Threatened Fauna Offset Plan to be developed will include:

- description of the environmental values of the area to be protected
- management objectives, performance indicators and timeframes
- details of how the conservation reserve will be protected in perpetuity
- details of management measures to be implemented to protect the conservation reserve (e.g. feral animal control).

This approach will be further developed in consultation with SEWPAC and DEC.

14.7 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to Matters of NES:

- 1) Approximately 12 600 ha of potential Matter of NES habitat will be disturbed by the Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga woodland and Spinifex on low hills habitat.
- 2) A maximum of 0.2% of the extent of potential Night Parrot and Mulgara habitat in the Cloudbreak survey areas (halophytic shrubland and hummock grassland along the edge of Fortescue Marsh) will be directly disturbed as a result of the Proposal.
- 3) A maximum of 8 ha of suitable habitat for the Greater Bilby and 10 911 ha (39%) of the area that may contain patches of suitable habitat will be directly disturbed. Areas that are suitable for Bilby are widely available at a regional level.
- 4) Clearing will be avoided in the rocky escarpment habitat which is habitat for the Northern Quoll.
- 5) It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under the EPBC Act.
- 6) It is unlikely that the Proposal will result in significant impacts to Migratory bird species listed under the EPBC Act.
- 7) Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal.
- 8) A Threatened Fauna Offset Plan will be developed to protect at least 3300 ha of habitat for threatened fauna species.

It is considered that with the management and mitigation measures in place, the Proposal will not significantly impact upon Matters of National Environmental Significance.

15. GREENHOUSE GASES IMPACT ASSESSMENT

The greenhouse effect is a natural phenomenon caused by the accumulation of atmospheric gases such that heat radiating off the Earth's surface is trapped within the atmosphere. An enhanced greenhouse effect is understood to be the driving force behind the climate change phenomenon currently being experienced across the globe. Carbon dioxide is the main anthropogenic source of greenhouse gases and has increased in concentration in the atmosphere by about 30% over the last 200 years (EPA 2002a). Other major greenhouse gases include methane, perfluorocarbons, hydrofluorocarbons, sulphur hexafluoride and nitrous oxide.

15.1 RELEVANT ENVIRONMENT OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

The EPA applies the following objective to the assessment of proposals that might generate greenhouse gas emissions:

- To reduce emissions to a level which is as low as is practicable.

To achieve this, the EPA environmental assessment objective is to ensure that potential greenhouse gas emissions emitted from proposed projects are adequately addressed in the planning/design and operation of projects and that:

- best practice is applied to maximise energy efficiency and minimise emissions
- comprehensive analysis is undertaken to identify and implement appropriate offsets
- proponents undertake an ongoing program to monitor and report emissions and periodically assess opportunities to further reduce greenhouse gas emissions over time (EPA 2002a).

15.1.1 EPA Guidance Statement No. 12

EPA Guidance Statement No. 12 provides guidance on the process for the assessment of greenhouse gas emissions.

In its assessment of proposals, the EPA will expect proponents to address the following:

- greenhouse gas emissions inventory and benchmarking
- measures to minimise greenhouse gas emissions
- carbon sequestration potential
- minimising emissions over the life of the project
- benefits on a national or global scale.

15.1.2 International Agreements

In December 2009, in Copenhagen, the world came together under the United Nations to agree a path forward on climate change. The Copenhagen Accord, noted at that meeting, is an important step along the path.

The Accord, which is strongly supported by both developed and developing countries, is the first time there has been agreement under the United Nations Framework Convention on Climate Change to:

- hold any increase in global temperature to below 2°C
- specify, side by side, emissions targets for developed countries and actions to reduce emissions by developing countries
- a framework for national and international monitoring of what developed and developing countries will do
- considerable financing to support emissions reductions and adaptation in developing countries.

Australia formally registered its support for the Accord in Copenhagen and is encouraging its fast and full implementation. Target setting under the Accord is likely to be an iterative process and Australia will continue to work with others to maximise the level of global ambition (DCCEE 2010).

15.2 POTENTIAL SOURCES OF IMPACT

Greenhouse gas emissions are currently being released from the following activities at Cloudbreak:

- combustion of diesel fuel for mining vehicles and remote power sources
- combustion of diesel fuel from Power Station
- combustion of explosive products
- decomposition of cleared vegetation and release of carbon from the soil.

Emissions during construction from vegetation clearing will be 'once-off' and will not contribute to operational annual emissions.

15.3 FINDINGS OF SURVEYS AND INVESTIGATIONS

Fortescue has completed an assessment of predicted greenhouse gas emissions for the Solomon Project based on the current concept design and anticipated fuel consumption (Section 15.5).

15.4 EVALUATION OF OPTIONS OR ALTERNATIVES TO AVOID OR MINIMISE IMPACT

Fortescue is considering a range of energy supply options that could realise significant energy and greenhouse savings. These studies are under way at the current time. They include:

- connecting the Fortescue Pilbara operations to a high voltage regional grid to capture energy efficiencies
- fuel replacement enabling a substitution of gas generation for diesel power generation
- the potential to either electrify or convert the mining fleet to gas power
- potential incorporation of renewable energy such as wind or solar thermal power.

Fortescue has been in ongoing negotiations to access natural gas, but has not been able to complete these negotiations at this time. Fortescue will continue to pursue this option and the outcomes of the above study, together with potential benefits derived from the Solomon and Chichester Hubs may change this scenario.

Several renewable energy sources were considered during the planning and design of the Proposal as options to reduce greenhouse gas emissions.

15.4.1 Solar Energy

Current commercially available solar technology is not considered suitable for base load operations since it is only available during daylight hours. Although solar energy may offset gas generation and reduce greenhouse gas emissions, it is still necessary to install full capacity generation infrastructure to ensure sufficient supply when solar energy is not available.

The full greenhouse gas benefit of solar power is not obtained since operation of the generation plant at reduced capacity (when being partially offset by solar energy) impacts on the thermal efficiency of the plant, and consequently on the intensity of its greenhouse gas emissions.

15.4.2 Wind Energy

In order for wind energy to be financially viable, a minimum average wind speed of about 7 m/s is required. As with solar energy, generation capacity to meet full demand will still be required for times when wind energy is not available and the full greenhouse gas benefit would not be obtained.

15.4.3 Geothermal Energy

There may be a potential for electricity generation from geothermal energy in the Pilbara but investigations to date do not provide sufficient indication of commercial viability.

15.5 ASSESSMENT OF LIKELY DIRECT AND INDIRECT IMPACTS

Estimations of annual operational emissions of greenhouse gases are shown in Table 49.

Table 49: Estimated Annual Greenhouse Gas Emissions

| Activity | Fuel Use (kL/a) | CO ₂ -e (tonne) | | | |
|-------------------------------------|--------------------|----------------------------|-----------------|------------------|----------------|
| | | CO ₂ | CH ₄ | N ₂ O | Total |
| Electricity production using diesel | 46 500 | 124 207 | 179 | 359 | 124 746 |
| Dewatering using diesel | 5 500 | 14 691 | 21 | 42 | 14 755 |
| Mining fleet | 180 000 | 480 802 | 695 | 1 390 | 482 886 |
| Diesel usage in explosives | 3 168 | 8 462 | 12 | 24 | 8 499 |
| Total | 235 168 | 628 162 | 908 | 1 815 | 630 885 |

The GHG emissions from WA were formally estimated in 2007 as part of the National Greenhouse Gas Inventory. Emissions by industry sector are shown in Table 50. The Department of Climate Change estimated that Western Australia emits approximately 76.3 Mtpa of greenhouse gas emissions in 2007. This accounts for about 12.8% of the total greenhouse gas emissions in Australia (597.2 Mtpa in 2007). Overall, Australia emits about 1% of the total global greenhouse gas emissions (Western Australian Taskforce 2004).

It is estimated that the Proposal will emit about 0.63 Mtpa of GHG emissions (Table 49). This represents approximately 0.8% of the total GHG emissions in WA (based on 2007 estimates).

Table 50: Estimated Greenhouse Gas Emissions in Western Australia - 2007

| Sector | 2007 GHG Emissions (Mtpa) |
|------------------------------|---------------------------|
| Energy | 55.5 |
| Industrial process | 7.1 |
| Agriculture | 13.5 |
| Land use change and forestry | -1.2 |
| Waste | 1.3 |
| Total | 76.3 |

The total greenhouse gas emissions for the Proposal are estimated to be approximately 631 000 tonnes CO₂-e/year representing approximately 18 kg CO₂-e per tonne of ore mined, based on the fuel consumption estimates provided and on an average mining rate of 35 Mtpa. This is an increase from the existing rate of 10 kg CO₂-e per tonne. This predicted increase in greenhouse gas emissions can be attributed to an increase in stripping ratio from the current 2.8:1(waste:ore) to 5.7:1 and greater transport distances from plant to pit for some areas of mining. It is also higher than the greenhouse intensity figures reported by BHP and Rio Tinto in past years (Table 51). However, this can be attributed to a number of factors including the amount of dewatering and injection required, the beneficiation process, the stripping ratio and the lack of access to natural gas as a fuel.

