Pilbara Iron Ore and Infrastructure Project

Cloud Break

Public Environmental Review
September 2005

FMG

ENVIRON

ENVIRON Australia Pty Ltd

PUBLIC ENVIRONMENTAL REVIEW

Cloud Break Iron Ore Project – No Beneficiation

for

Fortescue Metals Group Limited

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Ref: Job No. 30-0157E; Cloudbreak September 2005

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Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions emailed to the EPA Service Unit project officer would be most welcome.

Fortescue Metals Group Limited (FMG) proposes to develop the Cloud Break iron ore mine in the East Pilbara and link this mine to their proposed east – west rail spur and the proposed north-south railway and port facility for export from Port Hedland. This document covers the assessment of the Cloud Break mine sites only. (The north-south railway and port facility have been assessed separately as Stage A and the east – west rail has been assessed separately as Stage B of the Pilbara Iron Ore and Infrastructure Project). In accordance with the *Environmental Protection Act*, 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 12 September 2005 closing on 24 October 2005.

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

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. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the *Freedom of Information Act*, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group 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 more environmentally acceptable.

When making comments on specific elements of 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 and the reason why you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is: 24 October 2005

Submissions should ideally be emailed to:

douglas.betts@environment.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822
PERTH WA 6842

OR

Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: Doug Betts

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EXECUTIVE SUMMARY

E1. Introduction

Fortescue Metals Group Limited (FMG) holds a number of mining tenements that cover substantial iron ore resources in the Pilbara region of Western Australia (WA). FMG's proposed Pilbara Iron Ore and Infrastructure Project Stage A (port and rail infrastructure) and Stage B (iron ore mines and rail spur) have been formally assessed by the WA Environmental Protection Agency (EPA) as Public Environmental Reviews (PER).

The rail and port components of FMG's Pilbara Iron Ore and Infrastructure Project provide the infrastructure required to facilitate the development of other projects in the region. FMG's exploration programme has identified the Cloud Break deposit as an economically viable resource in close proximity to the Stages A and B infrastructure.

E2. The Project

The proposed Cloud Break Iron Ore Project (the Project is) located in the north of WA, in the Pilbara region, approximately 120 km northwest of Newman. The Project will consist of several open pits on the southern slopes of the Chichester Ranges. The pits will be progressively mined and backfilled to the extent of available material, prior to rehabilitation. The Project will mine high grade Marra Mamba material which can be direct shipped to market, and lower grade material which will require beneficiation. The Project will have a life of 12 years and produce between 10 and 30 million tonnes per annum (Mtpa) of iron ore product. It is proposed to utilise the Stage A port and railway from Port Hedland to the East Pilbara, and the Stage B rail spur and beneficiation plant, to process and export iron ore from Cloud Break.

While the Project is considered to be a separate project from FMG's Stage B development, the total proposed production from all of FMG's projects will not exceed 45 Mtpa (as originally proposed for the Stage A and B projects). Subject to all Project approvals being in place, construction of the mine is programmed for Quarter 3 in 2006 with mining commencing in Quarter 2 in 2007.

This document is submitted to the Western Australian EPA as a PER for assessment of the environmental impacts of the Project, and to propose management measures under the *Environmental Protection Act* 1986. The Project was also referred to the Federal Department of Environment and Heritage (DEH) due to the observed and likely presence of listed Threatened Fauna near the Project Area. FMG is currently awaiting advice on whether the DEH considers the Project to be a "controlled action" under the *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999)*.

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E3. Project Justification

World steel production has recently undergone a significant expansion, predominately driven by economic growth in China. The outcome is a global demand for iron ore that exceeds supply. As a result, the Pilbara region is the focus of several major iron ore mining developments. The development of the Project will provide a number of benefits to the Pilbara region, and the State of WA, including creation of employment opportunities, local and regional expenditure, and improved community support.

E4. Project Overview

FMG proposes to develop the Project which consists of a number of open pits that will be progressively developed and backfilled once they are mined out, to the extent of available material. High grade material will be mined in the first six years and crushed and screened before being transported to Port Hedland via FMG's proposed Stage A and B rail and port infrastructure. Low grade material will be mined over the life of the Project (12 years) and will stockpiled in the first six years. This lower grade material will be transported to the Stage B beneficiation plant for processing in years 7 to 12. The Key Characteristics of the Project are summarised in Table E1.

Table E1. Key Project Characteristics

Project Component	Characteristics
Construction period	6-12 months, commencing Q1 in 2006
Project life	12 years
Export tonnage	10 - 30 Mtpa
Cloud Break Iron Ore Mine	
Estimated resource	500-600 Mt
Ore type	Marra Mamba Iron Ore
Target grade	~60% Fe
Method of mining	Open pit with back filling as far as practicable
Total area of disturbance over LOM	5,500 ha
Total area of rehabilitation over LOM	5,500 ha
Average size of working open pit	475 ha
Average pit depth	Ranges from 0 m to 70 m based on current exploration results
Stripping ratio	Average 4:1 over LOM
Overburden produced	1,275 Mt over LOM (340 Mt in external areas; remainder placed in pit)
Processing requirements	Years 1-6: higher grade material, crushed and screened at Cloud Break Years 7-12: beneficiation of lower grade material at Christmas Creek beneficiation plant (plant included in Stage B Project and therefore not part of this assessment)
Dewatering requirements	Dewatering will produce excess water which will be temporarily stored in ponds located in an area earmarked for mining for the first six years. The water will then be transported to Christmas Creek for use in the beneficiation plant
Infrastructure	
Power	Provided and maintained by third party supplier
Water	Water will be required for dust suppression and general potable uses. This will be sourced from dewatering of the pits. A Reverse Osmosis (RO) plant may be required if dewatering water is not of sufficient quality for potable use. The saline waste water from the RO plant will be disposed of in the dewatering storage pond
Roads	Haul roads and service roads required to link mine to crushing plant and rail loadout
Sewage	Package treatment and/or septic systems
Workforce (approximate peak levels)	
Construction	400
Permanent	400
Accommodation	Construction personnel accommodated in on-site facilities. Operational personnel accommodated in on-site facilities and in Newman

Key:

Fe - iron
ha – hectare
LOM – Life of Mine
m – metre
Mtpa – million tonnes per annum
Mt – million tonnes

E5. Existing Environment

The Project is located within the arid Pilbara Bioregion as described in the Interim Biogeographic Regionalisation for Australia (IBRA). The proposed mining area is located on the lower flanks of the Chichester Ranges which is characterised by gently undulating topography with a maximum relief of 600 mRL. Downstream of the Project Area is the Fortescue Valley with a maximum relief of 450 mRL.

With sufficient rainfall the upper Fortescue River flows into the valley and forms the Fortescue Marshes which are separated from the lower portion of the Fortescue River by the Goodiadarrie Hills. The Fortescue Marshes is an extensive intermittent wetland occupying an area around 100 km long by, typically, 10 km wide. It is listed on the Australian Heritage Commission Register of the National Estate as an “Indicative Place”, and in the Directory of Important Wetlands in Australia, and recognised as supporting a rich diversity of migratory birds when in flood.

Numerous ephemeral creeks also flow into the Marshes from the southern and northern flanks of the Fortescue Valley, including Goman Creek which passes through the Project Area. Where the land gently slopes and drainage lines are less defined, areas may also be subject to sheet flow. Some vegetation communities, such as the groved/intergroved Mulga (*Acacia aneura* and variants) communities are considered partially reliant on these surface water sheet flows.

Throughout the region, groundwater levels are a subdued reflection of topography. Maximum groundwater levels were observed along the topographic highs associated with rocks of the Hamersley and Fortescue Groups, whilst groundwater levels were lowest in low-lying areas associated with creeks of the Fortescue River system and the Fortescue Marshes. The Marshes are recognised as predominantly a surface water feature and are not dependent on groundwater recharge. Groundwater both below and close to the Marshes is thought to be saline, whilst closer to the Chichester Ranges the water is fresh.

Vegetation at Cloud Break is a mosaic of low woodland with Mulga and hummock grasslands in valleys, low open tree steppe with Snappy Gum (*Eucalyptus leucophloia*) over *Triodia wiseana*, and Kanji (*Acacia pyrifolia*) over soft spinifex and *Triodia wiseana* hummock grasslands. None of the vegetation communities were considered Threatened Ecological Communities under the *EPBC Act 1999*, although a number of communities were considered locally significant as they supported Priority Flora species and Mulga communities near the northern extent of their main distribution. Four Priority Flora species were recorded within the Project Area and no Declared Rare Flora were observed. Four vegetation communities on the samphire flats were considered regionally significant as they are locally restricted and associated with the nationally recognised Fortescue Marshes.

Four species of fauna listed under the Commonwealth *EPBC Act 1999*, or the State *Wildlife Conservation Act 1950,* were recorded (or evidence of their presence was recorded) in the vicinity of the Project Area including the critically endangered Night Parrot *Pezoporus occidentalis* and the vulnerable Bilby *Macrotis lagotis*. The Project is not expected to have a direct impact on either of these species. Four other Priority Fauna species listed by the Department of Conservation and Land Management (CALM) were recorded within or near the Project Area and a number of other species may also be present, based on previous surveys undertaken in the region.

Stygofauna (groundwater-dwelling fauna) were identified from groundwater bores in the Project Area. To date, none of the stygofauna species recorded within drawdown areas were considered of significance to the Project.

The Project is set in the Shire of East Pilbara with the nearest town, Newman, approximately 120 km to the southeast of the Project Area. This is where FMG proposes to base most of its operational workforce.

The Project is located on two active pastoral leases. Portions of these pastoral leases around the Fortescue Marshes have been nominated for conservation purposes when the pastoral leases expire on 20 June 2015. However, these areas have not yet been formally proposed as a Conservation Reserve and will be required to be assessed under Part 4 of the *Land Administration Act 1997*.