Table 51: Benchmarking Greenhouse Gas Intensity of Iron Ore Mining

| | 2006 | 2007 | 2008 | 2009 |
|--------------------|------|------|------|------|
| Rio Tinto Iron Ore | 8.1 | 7.8 | 8.2 | 8.3 |
| BHP Iron Ore | N/A | 8.5 | 10.5 | 9.1 |

15.6 MANAGEMENT MEASURES AND PERFORMANCE STANDARDS

Fortescue has developed a Greenhouse Gas Management Plan for the Cloudbreak operation which identifies the following objectives:

- to quantify greenhouse gas emissions and efficiencies
- to minimise greenhouse gas emissions for the project
- to reduce greenhouse gas emissions per unit product to as low as reasonably practicable
- to manage greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992 and with established Commonwealth and State policies.

Greenhouse gas emissions from the Proposal are managed via internal processes based around the *Energy Efficiency Opportunity Act 2006*. The Proponent complies with its various obligations under the *National Greenhouse and Energy Reporting Act 2007* and the *Energy Efficiencies Opportunity Act 2006*.

In addition, the Fortescue Board of Directors has requested that energy intensity reduction targets be developed and presented for their endorsement.

Fortescue's approach to minimise its GHG emissions covers the following strategies:

- **Carbon reduction:** Overall, the proposed Project aims to use proven, best in class technologies for the mining, processing, power production and transport functions. Fortescue will strive to further increase energy efficiencies and reduce greenhouse gas emissions via a continuous improvement program throughout the lifetime of the Project.
- **Energy Supply Options:** As mentioned above, Fortescue is considering a range of energy supply options that could realise significant energy and greenhouse savings. These studies are under way at the current time. They include connecting Fortescue's Pilbara operations to a high voltage regional grid to capture energy efficiencies, fuel replacement enabling a substitution of gas generation for diesel power generation, the potential to either electrify or convert the mining fleet to gas power, and potential incorporation of renewable energy such as solar thermal power.
- **Mine Planning and Design:** A number of energy efficiency initiatives have been identified by Fortescue as part of its participation in the Energy Efficiency Opportunities program. Fortescue intends to incorporate lessons from this work into future expansions. Initiatives include designing the haul routes to minimise stop signs, better matching of generators and pumps to individual bore's dewatering requirements, and incorporating best practise energy efficiency measures into the permanent mining village. Fortescue is incorporating the consideration of energy efficiency measures into its capital procurement process, and is also seeking to reduce the greenhouse gas emissions associated with the transport of equipment to site.

The implementation of greenhouse gas and energy conservation measures enables the company to minimise emissions and provide a mechanism for continuous improvement in greenhouse gas emissions resulting from the Proposal.

The Proponent will comply with all relevant statutory requirements relating to greenhouse gas emissions including any national carbon pollution reduction scheme, if one is introduced.

15.6.1 Offsets

Given the reasonable expectation of implementation of some form of national carbon pollution reduction scheme in the near future, and that the Proposal will be a mandated participant in the scheme, Fortescue does not believe that direct offsets for the resulting emissions are appropriate.

Fortescue acknowledges that some level of offsetting may be appropriate in the absence of a national scheme designed to achieve the State Government emission targets. However, based on published national policy positions on a carbon pollution reduction scheme, the broad coverage proposed for the scheme creates limited scope for the creation of offset credits. Requiring direct offsets prior to coverage by the national scheme could complicate subsequent transition into the scheme because coverage could then involve the loss of offset revenue at the same time that entities must take on scheme obligations. Establishing an offsets regime could divert industry from more critical coverage issues and add to scheme complexity, creating implementation risks.

Participation in a national scheme with an additional State requirement for offsets that cannot be credited is considered unjustified and unreasonably onerous and as consequently, greenhouse gas emissions from the Proposal are not proposed to be offset.

15.7 PREDICTED ENVIRONMENTAL OUTCOMES AGAINST ENVIRONMENTAL OBJECTIVES, POLICIES, GUIDELINES, STANDARDS AND PROCEDURES

Fortescue is committed to an ongoing program of review and reporting of greenhouse gas abatement measures. It is anticipated that periodic reviews through the life of the Proposal will identify opportunities to further reduce greenhouse gas emissions over time.

16. NOISE IMPACT ASSESSMENT

Noise emissions from operation at Cloudbreak include:

- drilling and blasting of areas to prepare for mining
- earthworks and vehicle noise
- ore processing
- loading and operation of trains to transport ore to Port Hedland.

The nearest residence to the Proposal area, Marillana Station homestead, is approximately 28 km to the south of the Proposal area and is not close enough to be affected by noise...

Noise was not considered a key relevant factor in the Environmental Scoping Document as the rate of mining is not increasing significantly as part of the Proposal and noise is not likely to increase substantially beyond that produced from the existing mine.

Noise at the Cloudbreak mine is managed under the Cloudbreak Environment Management Plan required to be implemented as a commitment under Statement 721 and is also managed in accordance with the Environmental Protection (Noise) Regulations 1997.

17. DUST IMPACT ASSESSMENT

Mining, handling of ore and overburden and exposed cleared areas have the potential to create a dust nuisance for workers and adjacent land users. The nearest residence to the Proposal area, Marillana Station homestead, is approximately 28 km to the south of the Proposal area and is not close enough to the Proposal area to be affected by dust.

Dust was not considered a key relevant factor in the Environmental Scoping Document as the rate of mining is not increasing significantly as part of the Proposal and dust is not likely to increase substantially beyond that produced from the existing mine.

Dust at the Cloudbreak mine is managed under the Dust Management Plan required to be implemented as a commitment under Statement 721 and is also managed through the licence conditions under Part V of the EP Act. The Dust Management Plan under Statement 721 is required to address:

- minimising clearing
- minimising the generation of dust and impacts and emissions on and off site
- dust control measures
- ore stockpiles moisture content
- dust monitoring
- complaints and response process.

This plan will be updated to include the expansion Proposal prior to construction and operation of the Proposal.

18. SUMMARY OF LIKELY ENVIRONMENTAL MEASURES AND CONTROLS

18.1 ENVIRONMENTAL MANAGEMENT FRAMEWORK

18.1.1 Overview

In addition to implementing the requirements of specific environmental conditions set by the EPA if the Proposal is approved, the Proponent will minimise environmental impacts through:

- maintaining an Environmental Management System (EMS)
- implementing the Environmental Management Plan (EMP) for the Proposal (Appendix A)
- regularly reviewing the performance of the EMS, EMP and developing environmental improvement plans for priorities identified in the reviews
- improving mechanisms to measure and minimise energy use and greenhouse gas emissions improving the efficiency of natural resource use
- continually updating mine plans and closure, progressively rehabilitating and measuring success
- training staff and contractors in environmental requirements and considerations of their work
- ensuring that stakeholder views are sought, respected and considered
- reporting regularly to stakeholders on performance
- aligning with the Fortescue Environmental Policy.

Fortescue will abide by all relevant current and future statutory requirements including greenhouse gas reporting requirements under the *National Greenhouse and Energy Reporting Act 2007*.

18.1.2 Environmental Policy

The Fortescue Environment Policy communicates what Fortescue are committed to achieving:

- 1) Fortescue is committed to maintaining sound environmental management practices and meeting our responsibilities.
- 2) Fortescue recognise the importance of minimising environmental impacts as it is important in ensuring the company's longevity, success, growth and positioning in the domestic and global markets.

- 3) Fortescue decision making processes will incorporate sustainability principles and the implementation of new and better technologies where feasible. Fortescue aims to inspire an ethic and attitude that strives for continuous improvement and ongoing learning.
- 4) Fortescue encourage employees to engage in positive attitudes and behaviour concerning respect for the environment. We recognise sustainability cannot be achieved without the contribution and action of the entire team.

18.1.3 Environmental Management System (EMS)

Fortescue is proactively working to ensure that the environmental impact from their activities is minimal and that they meet or exceed their approval obligations. Activities are supported by their environmental management systems, which cover environmental approvals, environmental management plans, incident management systems, internal audits and awareness and training programs.

18.1.4 Environmental Management Plan (EMP)

The proposed management of the key issues associated with the Proposal has been documented in the EMP (Appendix A) to be implemented to manage specific environmental aspects of the Proposal. Implementation of the Proposal in accordance with the EMP will ensure that the Proposal meets all respective environmental obligations including internal objectives, legislation, regulations, and conditions of approval relating to operation of the Proposal.

The EMP is comprised of management sub-plans that describe the specific environmental objectives and targets for each environmental factor, the management measures to be applied to avoid and minimise the environmental impact of the Proposal, monitoring measures to measure the performance of management against the targets, and contingency measures to mitigate unavoidable or accidental impact. The sub-plans are as follows:

- Groundwater Management
- Surface Water Management
- Fortescue Marsh Management
- Biodiversity Management
- Closure Management
- Cultural Heritage Management.

The EMP will be regularly reviewed and revised where appropriate. There are existing management plans in place in accordance with Statement 721 for the approved project. As Fortescue is aiming to achieve a single Ministerial Statement that covers both the existing approved project and the Expansion Proposal, management of the entire Fortescue mine will be undertaken consistent with the conditions of the Expansion Proposal if approved.

18.2 SUMMARY OF LIKELY ENVIRONMENTAL CONTROL INSTRUMENTS

Fortescue has identified the regulatory controls that will be applied to ensure appropriate management of the Proposal (Table 52). The key controls include (but are not limited to):

- environmental conditions in any Statement issued by the Minister for the Environment allowing the Proposal to be implemented
- conditions of DEC Works Approval(s) (under Part V of the EP Act) for construction of works on prescribed premises (ore processing, landfill and sewage facility)
- conditions of DEC Licence(s) (under Part V of the EP Act) for the operation of activities on prescribed premises (ore processing, landfill, sewage facility and discharge of excess water)
- conditions of the DoW Licences and Permits for activities relating to the abstraction of groundwater and disturbance to bed and banks (under the RIWI Act)
- conditions of Mining Proposals approved by Department of Mines and Petroleum (DMP), including closure management.

Management controls to be implemented as part of the Proposal to ensure key environmental factors are managed as described in this PER include measures and/or actions contained within the following documents:

- design and feasibility reports
- Environmental Management Plan
- Conceptual Closure Plan.

Table 52: Statutory and Environmental Management Controls for the Proposal

| Factor | Topic | Commitments | CEMP/ EMP/ Closure Management Plan** | Works Approval/ Licence (Part V) | Other Relevant Legislation and Regulations*** |
|--|---|-------------|--------------------------------------|----------------------------------|--|
| Key environmental factors | | | | | |
| Groundwater | Extent of groundwater drawdown | ✓ | ✓ | | ✓ Licence under RIWI Act |
| | Groundwater quality | | ✓ | ✓ | |
| | Injection | | | | |
| Surface water | Diversion of creek lines | ✓ | ✓ | | ✓ Bed and Bank licence under RIWI Act |
| | Site drainage | | ✓ | ✓ | |
| | Surface water quality | ✓ | ✓ | ✓ | |
| Vegetation and flora | Extent of vegetation clearing | ✓ | ✓ | | |
| | Declared Rare Flora | | ✓ | | ✓ WC Act |
| | Extent of indirect impacts from groundwater drawdown and mounding | ✓ | ✓ | | |
| Terrestrial fauna | Extent of habitat removal | ✓ | ✓ | | |
| | Rare and endangered fauna | | ✓ | | ✓ WC Act |
| Conservation areas | Protection of Fortescue Marsh | ✓ | ✓ | | |
| Aboriginal heritage | Aboriginal heritage sites | | ✓ | | ✓ Aboriginal Heritage Act |
| Closure | Decommissioning, decontamination/ remediation, and rehabilitation | ✓ | ✓ | | ✓ State Agreement Act ✓ Mining Act |
| Other management considerations | | | | | |
| Greenhouse gases | Emissions reduction | | ✓ | | ✓ Carbon Pollution Reduction Scheme (proposed) |
| | Reporting | | | | ✓ NGER Act |
| Dust | Emissions management | ✓ | ✓ | ✓ | |
| Noise | Emissions management | ✓ | ✓ | | ✓ EP (Noise) Regulations |

18.3 SUMMARY OF POTENTIAL IMPACTS, PROPOSED MANAGEMENT COMMITMENTS AND ENVIRONMENTAL OUTCOMES

Table 53 provides a summary of the potential impacts, proposed management commitments and environmental outcomes for each of the environmental factors assessed.