Aboriginal heritage surveys of the proposed and current exploration programme and proposed mine areas commenced late in 2003 and are ongoing. All surveys will be completed prior to the construction of the Project. The results of the preliminary ethnographic survey, and subsequent consultation meetings with senior Aboriginal Traditional Owners, has revealed that there are several ethnographic sites of significance to the Aboriginal people which FMG has agreed to avoid and protect.

The stakeholder consultation process for the Project was initiated by FMG during the early development stages of the Project. The consultation strategy was prepared to facilitate effective communication with the regulators, local and wider community and other stakeholders, and to allow issues raised during the consultation process to be taken into consideration in the design and planning of this Project.

E6. Potential Impacts and Proposed Management Strategies

Whilst FMG's Project involves mining of a finite resource, and the use of fuel resources that will one day be depleted; the way in which the Project is constructed, operated and decommissioned can be undertaken in a manner which meets the Guiding Principles of the National Strategy for Ecologically Sustainable Development and the State Sustainability Strategy. In order to implement the principles of sustainability, FMG will develop a Sustainability Strategy which addresses contribution to global impacts such as Greenhouse Gas emissions and focuses on managing impacts across the triple bottom line of Social Capital, Economic Wealth and Environmental Assets.

FMG is in the process of developing and implementing an Environmental Management System (EMS) that will assist the Company to be proactive in managing environmental issues and promoting environmental excellence. The EMS will be developed to be consistent with the ISO 14001 standard and will be integrated with Quality, Health and Safety, and other business management systems. A Draft EMP for construction and operation of the Project has been developed and is presented as Appendix I of this document. Specific procedures for this EMP will be developed, prior to construction, for the management of site-specific environmental issues.

Key issues that were raised during the consultation programme are briefly discussed below and in Table E2.

Impacts on Surface Water

The proposed Cloud Break Mine is located on the southern flanks of the Chichester Ranges in an area which drains south towards the Fortescue Marshes south. Design, construction and operation of the open pits, stockpiles, access and haul roads, and other infrastructure, will account for natural surface hydrology conditions. These will include maintaining channel flows required downstream and redistribution of surface flows intercepted by these facilities. The pits and overburden placement areas will require drainage diversion structures. FMG and its consultants have designed the Project to minimise impacts on natural drainage flow patterns and downstream areas.

Impacts on Groundwater

Groundwater drawdown will occur in the vicinity of the pits to be dewatered, and will not extend below the Fortescue Marshes. There are a number of potentially groundwater dependent (phreatophytic) vegetation types within the Project Area. Outside the areas proposed to be disturbed by the mine, groundwater drawdown will generally not exceed the natural seasonal variation in groundwater levels. With the exception of the immediate vicinity of the pits, most vegetation is expected to be unaffected by dewatering operations unless groundwater drawdown is sudden, or vegetation is already subject to other stresses (e.g. drought). FMG has developed a Vegetation Monitoring and Management Programme as part of the Borefield and Dewatering Management Plan.

After Year 3, dewatering volumes are expected to exceed what the Project can use and will need to be disposed of. The results of a numerical modelling study suggest that although there is saline water close to the Cloud Break pits, the water abstracted during dewatering will remain fresh/brackish, increasing to 6,000mg/L Total Dissolved Solids (TDS). This water is suitable for use in the ore-beneficiation plant at Christmas Creek (described in the Stage B PER), and it is proposed to store the excess water in storage ponds in areas that will subsequently be mined. However, the options of aquifer re-injection and in-pit disposal will be investigated further.

On closure, pits will be backfilled to the extent of available material, at least to above the water table to ensure no long-term groundwater impacts occur as a result of mining.

Mulga Groves

The Mulga grove communities at the footslopes of the Chichester Ranges are considered near the northern limit of Mulga in WA. Within the Project Area, the total area of proposed disturbance of land systems containing Mulga accounts for approximately 2.3% of the Chichester footslopes unit, and 1.2% of the Fortescue Marshes unit. The Mulga is considered partially dependent on surface water sheet-flow and therefore, if not managed appropriately, has the potential to be adversely affected by changes to surface hydrology patterns as a result of the Project. Appropriate drainage structures will be designed to maintain sufficient surface water flows to support downstream Mulga communities.

The Mulga in the vicinity of the Project Area is on the Hillside and Mulga Downs pastoral stations and the vegetation in the area has been grazed by cattle for nearly 100 years. A vegetation condition assessment of the Project Area indicated that vegetation was generally in ‘degraded’ to ‘good’ condition. Other potential impacts to Mulga include fire and weed invasion. These impacts will be managed by FMG through its Environmental Management Plan (EMP).

FMG has developed a Rehabilitation and Revegetation Management Plan for the mining areas that will focus on re-establishment of native vegetation communities after mining, to resemble as closely as practicable the original Mulga communities.

Fortescue Marshes

FMG has committed to avoid direct or indirect impacts on the critical values of the Fortescue Marshes. As such, FMG has located the Project as far north of the Marshes as practicable considering resource location, environmental values, transport requirements, and engineering and heritage constraints. At its closest point, the proposed mine will be approximately 3 km from the peak flood boundary, recognised by the DEH, of the Fortescue Marshes. FMG conducted a Risk Assessment as part of this impact assessment to ensure all risks to the Marshes would be adequately managed.

Vegetation Clearing

FMG's iron ore resources are relatively shallow and as such, strip mining is considered the most suitable mining method. This method allows one or more strips (or parallel pits) to be mined, whilst progressively placing overburden as backfill in mined out sections of the pits. This reduces the extent of the open working pit, reduces the area of surface storage facilities required for overburden, and allows the pit to be progressively rehabilitated.

It is proposed to disturb, for the construction of mining areas and associated infrastructure, approximately 5,500 ha over the life of the Project. Land clearing will be kept to a minimum for safe working practices, and sensitive vegetation communities and significant flora species will be avoided if practicable. No Declared Rare Flora is known to occur within the Project Area.

FMG has developed a draft Rehabilitation and Revegetation Management Plan which outlines how FMG proposes to re-establish the vegetation communities as closely as practicable to those present prior to mining. This will include revegetation trials and ongoing research into revegetation methodology. The Plan will be frequently reviewed and updated to reflect trial results.

Threatened Fauna

The Project was referred to the Federal DEH under the *EPBC Act 1999* on the basis of evidence of the Night Parrot and Bilby, which are listed under the Act, occurring near (but not in) the Project.

FMG will minimise habitat disturbance and avoid, where practicable, known populations of Threatened Fauna species that may occur within the Project Area. Night Parrot and Bilby Management Plans are presented as Appendix L of this document. These documents have been prepared in consultation with CALM.

Stygofauna

FMG has developed a Subterranean Fauna Management Plan, which includes a bi-annual sampling plan to be implemented for the first two years prior to Project commissioning. Depending on the outcomes of further sampling work, it is proposed to continue stygofauna monitoring throughout the life of the Project.

E7. Conclusions

The proposed Project has been designed to minimise the environmental impacts associated with construction and operation of the Project. In particular FMG is aware of the significance of the Fortescue Marshes and has completed a risk-based assessment of potential impacts on the Marshes. The assessment has identified management measures that will be implemented by FMG to ensure that all identified environmental risks to the Marshes are low. The conservation significance of selected vegetation communities (such as Mulga communities occurring in groves) and Threatened Fauna species, has also been given priority, and the Project design incorporates management and mitigative measures to reduce impacts as far as practicable.

FMG has made a number of formal commitments with respect to this Project to demonstrate its commitment to constructing and operating in an environmentally responsible manner. The formal commitments will be implemented to the satisfaction of the Environmental Protection Authority.

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Table E2. Key Environmental Factors, Potential Impacts and Proposed Management for the Project