Table 53: Summary of the Impacts and Proposed Management Commitments

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
|----------------------|---|---|---|--|--|--|
| Groundwater | <ul style="list-style-type: none"> To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards. | <ul style="list-style-type: none"> National Principles for the Provision of Water for Ecosystems (ANZECC/ ARMCANZ 1996) National Water Quality Management Strategy (ANZECC/ ARMCANZ 2000) State Water Quality Management Strategy 2001 Department of Water's Water Quality Protection Notes Statewide Policy No 5 – Environmental water provisions policy for Western Australia, EPA 2000. | <p>The Cloudbreak area and Fortescue Marsh are underlain by the fractured rock aquifers of the Roy Hill Shales (Fortescue 2010a). Above this lies the Marra Mamba Formation, this includes the ore body. The Marra Mamba Formation aquifer is unconfined to partially confined in the north and partially confined to confined in the south. The topmost layers of the aquifer are Tertiary Detritals including clays, silts, sands and gravels.</p> <p>Aquifers are recharged by direct infiltration of rainfall at outcrop regions of the Marra Mamba Formation and Tertiary Detritals, however, rainfall recharge is low in the Cloudbreak area, reflecting the generally low rainfall of the region (Fortescue 2010a).</p> <p>Groundwater levels at Cloudbreak vary from the mine site (where the watertable is approximately 409 to 415 mAHD) to the Fortescue Marsh margin (approximately 405 mAHD) (Fortescue 2010a).</p> <p>Groundwater in the Cloudbreak region ranges from brackish (<6000 mg/L Total Dissolved Solids [TDS]) in recharge areas to hypersaline in areas closer to the Fortescue Marsh and in fractured rock zones below the Marra Mamba Formation (>100 000 mg/L TDS) (Fortescue 2010a).</p> | <ul style="list-style-type: none"> Dewatering of mine pits will reduce groundwater levels, which may potentially: <ul style="list-style-type: none"> reduce the duration of surface water on the Fortescue Marsh and the presence of Yintas result in loss of water supply to station supply bores in the vicinity of the mine remove water from subterranean voids leading to the formation of sinkholes potential oxidisation of Potentially Acid Forming (PAF) material resulting in acid mine drainage. Injection of dewatering water that may increase groundwater levels, which may potentially result in : <ul style="list-style-type: none"> surface discharge of groundwater if the aquifer at the injection zone is unable to receive the total quantity of water being injected. Changes in groundwater salinity due to injection of saline dewatering water. | <p>Groundwater will be managed in accordance with the Operating Strategy required by the DoW as part of the licensing process, which has been prepared by Fortescue for the management of mine dewatering and disposal at Cloudbreak (Fortescue 2009a).</p> <p>Key management strategies and proponent commitments relating to groundwater are:</p> <ul style="list-style-type: none"> manage saline and brackish dewatering and injection separately to protect aquifer water quality. progressive dewatering only in active mining areas to minimise dewatering requirements. monitor water levels and quality (including pH and salinity) prior to and during mining and post-closure (for three years on a six monthly basis), to address potential water quality issues including acidification of potential ASS. The monitoring results will be reviewed after 3 years and the need for any ongoing monitoring determined. Regulatory agencies will be consulted as a component of the review process. develop trigger criteria for water levels and modify operations should trigger criteria be breached. develop trigger criteria for water quality and undertake an investigation program should these criteria be breached. modify injection regime if required to mitigate potential effects of groundwater drawdown or mounding. establish a contingency plan in consultation with station manager/lease owners should station bore supply be affected by dewatering drawdown. develop a detection plan for sinkholes, should dolomite, calcrete and/or ferricrete with extensive voids, be encountered. <p>An adaptive management approach to groundwater management is being developed by Fortescue to monitor and respond to the actual water level changes as a result of dewatering and injection. This approach is described in the Groundwater Management Plan in Appendix A.</p> <p>Fortescue will develop a monitoring and contingency strategy for potential Acid Mine Drainage.</p> <p>Fortescue is also planning (and in some cases has already commenced) a series of investigations related to groundwater impacts. These investigations will include:</p> <ul style="list-style-type: none"> development of an eco-hydrological model of the Fortescue Marsh Samphire community to investigate soil moisture dynamics based on the marsh hydrogeological drilling program and soil profile assessments investigation of the geology and hydrogeology of the Fortescue Marsh investigation of Samphire use of groundwater and response to salinity changes and drying regimes investigation of the response of Mulga to drought, waterlogging and salinity stresses. <p>The findings of these investigations will inform mining operations in order to provide for ongoing vegetation protection and management. Fortescue will maintain an ongoing dialogue with regulatory authorities with respect to the implementation of these investigations and their outputs, which will be used to refine the EMP provided in Appendix A.</p> | <p>After mitigation measures as described in Appendix A, the Expansion Proposal and the cumulative effects of the current Proposal are expected to result in the following outcomes in relation to groundwater:</p> <ol style="list-style-type: none"> 1) An estimated average rate of abstraction of 58 GL/yr, of which an estimated 47 GL/yr will be injected back into the aquifer and 11 GL/yr will be used for processing and dust suppression. 2) A total of 607 ha outside the maximum disturbance footprint associated with mining may be affected by greater than 1 m of mounding over the life of the Proposal that results in groundwater levels reaching 2 m of the surface. No mounding greater than 1 m occurs in the Fortescue Marsh. 3) A total of 2709 ha outside the maximum disturbance footprint with a depth to groundwater levels initially less than 5 m may be affected by drawdown greater than 1 m over the life of the Proposal. Most drawdown occurs for periods of three years or less. A total of 150 ha of the Marsh may be affected by drawdown greater than 1 m for a period of less than three non-consecutive years. 4) Mounding and drawdown will slowly dissipate post-closure. Groundwater mounding will continue for between five and ten years post closure. Limited areas of drawdown will occur for at least 40 years post closure. 5) No impact is expected in terms of residence time of surface water in the Fortescue Marsh. 6) Impacts to groundwater salinity are expected to be minimal due to the geographically separated injection of saline and brackish water designed to match the quality of the receiving waters. 7) Any potential impact to station supply bores will be managed through well modification or substitution with an appropriate water source if water supply is affected. 8) Acidification of any potential ASS may occur in marsh areas if drawdown occurs during dry climate periods. The potential for acidification will be prevented through the manipulation of the injection regime to maintain water levels. 9) Acid mine drainage is not expected to occur as dewatering will not target the Roy Hill Shale member below the ore body and generally the dewatering cone of depression will not extend into the Roy Hill Shale. However, a monitoring and contingency strategy will be developed to address this risk. 10) No impact is expected in terms of sinkhole formation. <p>These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Proposal will not be significantly affected. The key mitigation measure is the separation of saline and brackish water and managed injection that minimises mounding and drawdown effects and maintains a net abstraction of less than 15 GL/yr. The impact of mounding and drawdown upon vegetation is discussed in Section 8.5.2. Fortescue expects that the EPA objective for this factor will be met.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Surface water | <ul style="list-style-type: none"> To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards. | <ul style="list-style-type: none"> National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996) National Water Quality Management Strategy (ANZECC/ARMCANZ 2000) Water Quality Protection Notes and Guidelines – Mining and Mineral Processing (2000) Department of Water's Water Quality Protection Notes Statewide Policy No 5 – Environmental water provisions policy for Western Australia, EPA 2000. | <p>The Proposal area is located in the Upper Fortescue River catchment. Surface water in the Proposal area drains in a southerly direction from the Chichester Range to the Fortescue Marsh. The Fortescue Marsh is an extensive, ephemeral wetland bounded by the Chichester Range to the north and the Hamersley Range to the south, occupying an area of approximately 1000 km² when in flood (Figure 4, Worley Parsons 2011). The Fortescue Marsh is within the internally draining upper catchment of the Fortescue River system.</p> <p>Surface water flow in and around the Proposal area takes several different forms including:</p> <ul style="list-style-type: none"> channel flow – convergent flow to large creek channels and adjacent floodplains sheet flow – overland flow in a broad shallow front. <p>Channel flow zones are associated with large catchments that predominantly drain the steep upland areas, rather than the flatter terrain closer to the Fortescue Marsh, Sheet flow occurs over extensive areas within and to the south of the Proposal area. Such flat areas occur where the terrain has been formed by remnant alluvial fans (Worley Parsons 2011).</p> <p>Surface water runoff entering the Marsh is generally considered to be of low salinity and turbidity, though turbidity increases after flooding (Aquaterra 2005). During flooding events, salts deposited from previous drying episodes are redissolved, and the water entering the Marsh becomes moderately saline (Fortescue 2009a).</p> | <ul style="list-style-type: none"> Disruption to channel and sheet flow surface water regimes through the diversion, ponding or capture of surface water flows by mine pits, waste landforms and linear infrastructure. Surface water discharge of dewater may occur as a contingency if injection infrastructure fails may cause surface water quality impacts and create new flow paths and erosion risk. Deterioration of surface water quality due to: <ul style="list-style-type: none"> drainage from mine waste facilities (increasing surface water turbidity and acidification of mine waste, should this occur) storage and use of hydrocarbons contaminating storm water discharge. erosion, earthworks and clearing. | <p>The key management strategies and proponent commitments relating to surface water are to:</p> <ul style="list-style-type: none"> divert surface water away from mine pits and waste landforms, and maintain downstream flow regimes where feasible. separate surface water from mining areas from clean water. Surface water from mining areas will be pumped to sedimentation ponds prior to release into injection. minimise the impacts of waste landforms on water quality and quantity through stabilisation to prevent erosion and berms and perimeter drains to prevent stormwater entering waste landform areas. locate buildings and process infrastructure out of the 1 in 100 year floodway or ensure that they are suitably protected through bunds or by vertical separation. ensure that pipelines are either buried or raised at channel crossings and at regular intervals (nominally 75 m) in sheet flow areas to allow surface water flow and prevent ponding. disposal of water via surface water flow paths will only occur during emergencies and when maintenance is required. ensure that chemical storage is undertaken in a manner that limits potential surface water contamination. manage clearing and earthworks to minimise erosion. at closure, the twelve major creek lines defined by Worley Parsons (2010) will be re-established in their original alignments and rehabilitated. | <p>After mitigation measures as described in Appendix A, the Proposal and the cumulative effects of the approved project are expected to result in the following outcomes in relation to surface water:</p> <ol style="list-style-type: none"> No significant impact on water quality and quantity of water entering Fortescue Marsh. Increases in velocity of peak flows in major creek lines during the later stages of mining, with velocities generally returning to close to the pre-development values following closure. A post-closure effect of 170 ha of areas formerly inundated in the 1 in 100 year event may become dry and around 45 ha of previously dry areas become inundated (Figure 46) (Worley Parsons 2011). The change in the areas inundated in the 1 in 2 year event is less than 1 ha. A post-closure effect of 300 ha of sheet flow area outside the approved footprint may be affected by shadowing and 20 ha subject to ponding. Temporary decrease of up to 7% in catchment areas for the yintas and long term post-closure reduction of 2% or less. All surface flow from potentially contaminated areas contained. Possible increase in turbidity during high flow events, although flows in the area are already highly turbid. At closure, the twelve major drainage lines defined by Worley Parsons (2011) will be re-established as close as practicable to their original alignments and levels and rehabilitated. <p>These impacts are considered to be acceptable as the key environmental values surrounding the Proposal will not be significantly affected. The key mitigation measure is the progressive stabilisation and rehabilitation of final landforms, including the re-establishment of the major drainage lines at closure. More information on closure management is provided in Section 13. It is expected that the EPA objective for this factor will be met.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Vegetation and Flora | <ul style="list-style-type: none"> To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. | <ul style="list-style-type: none"> National Strategy for the Conservation of Australia's Biological Diversity National Strategy for Ecologically Sustainable Development EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA 2000) EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b) EPA Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004c). | <p>21 vegetation types have been mapped in the Proposal area (ENV 2011), none of which are considered to resemble Threatened Ecological Communities. The Fortescue Marsh which occurs to the south of the Proposal area is listed by DEC as a Priority 1 Priority Ecological Community. The condition of the vegetation within and in the vicinity of the Proposal area ranges from Excellent to Good.</p> <p>Significant vegetation communities in and adjacent to the Proposal area include:</p> <ul style="list-style-type: none"> Mulga communities, which are considered dependent on sheet flow Coolibah and River Red Gum Communities, which are considered ground-water dependent Samphire communities, which are associated with the Fortescue Marsh PEC (P1). <p>No Threatened species pursuant to the <i>Environment Protection and Biodiversity Conservation Act 1999</i> or, plant taxa gazetted as Declare Rare (DRF) pursuant to the <i>Wildlife Conservation Act 1950</i> are known from the Proposal area.</p> <p>Seven Priority flora listed by the DEC have been recorded within or adjacent to the Proposal area, these are: <i>Eremophila spongicarpa</i> (P1); <i>Gymnanthera cunninghamii</i> (P3); <i>Phyllanthus aridus</i> (P3); <i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3); <i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) (P3); <i>Eremophila youngii</i> subsp. <i>Lepidota</i> (P4) and <i>Goodenia nuda</i> (P4).