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
INTEGRATION					
Biodiversity	To avoid adverse impacts on biological diversity, comprising the different plants and animals and the ecosystem they form, at the levels of genetic, species and ecosystem diversity. To avoid, minimise, mitigate and offset direct and indirect impacts on the critical values of the Mulga woodlands (Chichester Ranges foot-slopes and the Fortescue Marshes).	The Project Area occurs in the Pilbara Bioregion. FMG's Project is located in the Chichester Range and on the Fortescue Plains The total size of the Chichester footslopes Mulga Woodland is 1,641 km^2 (based on Range-land Mapping). The Fortescue Marshes is downstream of the Project and listed as is a 'Nationally Important Wetland' and an 'Indicative Place' on the Register of the National Estate (natural heritage).	There are a number of significant flora and fauna species, and vegetation communities, that occur within the Project Area and which may be affected by land clearing or construction or operational impacts. Clearing of approximately 5,500 ha of native vegetation, most of which is currently used for pastoral purposes. However, cleared areas will be revegetated progressively throughout the life of mine to agreed completion criteria. Other potential impacts on biodiversity within and adjacent to the Project Area are: • disruption to surface hydrology; • introduction and/or spread of weed species; • increased risk of fire; • coating of vegetation in dust; and • groundwater drawdown. FMG's Cloud Break and Stage B projects will avoid impacting on the regionally significant vegetation communities associated with the Fortescue Marshes. Of the Mulga groves occurring on the footslopes of the Chichester Ranges, the	FMG will implement an Environmental Management Plan (EMP) which will have specific plans for the management of fauna, flora and vegetation, weeds, surface water, groundwater, hazardous materials, dust and fire. FMG has developed, and will implement, the Rehabilitation and Revegetation Management Plan to address the impact of clearing. The Subterranean Fauna Management Plan will be implemented prior to commissioning of the Project. Specific management plans have been developed for Threatened Fauna species recorded near the Project Area (Night Parrot and Bilby).	No unacceptable impacts on the biological diversity of the Project Area.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
			cumulative impacts of FMG's Project are expected to be 4.5% of the Chichester Ranges footslopes unit (based on Rangeland mapping).		
Sustainability	To ensure, as far as practicable, that the proposal meets or is consistent with the sustainability principles in the *National Strategy for Ecologically Sustainable Development (Common-wealth 1992)*. Assess the cumulative impacts of the Project and similar iron ore projects in the area.	The Project Area is currently used for pastoral activities and has been grazed for nearly 100 years. Resource projects are the main economic and employment generators in the Pilbara region.	Poor design and management of a development such as FMG's proposal could result in unacceptable economic, environmental and social impacts. Conversely, protection of the environment and social values needs to take into consideration economic constraints. Potential impacts are: • environmental – e.g. land clearing, interruption of surface water flow, ground-water drawdown, dust, noise; • social – e.g. employment opportunities, restricted access to certain areas, increased pressure on local services and housing; • economic – e.g. royalties, procurement.	FMG will have an Environmental Management System (EMS) for the management of specific environmental and social issues, which will be integrated with other business, quality and safety systems. FMG will: • facilitate community involvement in company planning processes and decision making; • use a predominantly non-FIFO operational workforce; • develop a housing plan; • develop a Vocational Training and Education Centre (VTEC); • maintain a focus on regional capacity building. On completion of mining, FMG intends to leave the Project Area in a state that resembles pre-mining conditions as closely as practicable.	The Project will be developed in a way which meets the needs of the present without compromising the ability of future generations to meet their own needs, and assists the development of the Pilbara region in a sustainable manner.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Future Conservation Estate	To avoid adversely affecting the future conservation value of areas of the pastoral stations proposed to be included in the Conservation Estate, or managed for conservation purposes.	Portions of Hillside and Mulga Downs pastoral stations near the Fortescue Marshes have been nominated for conservation purposes once the pastoral leases expire in 2015. The Fortescue Marshes are listed as a 'Nationally Important Wetland' and as an 'Indicative Place' on the 'Register of the National Estate. The Fortescue Marshes are approximately 3 km from the proposed mining areas.	The key issues relating to the protection of future conservation values of the area include potential impacts to the Fortescue Marshes catchment, impacts on migratory birds through noise, and impacts to Mulga groves. Also relevant are mine dewatering activities and surface water runoff to the Marshes. Some direct clearing of land systems containing Mulga will be required for the Project. Cumulative impacts on Mulga from clearing associated with FMG's projects are expected to cover 2.3% of the Fortescue Marshes surrounds unit. Noise and vibration impacts on fauna using the Marshes are expected to be minimal due to the distance of mining activity from the Marshes.	FMG has conducted a Risk Assessment of the potential impacts of the Project on the Fortescue Marshes and developed appropriate management measures to ensure residual risk is low. Indirect impacts on Mulga, through disruption of sheet flow, will be minimised by redistribution of surface water flows downstream of active mining areas. FMG will implement a blast management strategy to manage the potential noise and vibration impacts on the Marshes.	No unacceptable impacts on the Mulga woodlands or Fortescue Marshes within the areas proposed for future conservation.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
BIOPHYSICAL					
Terrestrial Flora – vegetation communities	Maintain the abundance, species diversity, geographic distribution, health and productivity of vegetation communities, by avoiding, or minimising, managing and mitigating direct and indirect impacts.	Vegetation types of conservation significance include those which contain Priority flora species, Mulga communities at the northern extent of their distribution, and the regionally significant samphire flats fringing the Fortescue Marshes.	Approximately 5,500 ha will require clearing over the life of the Project, which will be progressively rehabilitated and revegetated. Cumulative clearing impacts are expected to be 17,675 ha in conjunction with the Stage B Project, to be cleared over 20 years. Other potential impacts on vegetation within the Project Area are: • disruption to surface hydrology; • erosion; • introduction and/or spread of weed species; • increased risk of fire; • coating of dust on vegetation; • groundwater drawdown; and • unauthorised off-road driving.	FMG has designed the Project to avoid regionally significant vegetation communities. Vegetation clearing will be kept to the minimum necessary for safe construction and operations and clearing limits will be marked on all design drawings and pegged in the field. FMG has developed, and will implement, a Rehabilitation and Revegetation Management Plan. FMG will also implement prior to construction, an EMP which will have specific Plans for the management of surface water, groundwater, weeds, dust and fire. Monitoring of groundwater-dependent (phreatophytic) vegetation will be under- taken as part of the Borefield and Dewatering Management Plan.	Vegetation clearing and revegetation will be undertaken progressively throughout the life of the Project, with all disturbed areas revegetated on closure of the Project. The Project will not threaten the conservation status of significant vegetation communities. The final Project design will take into consideration the location of significant vegetation and where practicable, avoid these areas.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Terrestrial Flora – Declared Rare and Priority Flora; flora of Conservation Significance	Protect Declared Rare and Priority Flora (DRF), consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect other flora species of Conservation Significance.	No DRF species were recorded during the field survey of the Project Area and none would be expected to occur in the habitats present. The following Priority species were recorded: • *Eremophila spongiocarpa (ms)* (Priority 1); • *Rostellularia adscendens* var. *latifolia* (Priority 3); • *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3); and • *Eremophila youngii* subsp. *lepidola (ms)* (Priority 4).	Significant flora species could potentially occur within proposed areas of disturbance.	FMG will refine the Project design to avoid populations of significant flora where practicable. Clearing limits will be marked on all design drawings and pegged in the field prior to any clearing works commencing. FMG will investigate the use of significant flora species in revegetation practices.	The Project will not threaten the conservation status of significant flora present in the Project Area.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna.	A wide range of fauna was recorded from the vicinity of the Project Area including a number of significant species. The Fortescue Marshes, when in flood, are nationally recognised as an important habitat for migratory birds when in flood. The spinifex/chenopod ecotone near the Fortescue Marshes is considered potential habitat for Night Parrot (*Pezoporus occidentalis*) (Critically Endangered) and Bilby (*Macrotis lagotis*) (Vulnerable).	Terrestrial fauna may be affected directly by earth-works, noise and blasting vibration, or indirectly due to modification of habitat. Land clearing will disturb some fauna habitats. Fauna habitats may also be affected by changes to surface hydrology, groundwater drawdown, fire or dust.	The detailed design of the Project will consider the location of significant fauna habitats and will avoid these where practicable. Vegetation protection measures above will be implemented to mitigate impacts on fauna habitat. Off-road driving will be strictly prohibited unless authorised, and speed restrictions will apply on all Project roads to minimise the risk of fauna being hit by vehicles. Staff will be made aware that all native fauna are protected. Firearms, traps and domestic pets will be prohibited on-site. FMG will implement prior to construction, an EMP which will have specific plans for the management of surface water, groundwater, hazardous materials, dust and fire.	No unacceptable impacts on fauna populations. The Project will not threaten the conservation status of any significant fauna habitats.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Terrestrial Fauna - Specially Protected (Threatened) Fauna	Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*.	A number of significant fauna were recorded in or near the Project Area including the: • Night Parrot (*Pezoporus occidentalis*) (Critically Endangered); • Bilby (*Macrotis lagotis*) (Vulnerable); • Peregrine Falcon (*Falco peregrinus*) (Other Specially Protected Fauna); • Rainbow Bee-eater (*Merops ornatus*) (Migratory species); • Grey Falcon (*Falco hypoleucos*) (Priority 4); • Australian Bustard (*Ardeotis australis*) (Priority 4); • Star Finch (*Neochmia ruficauda subclarescens*) (Priority 4); • Western Pebble Mound Mouse (*Pseudomys chapmani*) (Priority 4); and • Mulgara (*Dasycercus cristicaudata*) (of Conservation Significance).	Terrestrial fauna may be affected directly by earthworks, noise and blasting vibration, or indirectly due to modification of habitat. Land clearing will disturb some fauna habitats. Fauna habitats may also be affected by changes to surface hydrology, ground- water drawdown, fire or dust.	Site-specific surveys prior to construction of the Project will be carried out to identify any significant fauna species which may be present, with modification of the Project to avoid these species and their habitat where practicable. Other measures for the protection of significant fauna may include: • creating ‘no-go’ zones in the samphire/ spinifex ecotone with driving curfews in sensitive areas at dusk and night-time; • minimising night driving in potential habitat for the Pilbara Olive Python; • preparing and implementing manage-ment plans for threatened species; and • surveying any sandy/ sandy-loam spinifex habitats to be developed and which may support Mulgara or Bilby.	The Project will not threaten the conservation status of significant fauna populations present in the Project Area.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Stygofauna	Maintain the abundance, diversity and geographical distribution of subterranean fauna.	Sampling of groundwater indicates that stygofauna occur within the Project Area. No stygofauna species of Conservation Significance have been recorded in sampling undertaken to date.	Abstraction of groundwater for pit dewatering may impact stygofauna habitat.	FMG will implement the Subterranean Fauna Management Plan developed in consultation with CALM. Sampling will continue to be undertaken biannually until December 2006, with possible long-term monitoring through-out the life of the Project.	The Project will not threaten the conservation status of stygofauna populations present in the Project Area.
Water courses and wetlands	Maintain the integrity, functions and environmental values of watercourses and sheet flow.	The proposed Project Area is located in the upper Fortescue River catchment which drains to the Fortescue Marshes. Numerous small ephemeral creeks pass through the Project Area. Parts of the Project Area are subject to surface water sheet-flow.	Potential main surface water impact may be the interruption of existing surface water flow patterns and a potential reduction of surface water run-off volume and water quality to the downstream environment. Vegetation communities which are dependent on sheet-flow runoff (e.g. grove/intergrove Mulga), may occur down-stream of mining areas. Other potential impacts include erosion and sedimentation. The maximum area of pits open at Cloud Break and Stage B is not expected to be greater than 0.04% of the total upper Fortescue River catchment.	Bunding will be constructed around the upstream end of the pits to divert surface water to existing adjacent or downstream flow paths. The final location of mine infrastructure will take surface water flows into consideration, and will be placed to minimise impacts. In sheet-flow areas, diverted flows will be discharged over riprap pads to lessen flow (thus reducing the risk of erosion) and disperse. Selected irrigation of sheet-flow dependent vegetation down-stream of working open pits, following significant runoff events. Progressive backfill and rehab-ilitation of mined-out pits will be undertaken according to the Rehabilitation and Revegetation Management Plan presented as a draft within this document.	Safe construction and operating conditions will be maintained. No adverse downstream surface water impacts, particularly in sheet-flow zones.

				Surface water collected from within the pits will be treated via sedimentation ponds, prior to external discharge or reuse within the mining operations.	
Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Water supply	Maintain (sufficient) quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	Surface water supplies are ephemeral so the Project will rely on groundwater for water supply. The majority of water for the Project is expected to be supplied by pit dewatering (unless too saline). The nearby Fortescue Marshes are considered predominantly a surface water feature and not reliant on groundwater discharge.	Potential impacts of ground-water abstraction may be: • effects on phreatophytic vegetation within the groundwater drawdown zone; • impacts on water quantity and quality in nearby station bores; • upconing of underlying saline water; • impacts on stygofauna habitat. Impacts on the Fortescue Marshes from borefield operation and pit dewatering are considered unlikely. The potential groundwater drawdown zones from the Project will not overlap with the Stage B Project and will not extend as far as the Fortescue Marshes. The cumulative impacts of groundwater abstraction from FMG's projects in the upper Fortescue River catchment (e.g. effects on phreatophytic vegetation and station bores) are not expected to be significant.	FMG has developed a Borefield and Dewatering Management Plan which will be implemented with development of the bore-field. It will include monitoring groundwater trends and calibrating the groundwater model. Condition monitoring of phreatophytic vegetation will be undertaken in areas where groundwater levels have declined as a result of ground-water abstraction. If station bores are affected by abstraction for the Project, these will be deepened, or an alternative water supply provided from Project bores.	No unacceptable ecological impacts from operation of the Project's borefield. No unacceptable impact on station bores from operation of the Project's borefield.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Rehabilitation	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and meets other environmental objectives including biodiversity.	The proposed mining area is located on the flanks of the Chichester Ranges. The existing land use is pastoral.	Approximately 5,500 ha of land will be progressively disturbed and rehabilitated over the life of the Project. Cloud Break and Stage B Projects will cumulatively disturb approximately 17,675 ha which will be progressively rehabilitated throughout the life of the Projects.	FMG has developed a Rehabilitation and Revegetation Management Plan which will be implemented throughout the life of the Project. Progressive rehabilitation activities will include, but not be limited to: • backfilling mined-out pits; • ripping of compacted areas; • re-establishment of a stable landform that resembles the pre-mining landscape as closely as practicable; • reinstatement of surface drainage patterns; • replacement of topsoil (direct return where practicable) or alternative growth media; • spreading of vegetation debris; • additional seeding and planting if required; and • on-going monitoring.	Re-establishment of safe and stable revegetated landforms that resemble the pre-mining landscape as closely as practicable.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Decommissioning	To ensure, as far as practicable, that decommissioning achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.	The predominant existing land use is pastoral.	Decommissioning will need to ensure that the Project Area is left safe and stable, and functional for the nominated land use to ensure no long-term hydrological, hydrogeological or ecological impacts.	Project closure will include the safe dismantling and removal of infrastructure, the appropriate disposal of waste materials, backfilling and/or contouring and site rehabilitation to return the environment to a safe stable landform. FMG has developed a Conceptual Closure Plan that will be revised at least every two years. Detailed closure procedures will be established in accordance with the applicable legislation and standards at the time of closure, and will be documented in the revised Final Closure Plan. Completion criteria will be developed in consultation with the relevant stakeholders and documented within the Closure Plan prior to final decommissioning.	No long-term adverse environmental or social impacts following closure.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
POLLUTION MANAGEMENT					
Air – Greenhouse Gases	Minimise Greenhouse Gas emissions for Project and reduce emissions per unit product to as low as reasonably practicable, and mitigate Greenhouse Gas emissions in accordance with the *Framework Convention on Climate Change 1992*, and with established Common-wealth and State policies.	The Project Area is currently used for pastoral activities and is largely vegetated by woodlands, shrublands and grasslands.	An estimated 9.04 kg CO_2e will be emitted per tonne of ore produced for the Project. However, as vegetation and soil breaks down over a long time, there is estimated to be an average of additional 43,310 tonnes CO_2e per year will continue to be released for a 25-year period after mining has ceased. This will be offset largely by progressive revegetation of the disturbed areas. If transport of ore to the port is taken into consideration (i.e. Cloud Break + Stage A Projects) approximately 13.3 kg CO_2e per tonne of ore will be released, which is comparable with other iron ore projects in the region. Approximately 15.1 kg CO_2e per tonne of ore is estimated for the Stage B + Stage A Projects. This does not consider revegetation offsets.	During construction and operation of the Project, FMG has committed to minimising clearance of land area and total amount of biomass. Clearing will occur over the life of the Project and cleared areas will be progressively rehabilitated as mining progresses. In designing the Project, FMG has, where practicable, selected the most energy efficient technology available. Once operational, FMG will monitor Greenhouse Gas emissions and continue to improve energy efficiency and reduce Greenhouse Gas emissions. Renewable energy sources will be used where appropriate (e.g. solar panels for power in remote areas).	Minimisation of Greenhouse Gas emissions and offsets where practicable.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Air – particulate dust emissions during construction	Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems.	The Project is in an arid area where background dust levels are relatively high. Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads and pastoral activities.	Dust from earthworks during construction may 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. Unsealed areas within the Project Area may generate dust, smothering vegetation.	A Dust Management Plan will be prepared prior to the commencement of construction and operations, and will include such measures as: • the use of water carts on high traffic areas; • progressive rehabilitation of disturbed areas; • minimisation of vegetation clearing; • optimisation of vehicle movements; • daily visual inspections of construction areas; and • regular vegetation inspections to assess ongoing dust impacts.	No unacceptable dust impacts during construction.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Air – particulate dust emissions during operations	Ensure that particulate/dust emissions from FMG's activities meet appropriate criteria, and do not cause environmental or human health problems.	The Project is in an arid area where background dust levels are relatively high. Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads and pastoral activities.	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.	A Dust Management Plan will be prepared prior to the commencement of construction and operations and will include such measures as: • 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; and • ambient dust monitoring where appropriate.	No unacceptable dust impacts during operation.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water Quality - surface water	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance, are protected, consistent with the *Australian and New Zealand Water Quality Guidelines (ANZECC/ARMCANZ, 2000).*	Creeks within the Project Area are ephemeral, only flowing after significant rainfall events and often have high sediment loads.	Surface water runoff, or discharge of waste water from the Project Area, could contaminate or increase sediments flowing into nearby water bodies.	Surface water collected from around the Project Area (including pits) will be treated via a sedimentation pond, prior to external discharge or use within the Project. Surface waters from hard-stand areas will be treated via an oil/water separator and sedimentation pond prior to discharge or use within the Project. Areas prone to erosion during construction and operation will be stabilised. Surface water monitoring will be conducted as detailed in the EMP.	No adverse impacts on surface water quality downstream of the Project.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water Quality - groundwater	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the *Australian and New Zealand Water Quality Guidelines (ANZECC/ARMCANZ, 2000).*	Groundwater within the Project Area ranges from fresh to saline. A number of station bores supply water for stock.	There is potential for spills or contaminated runoff from the Project Area to seep into the underlying groundwater. Where fresh water occurs over saline water in an aquifer, continued pumping of the overlying fresh water can result in a rise in the interface between fresh and saline water ('upconing'). This could affect water quality in nearby station bores, or require disposal of saline water from pit dewatering. Saline dewatering may require discharge if it is not suitable for use by the Cloud Break or Stage B Projects.	FMG will have specific spill prevention and clean up procedures to reduce the risk of harm to the environment from spills. All hydrocarbons and chemicals will be stored in bunded facilities constructed to AS 1940. Groundwater will be managed according to the Borefield and Dewatering Management Plan. Should saline dewatering require discharge this will be disposed of in a manner which will not result in contamination of fresher groundwater resources, surface water bodies, soils or impact on vegetation. Current proposed management measures have been developed for the worst-case scenario (i.e. storage ponds) although aquifer re-injection and in-pit disposal will be further investigated. FMG will monitor water quality in Project bores and nearby station bores. FMG will provide alternative water supplies if impacts on water quality in station bores are unavoidable.	No unacceptable impacts on groundwater quality.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Waste Management - overburden - general waste	To ensure that disposal/ management of wastes do not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The Project Area is predominantly used for pastoral activities.	Incorrect disposal of wastes can lead to contamination of soils, surface and ground water and/or air, and increase health risks.	Overburden will be placed in off-path storage areas for the first two years of operations. These will be contoured and rehabilitated according to the Rehab- ilitation and Revegetation Management Plan. Once sufficient mined-out pit areas become available, overburden will be used to backfill the pits, which will be contoured to resemble the pre-mining landform where practicable, and revegetated according to the Rehabilitation and Revegetation Management Plan. General waste management will be along the principles of: • avoid; • re-use; • recycle; • energy recovery; and • treatment and/or disposal.	Appropriate management of waste generated by the Project with no risk to human health or adverse impacts on the environment.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Contamination - Acid Mine Drainage (AMD)	Minimise the risk to the environment resulting from potentially acid forming materials.	Geochemical tests undertaken to date indicate that, with the exception of the Roy Hill Shales, the regoliths and waste-bedrocks are not acid forming.	The potentially acid-forming Roy Hill Shales will not be mined. The cone of groundwater draw-down from pit dewatering may extend into the Roy Hill Shales. However, the primary pore spaces within the black shales are expected to remain near saturated and therefore protect the pyrite against oxidation.	An Acid Mine Drainage Management Plan will be developed should acid-generating materials potentially be encountered. This plan will outline measures to minimise the risk of oxidation and subsequent transport of low pH drainage. FMG will monitor bores within the cone of depression to determine if dewatering activities are impacting on the black shales and if so, will undertake additional modelling (such as oxygen diffusion modelling) to determine the extent of impact and how best to manage this.	No adverse impacts on the environment as a result of AMD.
Noise	Ensure noise impacts emanating from construction and operation activities comply with statutory requirements and acceptable (and appropriate) standards.	The Project Area is relatively remote from residential settlements.	The mining areas are expected to be sufficiently remote to not impact on any nearby residences. Blasting impacts may initially have a minor impact on birds and other fauna using the Fortescue Marshes. Cumulative impacts of noise from FMG's Cloud Break and Stage B Projects are not expected to be significant.	Use low-noise equipment where practicable. Monitor blast noise near sensitive receptors to determine allowable blasting mass. Monitor the effects of blast noise on birdlife and other fauna using the Fortescue Marshes. Avoid blasting under worst-case meteorological conditions and design the mine to reduce potential noise impacts.	No unacceptable noise impacts on residences or birds on the Fortescue Marshes.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
SOCIAL SURROUNDS					
Heritage – Aboriginal culture and heritage	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*. Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations within the area.	The Chichester Range, the Fortescue Plain and the Hamersley Plateau are known to contain a rich diversity of Aboriginal sites. The Project Area impacts upon a number of native title claims: • Nyiyaparli (WC99/4), • Palyku (WC99/16); and • Martu Idja Banyjima (WC98/62).	Sites of Aboriginal Heritage significance could potentially occur within the Project Area. FMG has been able to avoid significant Aboriginal sites to date, although it is acknowledged it may not be possible to avoid all sites.	FMG will complete heritage surveys prior to commencement of construction and will ensure that Aboriginal sites are located, recorded and, where possible, protected. FMG will implement a Cultural Heritage Management Plan which will provide for Aboriginal monitors to oversee the construction of the Project within the relevant Native Title claims to ensure that no known Aboriginal sites are inadvertently impacted upon. They will also ensure that changes to the physical environment do not affect Aboriginal heritage and culture.	No unacceptable impacts on the Aboriginal cultural values of the Project Area.
Heritage – European heritage	Comply with statutory requirements in relation to areas of cultural or historical significance.	No sites of European Heritage significance are known to occur in or near the Project Area.	It is not expected that any sites of European Heritage significance will be affected by the Project.	No specific management measures required.	No impact on sites of European Heritage value.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Economic and Social Impacts	To ensure a net benefit to the local community potentially affected by the Project.	FMG's Project is located within the Ashburton Shire near the border of the Shire of East Pilbara. The Shire of Ashburton has a population of 6,888 and the East Pilbara Shire has a population of 6,786. The nearest town to the Project is Newman approximately 120 km to the south-east.	The Project activities that have the potential to give rise to socio-economic impacts at the planning and pre-construction stage include project approvals and negotiations, public communications about the Project procurement and changes to land tenure. Project activities that have the potential to give rise to impacts at the construction and operational stage include: • payment of royalties and taxes; • procurement; • mobilisation of the workforce; • construction of temporary work camps; • accommodation in residential areas; • earthworks and blasting activities; • general construction activities; • power use and water use; and • creation of an area around activities that excludes the public.	FMG will: • facilitate community involvement in company planning processes and decision making; • use a predominantly non-FIFO operational work-force; • develop a housing plan to ensure quality and equitable housing for employees whilst minimising negative impacts on existing communities; • develop a Vocational Training and Education Centre (VTEC); • maintain a focus on regional capacity building.	No unacceptable socio-economic impacts on the local and wider community. Support of local businesses and training and employment opportunities throughout the life of the Project.