</p> | <ul style="list-style-type: none"> Vegetation clearing for mine pits, waste dumps, tailings facilities, infrastructure corridors, product stockpiles and processing facilities will lead to the direct disturbance of vegetation communities and may potentially affect Priority flora species. Dewatering of mine pits will lower watertables and potentially stress or cause death of groundwater-dependent vegetation communities. Injection of excess groundwater may result in groundwater mounding and potentially stress or kill vegetation communities due to waterlogging and/or salt accumulation in the vegetation root zone. Disruption of surface hydrology may affect vegetation communities that rely on surface water flows. | <p>A maximum of 12 600 ha of vegetation will be cleared by the Proposal. All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing.</p> <p>Potential impacts to significant vegetation communities, such as Mulga and Samphire communities, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in the EMP (Appendix A). The adaptive management approach is based on responding to information provided through implementation of a monitoring program and response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management framework outlined in Appendix A.</p> <p>Impacts to vegetation and flora will be managed under the Biodiversity Plan in the EMP (Appendix A). Key management measures include:</p> <ul style="list-style-type: none"> road and other access alignments and borrow pit areas are to be constructed to avoid DRF and Priority flora as far as practicable all DRF locations (if found) are to be demarcated on the ground with appropriate fencing, signage and flagging where clearing of DRF cannot be avoided: <ul style="list-style-type: none"> assess the local/regional conservation significance of the species prior to clearing consult with DEC regarding the proposed clearing translocation of individuals to nearby similar vegetation associations will be attempted if practicable, dependent on research advice from consultant botanists and the DEC seed and other propagules of DRF planned for clearing will be collected and used for revegetation where practicable collect seed from areas to be cleared within the Proposal area; for use in future rehabilitation clearing to be undertaken progressively. <p>Fortescue is also planning (and in some cases has already commenced) a series of investigations into the water use dynamics of Samphire and Mulga vegetation. These investigations will include:</p> <ul style="list-style-type: none"> development of an eco-hydrological model of the Fortescue Marsh Samphire community to investigate soil moisture dynamics based on the marsh hydrogeological drilling program and soil profile assessments investigation of Samphire use of groundwater and response to salinity changes and drying regimes investigation of the response of Mulga to drought, waterlogging and salinity stresses. <p>The findings of these investigations will inform mining operations in order to provide for ongoing vegetation protection and management. Fortescue will maintain an ongoing dialogue with regulatory authorities with respect to the implementation of these investigations and their outputs, which will be used to refine the EMP provided in Appendix A.</p> | <p>After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to vegetation and flora:</p> <ol style="list-style-type: none"> Approximately 12 600 ha of vegetation will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance within a 23 000 ha area combined with the approved project) with the majority of this occurring in Mulga woodland on flats and broad plains and Spinifex on ranges and hillslopes. Up to 10 500 ha of Mulga vegetation will be directly affected by the Proposal with an additional 250 ha potentially indirectly affected by an altered surface water regime and groundwater mounding. Up to 4 ha of Samphire vegetation communities (associated with the Priority 1 PEC) will be directly affected by the Proposal with an additional 13 ha potentially indirectly affected for two or more years through dewatering activities (groundwater drawdown). Up to 473 ha of Coolibah and River Red Gum vegetation will be directly affected by the Proposal. No additional indirect impact from dewatering and injection activities (groundwater drawdown and mounding) is expected. Clearing for the Proposal and potential indirect impacts to vegetation will not compromise any vegetation association by taking it below the "threshold level" of 30% of its pre-clearing extent. No DRF will be affected by the Proposal and impacts to Priority flora are not expected to be significant. |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Terrestrial Fauna | <ul style="list-style-type: none"> To maintain the abundance, diversity geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge. To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity. | <ul style="list-style-type: none"> EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b) EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a) EPA Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (EPA 2009) EPA Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003) Draft Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007c). | <p>Five broad fauna habitats present within the Proposal area (Ecologia 2010a):</p> <ul style="list-style-type: none"> low halophytic shrubland hummock grassland on fringe of Fortescue Marsh low Mulga, Snakewood and other Acacia woodland Spinifex covered hills and ranges creek lines and wells with Acacia shrubland and/or eucalypt woodland. <p>Desktop studies have identified 238 species that either may potentially occur or have previously been recorded in the surveyed area. This total included 165 species of birds, 34 species of native mammals, nine introduced mammals, 96 species of reptiles and five amphibians. Surveys within the Cloudbreak area have recorded 62% of the native mammals, 84% of the birds and 80% of the amphibians potentially occurring.</p> <p>There is potential for 23 species of conservation significance to occur in the Proposal area. Twelve of these species have been recorded within the Proposal area.</p> <p>Seven potential SRE species have been previously recorded in the Proposal area.</p> | <ul style="list-style-type: none"> Vegetation clearing for development within the mining areas and installation of water conveyance infrastructure will directly remove fauna habitat. Trenching for burial of some pipelines may result in the loss/injury of individual fauna. Physical presence of linear infrastructure such as roads and pipelines may disrupt fauna linkages. Redistribution of surface water flows around the mine and its infrastructure may alter fauna habitat. Dewatering and injection activities may affect groundwater-dependent vegetation and affect the value of significant fauna habitat. Vehicle movements during construction and operation may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes. Presence of artificial water bodies may result in the impact to native fauna through increases in introduced fauna, entrapment, poisoning or alteration of fauna behaviour. Loss or disturbance of stygofauna or troglafauna habitat from mining of ore bodies and/or groundwater drawdown and injection. | <p>A maximum of 12 600 ha of habitat will be cleared by the Proposal.</p> <p>All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing.</p> <p>Impacts to significant fauna habitat such as Mulga Woodland and the Fortescue Marsh from groundwater mounding and drawdown will be managed under an Adaptive Management Framework.</p> <p>Management of potential impacts on fauna from this Proposal are also addressed in Biodiversity Plan in the Environmental Management Plan (Appendix A) and includes the following key management actions:</p> <ul style="list-style-type: none"> clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above) significant fauna habitat will be spatially identified and where appropriate demarcated on site all lined surface water storage will have fauna egress points vehicles speeds will be restricted across the Proposal area off road driving or driving on restricted access routes will be prohibited other than for emergency situations clearing will not be undertaken outside authorised areas rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards lighting will be directed onto construction or operational areas. | <p>After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to terrestrial fauna:</p> <ol style="list-style-type: none"> Approximately 12 600 ha of fauna habitat will be disturbed by the Expansion Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga, Snakewood and other Acacia woodland and Spinifex covered hills and ranges habitat. There will be some loss of creek line habitat but very little clearing within halophyte shrubland and hummock grassland habitats. There will likely be some localised impacts to the Priority fauna species Pebble-mound Mouse and Northern Short-tailed mouse due to clearing activities. However, these species are widespread in the region and the Proposal is unlikely to significantly affect their regional abundance or range. Significant regional impact to fauna is highly unlikely as the habitats that occur within the Proposal area also occur extensively outside the Proposal area. The Proposal itself will not conflict with the WC Act, as no fauna species will cease to exist or have its conservation status affected as a result of the implementation of the Proposal. Significant regional impact to SRE species is not expected to occur as a result of the Proposal as it is likely species occurring within the Proposal area occur in the wider region. A troglafauna survey will be undertaken to better understand the impacts to troglafauna communities in the Proposal area. It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under either the WC Act or EPBC Act. Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal potentially adding to the body of knowledge available on this rare species. <p>Consistent with EPA objectives; species diversity, geographic distribution and productivity of terrestrial fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Fortescue Marsh Wetland Area | <ul style="list-style-type: none"> To protect the environmental values of areas identified as having significant environmental attributes. To maintain the integrity, functions and environmental values (of the Fortescue Marsh). | <ul style="list-style-type: none"> Environment Protection and Biodiversity Conservation Act 1999 Directory of Important Wetlands in Australia (Environment Australia 2001) Register of the National Estate The Japan Australia Migratory Bird Agreement (JAMBA), China Australia Migratory Bird Agreement (CAMBA) and Republic of Korea Australia Migratory Bird Agreement (ROKAMBA). | <p>The Fortescue Marsh is the largest ephemeral wetland in the Pilbara Bioregion:</p> <ul style="list-style-type: none"> the Fortescue Marsh is a wetland of National Significance in the Directory of Important Wetlands in Australia and is listed as an “Indicative Place” on the Register of the National Estate – Waterbirds the Marsh constitutes an arid wetland for waterbirds of national importance: 260 000 – 276 000 individuals from 47 species were recorded when the Marsh was inundated in 1999 & 2003. <p>The Fortescue Marsh is an intermittently inundated wetland with broad-scale inundation occurring approximately one year in ten for a period of three to six months. During smaller rainfall and runoff events, isolated pools form on the Fortescue Marsh at the main drainage inlets. Outflow from the marsh into the Lower Fortescue River does not occur.</p> <p>The marsh has recently been classified as a Priority 1 Priority Ecological Community.</p> <p>The Bilby (listed rare fauna) and other mammal species with conservation significance (Mulgara) are present on the apron to the Marsh.</p> | <ul style="list-style-type: none"> Dewatering and injection of groundwater may affect groundwater levels and vegetation health in areas with shallow groundwater such as the edge of the Fortescue Marsh. Installation of linear infrastructure, mine pits and waste landforms may result in interference with natural surface water flow regimes and increased erosion risk. | <p>Potential impacts to significant vegetation communities, such as Samphire communities within the marsh, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in Appendix A. The adaptive management approach is based on responding to information provided through implementation of hydrological and biological monitoring programs coupled with a response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management approach outlined in Appendix A.</p> <p>To support this monitoring and management framework, a water balance model for the Samphire communities of the Fortescue Marsh will be developed. This will be informed by the outputs of research projects undertaken by Fortescue and the University of Western Australia.</p> | <p>The key potential impact to the Fortescue Marsh from the Proposal is the potential for changes in groundwater levels and secondary effects on vegetation and fauna. However, hydrogeological modelling has predicted that any impact on marsh hydrology is unlikely to be significant and only small areas of vegetation may be affected.</p> <p>It is expected that the integrity, function, environmental and heritage values of the Fortescue Marsh will be protected and the EPA objective for this factor will be met.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Proposed Conservation Reserve (PCR) | <ul style="list-style-type: none"> To protect the environmental values of areas identified as having significant environmental attributes. | <ul style="list-style-type: none"> The National Strategy for the Conservation of Australia's Biological Diversity (Department of the Environment, Sports and Territories, 1996) National Objectives and Targets for Biodiversity Conservation 2001-2005 The Western Australian State Sustainability Strategy – Consultation Draft (CALM 2003). | <ul style="list-style-type: none"> The Marsh and surrounding Pastoral Leases are earmarked for reservation by DEC under pastoral lease renewal arrangements scheduled for 2015, subject to discussion with Fortescue and other parties concerned. This includes portions of the Life of Mine Footprint and Approved Footprint of the mine | <ul style="list-style-type: none"> Clearing and earthworks associated with mining will remove vegetation within the PCR. Dewatering of mine pits will lower watertables and potentially stress or cause death of groundwater-dependent vegetation communities within the PCR. Injection of excess groundwater may result in groundwater mounding and potentially stress or kill vegetation communities within the PCR due to waterlogging and/or salt accumulation in the vegetation root zone. Disruption of surface hydrology may affect vegetation communities in the PCR that rely on surface water flows. | <p>A procedure of internal review and approval of all proposed vegetation clearing and ground disturbance activities is required prior to the commencement of works (a Ground Disturbance Permit [GDP]). Under the permitting process areas of vegetation which may comprise high value may require ground-truthing surveys to assess its value. This process is based on a risk assessment approach such that where particular risk factors are triggered (such as proximity to the Fortescue Marsh, drainage lines, Mulga and where no previous surveys have been conducted), further surveys are conducted prior to clearing where required. Areas which are confirmed as having higher values may then be reassessed for suitability for clearing in consultation with DEC, for the purposes of strategic conservation planning associated with vegetation protection in the PCR</p> <p>Potential impacts to significant vegetation communities within the PCR, such as Mulga Woodland and Samphire communities, from drawdown and mounding will be managed through the adaptive management approach outlined in the Groundwater Management Plan in Appendix A. The adaptive management approach is based on responding to information provided through implementation of hydrological and biological monitoring programs coupled with a response plan. If monitoring indicates that unexpected and significant impacts are likely, the Fortescue, in consultation with the regulatory agencies, will implement an appropriate contingency action within the adaptive management framework outlined in Appendix A.</p> <p>Fortescue undertook consultation with the DEC regarding the PCR as part of the site tour to Fortescue's mining activities between 26 and 28th July 2010. Ongoing consultation will occur with DEC regarding the PCR. The PCR consultation process is expected to include consolidation of all parties' commitments and obligations with respect to reserve management. Should it be determined that the best use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this use.