ENVIRONMENTAL IMPACT ASSESSMENT

Cloud Break Iron Ore Project – No Beneficiation

for

Fortescue Metals Group Limited

1. INTRODUCTION

1.1 BACKGROUND

Fortescue Metals Group Limited (FMG) holds a number of tenements that cover substantial iron ore resources in the Pilbara region of WA. FMG's proposed Pilbara Iron Ore and Infrastructure Project Stage A (port and rail infrastructure) and Stage B (iron ore mines and rail spur) have been formally assessed by the WA Environmental Protection Agency (EPA) as Public Environmental Reviews. The EPA has recently released its Report and Recommendation for Stage A (EPA Assessment No. 1505) and FMG is awaiting a final decision from the Minister for the Environment.

The rail and port components of FMG's Pilbara Iron Ore and Infrastructure Project provide the infrastructure required to facilitate the development of other projects in the region. FMG's exploration programme has identified the Cloud Break deposit as an economically viable resource in close proximity to the Stages A and B infrastructure.

1.2 PROJECT OVERVIEW

The proposed Cloud Break Iron Ore Project (the Project) is located in the north of WA in the Pilbara region approximately 120 km northwest of Newman (see Figure 1) on exploration leases E 45/2498, E 45/2499, E 45/2652 and E 46/590 (Figure 2). The Project will consist of several open pits on the southern slopes of the Chichester Ranges which will be progressively mined and backfilled prior to rehabilitation. The Project will mine high grade Marra Mamba material which can be direct shipped to market, and lower grade material which will require beneficiation. The Project will have a life of 12 years and produce between 10 and 30 million tonnes per annum (Mtpa) of iron ore product.

It is proposed to utilise the Stage A and B port, railways, and beneficiation plant to process and export iron ore from Cloud Break. The Stage A railway will be constructed from the East Pilbara to Port Hedland and the Stage B railway will link FMG's mining areas on the slopes of the Chichester Ranges to the Stage A railway. Iron ore will be exported through FMG's proposed Stage A port facility at Port Hedland.

While the Project is considered to be a separate project from FMG's Stage B development, the total proposed production from all of FMG's projects will not exceed 45 Mtpa. FMG was not able to gain access to the Cloud Break tenements in time to allow sufficient exploratory work to be undertaken to estimate resources at Cloud Break for inclusion in the Stage B Public Environmental Review (PER).

1.3 PURPOSE OF THIS DOCUMENT

This document is submitted to the Western Australian EPA as a PER to assess the environmental impacts of the Project and propose management measures under the *Environmental Protection Act 1986*. Preparation of this document has been undertaken in accordance with the scope outlined in the Environmental Referral and Scoping Document for the Project (Appendix A) as agreed with the EPA.

1.4 THE PROPONENT

The Proponent and owner of the proposed Cloud Break Iron Ore mine is Fortescue Metals Group Limited. The address is:

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50 Kings Park Road,
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The relevant contacts are:

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All correspondence should be addressed to Mr Graeme Rowley.

1.5 COMMUNITY CONSULTATION PROCESS

The stakeholder consultation process for the Project was initiated by FMG during the early development stages of the Project. The consultation strategy was prepared to facilitate effective communication with the regulators, local and wider community and other stakeholders, and to allow issues raised during the consultation process to be taken into consideration in the design and planning of this Project. Detail on the community consultation process, consultation undertaken to date, and how FMG has addressed issues raised by the community, is presented is Section 7 (see Table 26 which refers to specific Sections 5 and 6).

1.6 PROJECT TIMING

Subject to all Project approvals being in place, construction of the mine is programmed for Quarter 1 in 2006 with mining commencing in Quarter 2 in 2007.

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2. PROJECT JUSTIFICATION

2.1 PROJECT BACKGROUND

World steel production has recently undergone a significant expansion predominately driven by economic growth in China. The outcome is a global demand for iron ore that exceeds supply, a situation which is forecast to continue in the near future. As a result, the Pilbara region is the focus of a new wave of major iron ore mining developments (mining of iron ore commenced in WA in the early 1960s). Hamersley Iron (HI) opened its Yandicoogina mine in 1999, which included an extension of its rail line from Marandoo and provided a link to the HI main line network to Dampier. BHP Billiton's (BHPBIO) adjacent Yandicoogina operation has been subject to capacity upgrades since its start up in 1992, and is serviced by the rail spur linkage to BHPBIO's main line network to Port Hedland. New projects now on line in this area include Rio Tinto's West Angelas and BHPBIO's Mining Area C (MAC).

Based on the current exploration work the inferred resource estimate at Cloud Break is 390 Mt. The distribution of mineralised drill hole intersections indicate that the Cloud Break deposit is potentially a higher grade material with fewer contaminants than some of FMG's other deposits.

2.2 STATE AND NATIONAL BENEFITS

The development of the Project will provide a number of benefits including:

- creation of significant direct and indirect employment opportunities through materials purchase, construction, operation and support services;
- expenditure for the Cloud Break Mine and associated infrastructure; and
- improved regional community support through local employment opportunities, including specific targets for indigenous employment and basing the majority of the workforce in the regional centre of Newman.

2.3 NO DEVELOPMENT OPTION

The 'no project' option would result in the loss of opportunities to add to Australia's raw material trade; the loss of potential for future developments in downstream processing of raw materials; and the loss of economic, social and employment opportunities particularly within local regional communities. The World's increasing demand for iron ore would then be met through the development of overseas projects with the loss of associated benefits to the Pilbara, WA and Australia.

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3. ENVIRONMENTAL APPROVALS PROCESS

3.1 RELEVANT LEGISLATION AND POLICIES

3.1.1 State Government Legislation

State legislation relevant to the Project includes the following:

- *Aboriginal Heritage Act 1972*
- *Agriculture and Related Resources Protection Act 1976*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Contaminated Sites Act 2003*
- *Environmental Protection Act 1986* and regulations
- *Dangerous Goods Safety Act 2004*
- *Land Administration Act 1997*
- *Local Government Act 1995*
- *Mining Act 1978*
- *Mines Safety and Inspection Act 1994*
- *Rights in Water and Irrigation Act 1914*
- *Soil and Land Conservation Act 1945*
- *Wildlife Conservation Act 1950*

The *Environmental Protection Act 1986* is the principal statute relevant to environmental protection in WA. The Act makes provision for the establishment of the Environmental Protection Authority (EPA), for the prevention, control and abatement of pollution and for the conservation, preservation, protection, enhancement and management of the environment. This Act provides for the control and licensing of potentially polluting activities and is the Act under which the State environmental approvals process operates.

It has been determined by the EPA that the Project requires formal assessment at the Public Environmental Review (PER) level. The process for submission and assessment of a PER is as follows:

1. the Proponent refers the proposal to the EPA to set level of assessment;
2. the EPA determines level of assessment (in this case a PER) and advertises this decision and length of the public review period, subject to appeal;
3. Proponent and EPA negotiate an agreed Scope of Works for the PER;
4. a draft PER is prepared by the Proponent and submitted to the EPA Service Unit for comment;

5. final draft of the PER is submitted to the EPA for authorisation to release as a public document;
6. the PER (*this document*) is released for public review for a period nominated by the EPA;
7. any submissions received by the EPA at the end of the review period are provided to the Proponent, for the Proponent to summarise and respond;
8. the EPA undertakes an assessment of the proposal and publishes its Report and Recommendations;
9. a two-week statutory appeal period commences;
10. The Minister determines any appeals on the EPA's Report and Recommendations, and consults with the key Decision Making Authorities to seek agreement on whether or not, and in what manner the proposal may be implemented; and
11. The Minister issues a Statement, provided approval for the Project is given.

Once approval for a project is obtained under Part IV of the *Environmental Protection Act 1986*, licensing of construction and operations is required under Part V of the Act. This requires Works Approval Applications prior to construction and Applications for Licences to Operate to be submitted to the Department of Environment (DoE). Approvals from the Department of Industry and Resources (DoIR) through submission of a Notice of Intent (NOI) are also required under the *Mining Act 1978*.

3.1.2 Commonwealth Government Legislation

Commonwealth legislation likely to be relevant to the Project includes the following:

- *Environment Protection and Biodiversity Conservation Act 1999*; and
- *National Native Title Act 1993.*

Under the *Environment Protection and Biodiversity Conservation Act 1999*, (*EPBC Act*) an action requires approval from the Federal Environment Minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance such as:

- World Heritage properties;
- Ramsar wetlands of international importance;
- listed threatened species and communities;
- migratory species protected under international agreements;
- nuclear actions; and
- the Commonwealth marine environment.

Migratory species, such as wading birds, protected under international agreements are also covered under the *EPBC Act 1999*. The Project was referred to the Federal Department of Environment and Heritage (DEH) due to the observed and likely presence of listed Threatened Fauna near the Project Area. FMG is currently awaiting advice on whether the DEH considers the Project to be a “controlled action” under the *EPBC Act*. FMG’s Stage A and B Projects were referred under the *EPBC Act* due to the possible presence of listed Threatened Fauna. The DEH determined these Projects were not controlled actions.

3.2 GUIDELINES AND STANDARDS

A number of State and National guidelines and standards are applicable to this Project. These guidelines and standards will be observed during the scoping and implementation of studies as well as Project design and management. With regards to assessment of environmental impacts, the following EPA Guidance Statements are of relevance:

- No. 12 - Minimising Greenhouse Gases, October 2002;
- No. 18 - Prevention of Air Quality Impacts from Land Development Sites, March 2000;
- No. 34 - Linkage Between EPA Assessment and Management Strategies, Policies, Scientific Criteria, Guidelines, Standards and Measures Adopted by National Councils, April 2004;
- No. 41 - Assessment of Aboriginal Heritage, April 2004;
- No. 48 - Draft Guidance on Groundwater Environmental Management Areas;
- No. 51 - Terrestrial Flora and Vegetation surveys for Environmental Impact Assessment in Western Australia, June 2004;
- No. 54 - Consideration of Subterranean Fauna in Groundwater and Caves During Environmental Impact Assessment in Western Australia, December 2003;
- No. 55 - Implementing Best Practice in Proposals Submitted to the Environment Impact Assessment Process, December 2003; and
- No. 56 - Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, June 2004.

In addition, the EPA has released the following Position Statements of relevance to the Project:

- No. 2 - Environmental Protection of Native Vegetation in Western Australia, December 2000;
- No. 3 - Terrestrial Biological Surveys as an Element of Biodiversity Protection, March 2002;
- No. 4 - Environmental Protection of Wetlands, November 2004;

- No. 5 - Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia, November 2004;
- No. 6 - Towards Sustainability, August 2004;
- No. 7 - Principles of Environmental Protection, August 2004;
- No. 8 - Environmental Protection in Natural Resource Management, June 2004; and
- No. 9 - Environmental Offsets (Preliminary), July 2004.

The DoIR has several guidelines relevant to mining projects such as:

- Australian and New Zealand Environment and Conservation Council and Minerals Council of Australia (ANZECC/MCA) (2000), Strategic Framework for Mine Closure;
- Guidelines for Mining in Arid Environments, June 1996;
- Guidelines for the Protection of Surface and Groundwater Resources During Exploration Drilling, November 2002;
- Guideline to Help You Get Environmental Approval for Mining Projects in Western Australia, March 1998;
- Mining Below the Water Table in the Pilbara, August 1999;
- Environmental Notes on Waste Rock Dumps, January 2001; and
- Environmental Notes on Firebreaks, March 2001.

For the assessment of water quality, air quality and noise emissions, the following guidelines will be used:

- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ ARMCANZ) (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000;
- Batley, G.E., Humphrey, C.L., Apte, S.C. and Stauber, J.L. (2003). A Guide to the Application of the ANZECC/ARMCANZ Water Quality Guidelines in the Minerals Industry. Aust. Centre for Mining Environmental Research: Brisbane.
- National Environment Protection Council (NEPC) (1998). National Environment Protection Measure for Ambient Air Quality. NEPC, June 1998.
- *Environmental Protection (Noise) Regulations* 1997; and
- Western Australian Planning Commission, Draft Statement of Planning Policy: Road and Rail Transport Noise, May 2005.

The following international and Australian Standards (AS) are also relevant:

- Australian Standard AS 1940-2004 - Storage and Handling of Flammable and Combustible Liquids;

Australian Standard AS 2436-1981 - Guide to Noise Control on Construction, Maintenance and Demolition Sites; and

- AS/NZS ISO 14001:2004 - Environmental Management Systems - Requirements with Guidance for Use.

3.3 LAND USE ZONING

The Project Area is located on Mulga Downs and Hillside pastoral leases which are currently active pastoral stations (Figure 3).

All pastoral leases in WA issued under the now repealed *Land Act 1933* expire on 30 June 2015. Portions of numerous pastoral leases in the Pilbara have been nominated by the Department of Conservation and Land Management (CALM) to be released to the Conservation Estate or to be set aside for conservation management within the pastoral leases under conservation agreements, when the pastoral leases are renewed. Portions of both Mulga Downs and Hillside stations have been proposed for conservation management. It should be noted that these areas have not yet been formally proposed as a Conservation Reserve and will be required to be assessed under Part 4 of the *Land Administration Act 1997*. FMG is cognisant of the potential impacts of the Project on the proposed future conservation areas, and has investigated these in detail in Section 6.14.2.4.

3.3.1 Pastoral Activities

The pastoral industry in the Pilbara is increasingly geared to overseas export of live cattle, mainly through Port Hedland, with fewer animals being sent to the Midland (Perth) market. The cattle industry contributes about $22 million per annum to the Pilbara economy (for 1999/2000),but sheep numbers in the Pilbara are steadily declining: the annual value of wool and meat production in 2000 was estimated to be around $4.1 million per annum (Pilbara Development Commission, www.pdc.wa.gov.au).

Pastoral leases in the area are generally considered to be of poor grazing quality, with large areas required for grazing. Some areas were never alienated for pastoral operations or were abandoned in the 1940s due to poor quality grazing (Dames and Moore, 2000).

The Project is on leases that occur on the Mulga Downs and Hillside pastoral stations. Hillside Station is privately leased, and Mulga Downs is held by Hancock Prospecting. It is common in the East Pilbara for mining companies to hold pastoral leases to ensure security of access to land adjacent to mines and infrastructure.

3.3.2 Mining

The Pilbara produces approximately 95% of Australia's iron ore exports, estimated at 157 Mtpa and with a value of over $5.1 billion per year (Pilbara Development Commission, www.pdc.wa.gov.au). Development of the iron ore rich deposits was accelerated in the 1960s after the Commonwealth lifted the 1938 export embargo on iron ore.

Development of the iron ore industry in the region has historically focused on the mining of high grade (65 - 66% Fe) Brockman ores. More recently exploitation has moved to pisolitic Channel Iron Deposits and Marra Mamba ore.

FMG is currently seeking approvals for several iron ore mines (including the Project) in the East Pilbara which are expected to produce the first shipment of ore in Quarter 2 of 2007. This document relates only to the Project, although the cumulative impacts from the other mining areas have been considered in the key studies undertaken for the Project.