</p> <p>In addition, Fortescue is committed to developing an offset package in consultation with the EPA and DEC which is consistent with and addresses the EPA Guidance Statement 19 and EPA Position Statement 9. This package will be targeted at enhancing the long term conservation value of the PCR through improved management and understanding of threatening processes.</p> | <p>The PCR would add local pastoral leases to the conservation estate upon lease expiry in 2015. The overall percentage of the PCR that will be affected by the mine is less than 4%. This area will be rehabilitated following closure. Should it be determined by Government that the end land use for the Proposal area post-closure is conservation, then discussions will be held with DEC and other stakeholders to ensure that closure and rehabilitation is undertaken in a way that is compatible with this end land use.</p> <p>Fortescue will also participate in the anticipated consultation process to be conducted by DEC as part of the establishment of a multi-user framework agreement with respect to the PCR.</p> <p>It is expected that the potential impacts of the Proposal are consistent with Government planning for the PCR which recognises mining interests in the area and that rehabilitation will be undertaken consistent with the long term management objectives for this area.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Aboriginal Heritage | <ul style="list-style-type: none"> To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation. | <ul style="list-style-type: none"> Aboriginal Heritage Act 1972 (WA) Guidelines, Interaction between Section 18 of the Aboriginal Heritage Act 1972 (WA) and Part IV of the Environmental Protection Act 1986 EPA Guidance Statement No. 41: Assessment of Aboriginal Heritage. | <p>The Proposal area expansions are located within areas subject to the following Federal Court Native Title Claims:</p> <ul style="list-style-type: none"> Niyaparli (WC99/4) Palyku (WC99/16). <p>Approximately 1573 heritage sites are located within the Chichester Project area (Cloudbreak and Christmas Creek), including 567 salvaged sites. These sites comprise artifact, man-made structure, mythological, repository, ceremonial, grinding patch, midden, skeletal material/burial, engraving, historical, scarred tree and quarry sites. Artifact scatters account for over 80% of the identified sites within the Chichester Project area.</p> | <ul style="list-style-type: none"> Physical disturbance of the land surface during clearing and removal of topsoil and overburden has the potential to disturb heritage sites and affect ethnographic values. Presence of construction and operational personnel has the potential to disturb heritage sites and affect ethnographic values. Alteration of surface water flows has the potential to result in erosion of Aboriginal heritage sites. | <p>A Cultural Heritage Management Plan (CHMP) will be implemented within the Proposal area which will provide for Aboriginal monitors to oversee construction of the expansion within the relevant native title claims (Appendix A).</p> <p>An Aboriginal sites register will be used providing the description, location and condition of heritage sites within Fortescue Project areas.</p> | <p>The Proponent has committed to undertake ethnographic and archaeological surveys and investigations in consultation with the Traditional Owners, native title claimant groups and DIA prior to any ground disturbance to identify any potential sites of Aboriginal significance. The Proposal will be carried out in accordance with EPA Guidance Statement No. 41 (EPA 2004b) through the implementation of the Cultural Heritage Management Plan and Native Title Claimant Group LAAs.</p> <p>The outcome is expected to be limited to impacts on Aboriginal heritage sites to the extent permitted under the AH Act Section 18 consent to disturb.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
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| Landform, Mine Closure Planning and Rehabilitation | <ul style="list-style-type: none"> To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values. To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge. | <ul style="list-style-type: none"> EPA Guidance Statement No. 6: Rehabilitation of Terrestrial Ecosystems (EPA 2006b) Draft Guidelines for Preparing Mine Closure Plans (DMP 2010) Environmental Notes on Mining – Waste Rock Dumps (DMP 2009a) Other key government and industry guidelines relevant to mine closure and rehabilitation include: <ul style="list-style-type: none"> Strategic Framework for Mine Closure (ANZMEC and MCA 2000) Enduring Value – the Australian Minerals Industry Framework for Sustainable Development (Minerals Council of Australia 2004) Best Practice Environmental Management in Mining Series (EPA 1995, Environment Australia 1998, 2002). | <p>Implementation of the Proposal will result in an expansion of the existing mining footprint allowing for additional mine pits, permanent above ground landforms, waste landforms, run of mine (ROM), tailings disposal (including below ground disposal), conveyor, roads, drainage, sewage treatment, dewatering and injection infrastructure and other associated mine infrastructure to enable iron ore production of up to 50 Mtpa of iron ore from the Cloudbreak mine for approximately 14 years. It includes increasing the capacity of the power station, accommodation camp, ore processing facility (including beneficiation) and sewage treatment facilities, although these will be expanded within the existing footprint approved under Statement 721.</p> <p>The Proposal includes the in-pit disposal of tailings from the beneficiation process, therefore will not require any additional footprint.</p> <p>The anticipated final land use will either be pastoral grazing or part of future conservation areas as identified by the Pastoral Exclusion Zone. If the area is to become a conservation area, it is assumed that the area will be managed by the DEC. A process to consult effectively with the final land manager, to understand the expectations of the DEC for the conservation estate post closure and its influences on closure activities have been included within the Conceptual Mine Closure Plan and will influence closure planning (Appendix I).</p> | <ul style="list-style-type: none"> Waste dumps, mine pits and tailings facilities may affect surface or groundwater quality if their chemical composition is different to the receiving environment. Altered landform and the effect on surface water flows and erosion potential. Erosion potential of the altered landform and associated potential water quality effects. Rehabilitation of disturbed areas. | <p>Closure management will assist in ensuring that disturbed areas are safe and suitably rehabilitated for the long term end land use as determined in consultation with relevant stakeholders and the community. Fortescue's environmental objectives in relation to rehabilitation and closure are to:</p> <ul style="list-style-type: none"> establish a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment leave site in a safe, stable, non-polluting and tidy condition with no remaining plant or infrastructure that is not required for post-operational use minimise downstream impacts on vegetation due to interruption of drainage identify any potential long-term soil, surface water or groundwater pollution associated with the operations and formulate an action plan to address this develop a stakeholder consultation group prior to closure, to facilitate discussion of closure planning continue to monitor environmental performance during decommissioning, rehabilitation and post-closure stages of the project and take appropriate action until the approved completion criteria have been met. <p>The closure objectives will be achieved through the implementation of the decommissioning and rehabilitation measures specified in a Closure Management Plan to be developed two years prior to mine closure. A Conceptual Mine Closure Plan (Appendix I) has been developed, identifying the key aspects of closure that will require further investigation and refinement through the life of the Proposal and the high risks associated with these aspects.</p> | <p>The Proposal is not likely to result in significant environmental impact following closure when management measures are considered. Ongoing investigations and monitoring undertaken during the life of mine will refine the management measures required to achieve the long term objectives of mine closure and in accordance with EPA's closure objective. This will include implementation of the existing Conceptual Mine Closure Plan to achieve documented objectives and monitoring to check implementation and measure outcomes.</p> <p>The key likely long-term outcomes for closure are:</p> <ol style="list-style-type: none"> Final landforms will have stabilised slopes of appropriate gradient and covered by vegetation re-established from respread topsoil and/or seed of local provenance. The groundwater table will recover to a level and quality to that of pre-mining. Altered surface water regimes will be stable and re-vegetated with stable self-sustaining ecosystems. All areas disturbed for mining and infrastructure are rehabilitated following decommissioning and meet specified final land use criteria. <p>The management measures to appropriately decommission, decontaminate and rehabilitate disturbed areas are in place to mitigate the potential risks to final mine closure. During life of mine operations, investigations and the adaptive management approach will ensure that risks to closure are detected early and are addressed so as to meet the EPA's closure objective.</p> <p>Fortescue is currently engaging with stakeholders, incorporating feedback into the ongoing closure planning process. Stakeholder input is integral throughout the life of mine to ensure their requirements are considered and support the closure planning process.</p> <p>The long term outcomes for closure are considered to be acceptable according to the EPA's closure objective.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
|---|---|---|--|--|---|--|
| Matters of National Environmental Significance | <p>The Environment <i>Protection and Biodiversity Conservation Act 1999</i> objectives for Matters of NES are to:</p> <ul style="list-style-type: none"> provide for the protection of the environment, especially matters of national environmental significance promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources control the international movement of wildlife, wildlife specimens and products made or derived from wildlife. | <ul style="list-style-type: none"> Matters of National Environmental Significance, Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999 (DEWHA2009) Environment Protection and Biodiversity Conservation Act 1999. (DEWHA 2010) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Japan-Australia (JAMBA), China-Australia (CAMBA) and Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements. | <p>Six Threatened fauna species and seven Migratory bird species listed under the EPBC Act may occur in the Proposal area. Several of these species have been recorded within or adjacent to the Proposal area during previous fauna surveys. These potential species include:</p> <ul style="list-style-type: none"> Night Parrot (<i>Pezoporus occidentalis</i>) Northern Quoll (<i>Dasyurus hallucatus</i>) Pilbara Olive Python (<i>Liasis olivaceus barroni</i>) Mulgara (<i>Dasyercus cristicauda</i>) Greater Bilby (<i>Macrotis lagotis</i>) Orange Leaf-nosed bat (<i>Rhinonictis aurantius</i>) Fork-tailed Swift (<i>Apus pacificus</i>) Rainbow Bee-eater (<i>Merops ornatus</i>) White-bellied Sea-eagle (<i>Haliaeetus leucogaster</i>) Eastern Great Egret (<i>Ardea modesta</i>) Wood Sandpiper (<i>Tringa glareola</i>) Common Greenshank (<i>Tringa nebularia</i>) Red-necked Stint (<i>Calidris ruficollis</i>) Cattle Egret (<i>Ardea ibis</i>). | <ul style="list-style-type: none"> Vegetation clearing for development within the mining areas and installation of water conveyance infrastructure will directly remove fauna habitat. Trenching for burial of some pipelines may result in the loss/injury of individual fauna. Physical presence of linear infrastructure such as roads and pipelines may disrupt fauna linkages. Redistribution of surface water flows around the mine and its infrastructure may alter fauna habitat. Dewatering and injection activities may affect groundwater-dependent vegetation and affect the value of significant fauna habitat. Vehicle movements during construction and operation may result in the loss of individual fauna, especially less-mobile species, from vehicle strikes. | <p>A maximum of 12 600 ha of potential habitat will be cleared by the Proposal</p> <p>All proposed vegetation clearing will be assessed through Fortescue's Ground Disturbance Permit process to manage the impacts of clearing. Impacts to significant fauna habitat such as Mulga Woodland and the Fortescue Marsh from groundwater mounding and drawdown will be managed under an Adaptive Management Framework.</p> <p>Management of potential impacts on fauna from this Proposal are also addressed in Biodiversity Plan in the Environmental Management Plan (Appendix A) and includes the following key management actions:</p> <ul style="list-style-type: none"> clearing will not be undertaken outside authorised areas as defined under the GDP process (as described above) significant fauna habitat will be spatially identified and where appropriate demarcated on site all lined surface water storage will have fauna egress points vehicles speeds will be restricted across the Proposal area off road driving or driving on restricted access routes will be prohibited other than for emergency situations clearing will not be undertaken outside authorised areas rehabilitation of disturbed areas within the pipeline corridors not required to remain open post-construction will be implemented appropriate site representatives will be trained in snake handling techniques and provided with equipment to safely handle snakes low noise equipment will be used where practicable and all activities will be carried out in accordance with statutory requirements and appropriate standards lighting will be directed onto construction or operational areas. <p>Annual Night Parrot Surveys will continue throughout the life of the mine</p> <p>Rehabilitation and mine closure is to re-establish a self-generating ecosystem comprising local native vegetation and fauna species which resembles the surrounding environment in line with set closure objectives.</p> <p>Fortescue will develop an approach to offsetting the areas of preferred habitat for Matters of NES that will be potentially affected by Fortescue projects.</p> | <p>After mitigation measures have been applied, the Proposal is expected to result in the following outcomes in relation to MNES:</p> <ol style="list-style-type: none"> Approximately 12 600 ha of potential MNES habitat will be disturbed by the Proposal (approximately 18 100 ha disturbance with approved project) with the majority of this occurring in Mulga woodland and Spinifex on low hills habitat. A maximum of 0.2% of the local extent of potential Night Parrot and Mulgara habitat (halophytic shrubland and hummock grassland along the edge of Fortescue Marsh) will be directly disturbed as a result of the Proposal. A maximum of 8 ha of suitable habitat for the Greater Bilby and 10 911 ha (39%) of the area that may contain patches of suitable habitat will be directly disturbed. Areas that are suitable for Bilby are broadly available at a regional level. Clearing will be avoided in the rocky escarpment habitat which is habitat for the Northern Quoll. It is unlikely that the Proposal will result in significant impacts to species listed as Endangered or Vulnerable under the EPBC Act. It is unlikely that the Proposal will result in significant impacts to Migratory bird species listed under the EPBC Act. Surveys will continue annually to determine the presence/absence of the Night Parrot in the vicinity of the Proposal. A Threatened Fauna Offset Plan will be developed to protect at least 3300 ha of habitat for threatened fauna species. <p>It is considered that with the management and mitigation measures in place, the Proposal will not significantly impact upon Matters of National Environmental Significance.</p> |

| Environmental Factor | Management Objectives | Relevant Standards and Guidance Documents | Existing Environment | Potential Impacts | Management Strategies / Proponent Commitments | Predicted Outcomes |
|-----------------------|---|--|---|--|--|--|
| Greenhouse Gas | <ul style="list-style-type: none"> To reduce emissions to a level which is as low as is practicable. | <ul style="list-style-type: none"> EPA Guidance Statement No. 12: Guidance Statement for Minimising Greenhouse Gas Emissions The Copenhagen Accord 2009. | <p>It is estimated that the Proposal will emit about 0.63 Mtpa of GHG emissions. This represents approximately 0.8% of the total GHG emissions in WA (based on 2007 estimates). The total greenhouse gas emissions for the Proposal are estimated to be approximately 631 000 tonnes CO₂-e/year representing approximately 18 kg CO₂-e per tonne of ore mined, based on the fuel consumption estimates provided and on an average mining rate of 35 Mtpa. This is an increase from the existing rate of 10 kg CO₂-e per tonne.</p> | <p>Greenhouse gas emissions are currently being released from the following activities at Cloudbreak:</p> <ul style="list-style-type: none"> combustion of diesel fuel for mining vehicles and remote power sources combustion of diesel fuel from Power Station combustion of explosive products decomposition of cleared vegetation and release of carbon from the soil. | <p>Greenhouse gas emissions from the Proposal will be reduced through implementation of a Greenhouse Gas Management Plan. Fortescue will develop and endorse energy intensity reduction targets. The Proponent will comply with its various obligations under the <i>National Greenhouse and Energy Reporting Act 2007</i> and the <i>Energy Efficiencies Opportunity Act 2006</i>.</p> | <p>Fortescue is committed to an ongoing program of review and reporting of greenhouse gas abatement measures. It is anticipated that periodic reviews through the life of the Proposal will identify opportunities to further reduce greenhouse gas emissions over time.</p> |
| Noise | <ul style="list-style-type: none"> To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards. | <ul style="list-style-type: none"> Environmental Protection (Noise) Regulations 1997 EPA Draft Guidance Statement No. 8 (EPA 2007a). | <p>The Project area is relatively remote from sensitive premises.</p> | <p>The mining areas are expected to be sufficiently remote to not impact on any nearby residences.</p> | <p>Use low-noise equipment where practicable.</p> <p>Monitor blast noise near sensitive receptors to determine allowable blasting mass.</p> <p>Monitor the effects of blast noise on birdlife and other fauna using the Fortescue Marsh.</p> | <p>Noise emissions from this Proposal are not expected to result in additional noise impacts to that of the approved project.</p> |
| Dust | <ul style="list-style-type: none"> To ensure that emissions do not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards. | <ul style="list-style-type: none"> Ambient Air Quality National Emission Protection Measure (NEPM) Draft State Environmental (Ambient Air) Policy 2009. | <p>The Project is in an arid area where background dust levels are relatively high.</p> <p>Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads and pastoral activities.</p> | <p>Mining, handling of ore and overburden, and exposed cleared areas have the potential to create a dust nuisance for workers and adjacent land users. Due to the remoteness of the sites, the potential for dust impacts on neighbours is expected to be low.</p> | <p>Update of the <i>Chichester Operations Dust Management Plan</i> will be prepared prior to the commencement of construction and operations and will include such measures as:</p> <ul style="list-style-type: none"> the incorporation of dust control measures into project design the use of water carts on high traffic areas progressive rehabilitation of disturbed areas optimisation of vehicle movements daily visual inspections to ensure dust control management measures are effective regular vegetation surveys to assess ongoing dust impacts ambient dust monitoring where appropriate. | <p>Dust emissions from this Proposal are not expected to result in additional impacts to that of the approved project.</p> |