3.3.3 Tourism

Tourism provides another significant economic driver in the Pilbara. In 2000/2001, tourism was worth $160 million to the Pilbara (Pilbara Development Commission, www.pdc.wa.gov.au). Karijini National Park is the primary tourism focus in the Central Pilbara (Figure 1). This National Park is some distance (over 50 km) from the Project Area.

4. EXISTING ENVIRONMENT

4.1 REGIONAL SETTING

The Project is located within the Pilbara Bioregion as described in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995; Environment Australia, 2000). The IBRA bioregions are used as a framework for conservation planning and sustainable resource management in a bioregional context. IBRA regions represent a landscape-based approach to classifying the land surface from a range of continental data on environmental attributes. This classification system is being used to develop the National Reserve System for Australia.

A "Mulgalands Conservation Park", east of Karijini National Park (Figure 1), has been proposed to provide for reservation of species and floristic communities that are not present, or are inadequately represented, within the National Park (particularly Mulga communities) (van Leeuwen and Bromilow, 2002). The proposed Conservation Park extends from the vicinity of Mt Meharry some 70 km to the south and east almost to Mt Newman, with the Great Northern Highway forming the eastern boundary.

In addition, portions of numerous pastoral leases in the Pilbara have been nominated to be released to the conservation estate in 2015, or set aside for conservation management within the pastoral leases under conservation agreements. In particular, the pastoral stations on which the Fortescue Marshes are located have been earmarked to be managed for conservation purposes (Section 4.4.3).

The proposed mining area occurs within two major physiographic units within the Fortescue District. These are:

- Chichester Plateau - a plateau of mainly basalts, with included siltstone, mudstone, shale, dolomite and jaspilite; forming a watershed between numerous rivers flowing north through the Abydos Plain to the coast, and the Fortescue drainage on the southern side of the range (Beard, 1975). The plateau supports shrub steppe characterised by *Acacia pyrifolia* over *Triodia pungens* hummock grass. Snappy Gum (*Eucalyptus leucophloia*) tree steppes occur on ranges.' (IBRA Revision 5.1; Environment Australia, 2000).

- Fortescue Valley - occupies a trough between the Chichester and Hamersley Plateaux. The eastern portion drains into the Fortescue Marshes, while the western portion drains through a valley through the Chichester Plateau (Beard, 1975). These alluvial plains and river frontages support salt Marshes, Mulga/bunch grass, and short grass communities. River Gum (*Eucalyptus camaldulensis*)/Coolibah (*E. victrix*) woodlands fringe the drainage lines. This is the northern limit of Mulga (*Acacia aneura*). (IBRA Revision 5.1; Environment Australia, 2000).

4.2 CLIMATE

The inland Pilbara region is classified as arid, with most rain falling during the hot summers. Climatic data from the Bureau of Meteorology weather station at Newman (www.bom.gov.au) indicates that peak rainfall occurs in the summer months between January and April with a smaller peak in June (Table 1).

Climatic conditions in the Pilbara are influenced by tropical cyclone systems predominantly between January and March. These cyclones normally develop over the ocean north of Australia and follow a south-westerly course parallel to the north-west coast. However, at some point, two thirds of these cyclones change direction and head south-east, crossing the coast and moving inland, bringing heavy rainfalls. Rainfall during May and June is generally a result of cold fronts moving across the south of the State, and which occasionally extend into the Pilbara.

Annual average rainfall for the Pilbara ranges from 180 mm to over 400 mm (Beard, 1975) with the Bureau of Meteorology data indicating an average of 312 mm at Newman. Average maximum summer temperatures are generally between 35°C and 40°C and winter maximum temperatures generally between 22°C and 30°C. In this climate, annual evaporation rates greatly exceed the mean annual rainfall.

Winds recorded at Newman are predominantly east-south-easterly between May and August with stronger west-north-westerly winds between September and March, and an annual average wind speed of 9.4 km/hr.

Table 1. Climatic Data for Newman

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Newman [1]													
Mean Daily Max. Temp (°C)	38.8	37.2	35.8	31.6	26.2	22.4	22.2	24.8	29.4	33.6	36.5	38.5	31.3
Mean Daily Min. Temp (°C)	25.3	24.4	22.5	18.5	13.3	9.6	8	10.2	13.7	18	21.5	24.1	17.3
Mean 9am Rel. Hum. (%)	35	41	37	41	49	56	50	43	30	25	24	30	39
Mean 3pm Rel. Hum. (%)	22	26	23	26	32	34	29	24	17	14	14	19	24
Mean monthly rainfall (mm)	51	80	39	25	23	25	13	11	4	4	10	27	312
Highest monthly rainfall (mm)	226	286	199	212	119	156	64	96	43	23	63	140	286
Highest recorded daily rainfall (mm)	142	151	108	72	47	101	29	36	31	17	57	63	151
Mean 3pm wind speed (km/hr)	10.1	10.7	8.8	7.7	7.9	8.3	9.3	9.2	10.2	11	10.2	9.6	9.4

Source: Bureau of Meteorology (www.bom.gov.au)
1. Data for Newman from 1965 to 2003

4.3 GEOMORPHOLOGY

4.3.1 Topography

Within the eastern Pilbara, the regional topography is dominated by the Hamersley Plateau in the south and the Chichester Ranges in the north, with the two features divided by the Fortescue Valley. The main drainage is the Fortescue River, which flows northwards on Ethel Creek Station and then flows north-west on Roy Hill Station into the Fortescue Marshes.

The topography of the Project Area can be described as gently undulating, with a maximum relief from the Fortescue Valley (400 – 450 mRL) to the Chichester Ranges (500 – 600 mRL) of approximately 50 – 200 m. The Chichester Ranges and the major drainage system of the Fortescue Valley to the south, trend towards west-north-west.

4.3.2 Land Systems and Soils

The land systems of the Pilbara region are mapped by Payne *et al.* (2002). The land systems present in the vicinity of the Cloud Break Project Area are:

- Adrian Land System - stony plains and low silcrete hills supporting hard spinifex grasslands;

- Christmas Land System – stony alluvial plains supporting snakewood and Mulga shrublands with sparse tussock grasses;
- Coolibah Land System – flood plains with weakly gilgaied clay soils supporting Coolibah woodlands with tussock grass understorey;
- Cowra Land System – plains fringing the Marsh Land System and supporting snakewood and Mulga shrublands with some halophytic undershrubs;
- Jamindie Land System – stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with spinifex understorey;
- McKay Land System - hills, ridges, plateaux remnants and breakaways of meta-sedimentary and sedimentary rocks supporting hard spinifex grasslands;
- Marsh Land System - lake beds and flood plains subject to regular inundation supporting samphire shrublands, salt water couch grasslands and halophytic shrublands; and
- Newman Land System - rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.

The dominant land systems within the Cloud Break lease areas are the Christmas, Jamindie and Newman Land Systems.

Soils of the region are dominated by Tertiary aged colluvium, characterised by angular fragments of Banded Iron Formation (BIF), chert and shale. The flanks of hills contain iron-rich gravely soils that form extensive sheets of scree which abut the plain levels of lower topography. The floodplains of the Fortescue Valley display extensive sheets of silty and sandy soils with increasing clay mineral constituents in closer proximity to the Fortescue Marshes. North-easterly trending ephemeral drainages dissect the Chichester Ranges and commonly display alluvial sediments characterised by silt and sand sized sediments with a red/ochre colour.

4.3.3 Geology

4.3.3.1 Regional Geology

The geological stratigraphy in the Pilbara region of WA is relatively continuous, with similar geological processes occurring across the region which have resulted in the enrichment of the iron deposits. The Project lies within the Hamersley Basin where granitoid rocks of the Pilbara Craton (2800 – 3500 Million years old), are overlain throughout most of the Project Area by sedimentary rocks. The lowest of the sedimentary group is known as the Fortescue Group, which is itself overlain, in parts, by the Hamersley Group. These sedimentary formations were originally formed in horizontal layers, but over time, tectonic movement has resulted in folding of the rocks and several major geological faults have developed.

Weathering processes have resulted in erosion of some of these rocks into alluvium and colluvium. These eroded rocks include gravels, sands and clays, which have been deposited in the lower lying areas, including ancient river channels.

The Marra Mamba Iron Formation (MMIF) is the lowest member of the Hamersley Group within the Mt Bruce Supergroup, which conformably overlies the Archaean basement rocks of the Pilbara Craton. The lowest member of the MMIF, termed the Nammuldi Member, is the host of the Christmas Creek, Mt Lewin, Cloud Break and Mt Nicholas iron ore deposits. Locally, the Nammuldi Member is characterised by extensive, thick and podded iron enriched BIF, separated by equally extensive units of siliceous and carbonate rich chert and shale. The Nammuldi Member rocks are underlain by the black shales and volcanic rocks of the Jeerinah Formation. Although these rocks do not outcrop extensively throughout the Project Areas, they do form a ridge of low lying hills. The rocks of the Nammuldi Member do not usually contain sulphide minerals and the deposits are largely of oxides (hematite and goethite).

Rock outcrop throughout the area is limited due to extended periods of erosional inactivity. The Nammuldi Member is characterised by low flat hills with relief generally restricted to less than 30 m. Furthermore, the weathering profile is deep with no fresh rock evident at surface. These profiles commonly display Tertiary aged colluvium containing both cemented and uncemented detrital products of BIF, chert and shale within a matrix of finer-grained sediments. Percolation of groundwater through the weathering profiles has resulted in precipitation of both calcrete and ferricrete creating resistant horizons within the extensive regolith. The structural geology of the area is concealed by limited outcrop exposure. However, extensive large-scale faulting has been interpreted in some areas.