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Short Titles and Acronyms

| Short Title/ Acronym | Full Title |
|-------------------------|--|
| % | Percentage |
| ² | Squared |
| AH Act | <i>Aboriginal Heritage Act 1972</i> |
| AMD | Acid Mine Drainage |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| ANZMEC | Australian and New Zealand Minerals and Energy Council |
| ARC | Australian Research Council |
| ARI | Average Recurrence Interval |
| ARMCANZ | Agricultural and Resource Management Council of Australia and New Zealand |
| ASS | Acid Sulphate Soils |
| BIF | Banded Iron Formation |
| BoM | Bureau of Meteorology |
| CALM | Department of Conservation and Land Management |
| CAMBA | China Australia Migratory Bird Agreement |
| CAR | Comprehensive Adequate Representation |
| CHMP | Cultural Heritage Management Plan |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| Cloudbreak | Cloudbreak Iron Ore Mine |
| cm | Centimetres |
| CMCP | Conceptual Mine Closure Plan |
| CO ₂ -e | Equivalent CO ₂ (CO ₂ e) is the concentration of CO ₂ that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas. |
| DEC | Department of Environment and Conservation |
| DEWHA | Department of Environment, Water, Heritage and the Arts |
| DIA | Department of Indigenous Affairs |
| DMP | Department of Mines and Petroleum |
| DO | Dissolved Oxygen |
| DoW | Department of Water |
| DRF | Declared Rare Flora |
| DSD | Department of State Development |
| EMP | Environmental Management Plan |
| EMS | Environmental Management System |
| Environment Minister | Federal Minister for Sustainability, Environment, Water, Population and Communities |
| EP Act | <i>Environmental Protection Act 1986</i> |
| EPA | Environmental Protection Authority |
| EPBC Act | <i>Environment Protection and Biodiversity Conservation Act 1999</i> |
| Fortescue | Fortescue Metals Group Ltd |

| Short Title/ Acronym | Full Title |
|-------------------------|---|
| GDP | Ground Disturbance Permit |
| GHG | Greenhouse Gas |
| ha | Hectare |
| In-pit TSFs | In-pit Tailings Storage Facilities |
| IUCN | International Union for Conservation of Nature |
| JAMBA | Japan Australia Migratory Bird Agreement |
| kg | Kilogram |
| kL/a | Kilolitres per year |
| kL/d | Kilolitres per Day |
| LAAs | Land Access Agreements |
| LANDSAT | Land Observing Satellite |
| LIDAR | Light Detection And Ranging – a highly accurate airborne topographic survey technique |
| m | Metre |
| mAHD | Metres Above Australian Height Datum |
| mbgl | Metres Below Ground Level |
| mg/L | Milligrams per Litre |
| mm | Millimetres |
| MMF | Marra Mamba Formation |
| MNES | Matters of National Environmental Significance |
| Mt | Million Tonnes |
| Mtpa | Million Tonnes Per Annum |
| MW | Megawatts |
| NEPM | National Emission Protection Measure |
| NES | National Environmental Significance |
| NHMRC | National Health and Medical Research Council |
| NMBSC | National Minimum Bore Specifications Committee |
| NRMMC | Natural Resource Management Ministerial Council |
| NWQMS | National Water Quality Management Strategy |
| OEPA | Office of Environmental Protection Authority |
| OPF | Ore Processing Facility |
| P | Priority |
| P1 | Priority 1 |
| P2 | Priority 2 |
| P3 | Priority 3 |
| P4 | Priority 4 |
| PAF | Potential Acid Forming |
| PCR | Proposed Conservation Reserve |
| PECs | Priority Ecological Communities |
| PER | Public Environmental Review |

| Short Title/ Acronym | Full Title |
|-------------------------|--|
| pers. comm. | Personal Communication |
| RHIO | Roy Hill Iron Ore |
| RIWI Act | <i>Rights in Water and Irrigation Act 1914</i> |
| RO | Reverse Osmosis |
| ROKAMBA | Republic of Korea Australia Migratory Bird Agreement |
| ROM | Run of Mine |
| RTIO | Rio Tinto Iron Ore |
| SEWPAC | Department of Sustainability, Environment, Water, Population and Communities |
| skyTEM | helicopter-borne electromagnetic and magnetic surveys |
| SPRAT | Species Profile and Threats Database |
| SRE | Short-Range Endemic |
| TDS | Total Dissolved Solids |
| TECs | Threatened Ecological Communities |
| The Proposal | Cloudbreak Expansion Proposal |
| TSS | Total Suspended Solids |
| TSSC | Threatened Species Scientific Committee |
| UWA | University of Western Australia |
| WAH | Western Australian Herbarium |
| WAM | Western Australian Museum |
| WC Act | <i>Wildlife Conservation Act 1950</i> |
| yr | Year |

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