4.3.3.2 Stratigraphic Units

Stratigraphic units in the Chichester Range are represented by a sedimentary basement of the Jeerinah Formation and Roy Hill Shale overlain by the Nammuldi Formation of the Marra Mamba Iron Formation.

This Formation is host to major iron deposits in the Province. It is the basal unit of the Hamersley Group and has been divided into three Members:

- the lowermost Nammuldi Member (~80 m thick), which consists of cherty BIF interbedded with thin shales;
- the MacLeod Member (~75 m thick), which consists of BIF, cherts and carbonates with numerous interbedded shales and several prominent podded BIF horizons which provide marker horizons invaluable for field mapping; and

- the upper Mount Newman Member (~65 m thick), consisting of more typical BIF with interbedded carbonates and shales. This Member is the major ore bearing horizon of the Formation.

The Nammuldi Member is overlain by various Tertiary detrital deposits of varying maturity which may also contain significant iron mineralisation. Within the Nammuldi Member, various textural variants are recognised and noted on drill logs.

4.3.3.3 Cloud Break Mineralisation

Geology of the Project Area is shown in Figure 4. The mineralisation at Cloud Break appears as a series of shallow dipping units that currently have a strike length stretching across 30 km (east to west).

The first six years of production will mine high material, which does not require any processing apart from crushing and sizing. Low grade material will also be mined in the first six years, but will be stockpiled and then continue to be mined and beneficiated from 7 to produce a product based on customer specifications.

Throughout the Cloud Break mineralisation area there are regions that contain high levels of contaminants (in terms of steel production) that must be blended at the face. This presents significant issues to selecting a mining strategy. Of note is that the high grade material frequently occurs as lenses within the low grade material, and is often in contact with waste zones. Blending of ore is a method that is often used to ensure a shipment meets the required specifications for steel production.

4.4 SURFACE WATER

4.4.1 Regional Surface Hydrology

The surface hydrology of the Project and surrounding areas were investigated by Aquaterra (see Appendix B) and is summarised below.

The proposed Project is located in the vicinity of the Fortescue Marshes in the upper Fortescue River catchment as shown on Figure 5. In common with other areas in the Pilbara Region, the Fortescue Valley is subjected to localised thunderstorm and cyclonic rainfall events. Typically these events occur during the period December to April and can produce very large runoff events. The period July to November typically has relatively low rainfall (Table 1), although significant runoff events during this time can occur.

The Goodiadarrie Hills, about 60 km east from the town of Wittenoom (Figure 5), effectively cut the Fortescue River into two separate river systems. West from the Goodiadarrie Hills, the Lower Fortescue River Catchment drains to the coast, whereas east from the hills the Fortescue Marshes receive drainage from the upper Fortescue River catchment. The alluvial outwash fan from the Weeli Wolli Creek system abutting the Goodiadarrie Hills is believed to be partially responsible for obstructing the Fortescue River and forming the Fortescue Marshes.

The Fortescue Marshes form an extensive intermittent wetland (located on the floor of the Fortescue Valley) occupying an area around 100 km long by typically 10 km wide. The Fortescue Marshes have an elevation of around 400 m above sea level (ASL). To the north, the Chichester Plateau rises to over 500 m ASL, whereas to the south the Hamersley Range rises to over 1,000 m ASL. Following significant rainfall events, runoff from the upper Fortescue River catchment (approximately 31,000 km^2) drains to the Marshes. For the smaller runoff events, isolated pools form on the Marshes at the main drainage inlets, whereas for the larger events the whole marsh area may flood.

On the southern and northern flanks of the Fortescue Valley, numerous creeks discharge to the Marshes. Rainfall runoff from the valley sides initially drains down-gradient as overland flow before concentrating in defined flow channels. In this process, surface detention, vegetation, infiltration and other mechanisms absorb water from the runoff stream. In steep areas, the runoff processes are rapid with relatively low losses, and defined drainage channels are typically in close proximity. In the lower slope areas, the runoff processes are slow with relatively higher losses and greater distances between defined drainage channels.

Where defined drainage channels from the steeper slopes enter the lower slope areas, the channels typically have a reduced discharge capacity and in many instances become less defined, braided, or may even completely disperse in flat areas. In these reducing slope channels, runoff tends to overspill the main channel flow zones and spread over a wider front. In some of the lower slope areas, vegetation communities (scrub and Mulga wood-lands) have developed. These are dependent on seepage water provided by the overland flow process. In these areas, the overland flow process has been termed sheet-flow. Conversely, the Fortescue River, Weeli Wolli Creek, and other main channels entering the Marshes typically support eucalypt woodlands on their banks and floodplains.

Published topographical mapping indicates that bed levels in the Fortescue Marshes predominantly lie between 400 m and 405 m ASL. Based on internal Water and Rivers Commission (WRC) records, the flood storage level in the Marshes would need to exceed 413 m ASL to overspill westwards past the Goodiadarrie Hills. Although no published flood level data are available for the Marshes, WRC internal records show a Marsh flood level near the BHPBIO railway in March 1980 of around 406.5 m ASL as a result of rainfall from consecutive cyclones Dean and Enid. Enquires with BHPBIO indicate that flood levels have never overtopped the railway crossing over the Marshes, although large floods in the early 1970s are reported to have caused inundation up to the existing railway track level (G. Liddell, BHPBIO, *pers. comm*.).

At the eastern end of the Marshes, an indication of flood levels can be obtained from the Roy Hill streamflow gauging station data (S708008) established on the upper Fortescue River. This gauging station, used to monitor streamflows entering the Marshes, was located just downstream from the Roy Hill Homestead and was operating from September 1973 to September 1986. At the gauging station, the main flow channel bed level was around 405.5 m ASL and during the 13 years of records, the maximum recorded streamflow level was 408.75 m ASL (February 1980). The corresponding peak flood storage level in the downstream Marshes would have been less than this gauge level, as indicated by the above internal WRC data (i.e. 406.5 m ASL in March 1980).

Surface water runoff to the Marshes is of low salinity and turbidity, though the runoff turbidity significantly increases during peak periods of flooding (WRC, 2000). Following a significant event that floods the whole marsh area, the ponded water may be over 4 m deep in the lower elevation marsh areas. Water stored on the Marshes slowly dissipates through the processes of seepage and evaporation. During the evaporation process, the water salinity levels increase and as the ponded areas recede, traces of surface salt can be seen. During the seepage process, as the ponds evaporate, increasingly more saline water is believed to seep into the valley floor alluvial deposits.

4.4.2 Cloud Break Surface Hydrology

The Cloud Break mining area is located on the southern flanks of the east-west running Chichester Plateau, north of the Fortescue Marshes (Figure 5). The proposed mine development comprises several various sized pits, waste dumps and associated stockpiles. The maximum area of disturbance over the life of the mine is expected to be up to 5,500 ha, but only a portion of this area would be open at one time, with mined-out areas progressively rehabilitated. Published topographical mapping indicates that no springs or pools are located in the Project Area.

The proposed Cloud Break Mine development has an elevation of around 415 m to 450 m ASL, which is considered well above any potential flood storage level in the Marshes.

Goman Creek, with a catchment area around 30 km^2 passes through the Project Area (Figure 6). The proposed Cloud Break pits are located in a zone extending around 24 km to the west and 12 km to the east from Goman Creek. During peak flood events, Goman

Creek would carry a significant discharge over the lower slopes of the plateau. These creek flows would be in a well-defined channel approximately 50 m wide. Two of the proposed pits abut the floodplain of Goman Creek. Numerous creeks smaller than Goman Creek discharge southwards through the proposed pit development area to the Fortescue Marshes. These creeks have relatively steep slopes in the higher rocky ridge areas and relatively flat slopes away from the ridge.

The pit development areas also intercept sheet-flow along the lower slopes of the Chichester Ranges. Catchments to these sheet-flow areas are difficult to define, as they comprise a combination of the directly upgradient overland flow areas plus overspill from nearby main creek flow zones. Scrub and Mulga woodland communities have developed in large sections of the lower slope, and these communities are reported to be partially dependent on seepage water provided by the sheet-flow process.

4.4.3 Fortescue Marshes

The Fortescue Marshes in the upper reaches of the Fortescue River are listed on 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).

They are recognised by CALM as supporting, when in flood, a rich diversity of migratory birds. Much of the northern area of the Fortescue Marshes is being sought by CALM during the review of pastoral leases that will occur when all leases expire in 2015. CALM would like this area to be added to the Conservation Estate at this time.

"The Marshes occupy a broad valley or small plain between the Chichester and Hamersley Ranges. It has an irregular elongate shape. A sinuous channel occurs at the upstream (eastern) end where the Fortescue River enters; there are no other substantial channels in the place. Near the western end of the place, a poorly defined floodway connects the main part of the Marshes to a discrete basin surrounded by low hills. Flow does not extend west from the place beyond the Goodiadarrie Hills to the lower reaches of the Fortescue River" (Australian Heritage Database, 2004).

The Fortescue Marshes are considered to be important habitat for animal taxa at a vulnerable stage in their life cycles, or provide a refuge when adverse conditions such as drought prevail in the region (Department of Environment and Heritage [DEH], website 2004).

4.5 GROUNDWATER

4.5.1 Regional Hydrogeology

The regional hydrogeology is described in Aquaterra's Hydrogeology Report for the Project (Appendix C) and is summarised below.

Regional groundwater levels were initially obtained from the DoE AQWABase system. In addition FMG has commenced a programme of regular groundwater level monitoring, as part of its ongoing monitoring programme. This programme has involved the construction of 34 monitoring bores throughout the Fortescue Valley and surveying of a further 25 existing bores (mainly pastoral bores) to determine accurate reference levels at each site. Water levels from these bores are monitored monthly and the data has been used to determine a groundwater contour plot for the area. Figure 7 shows these contours as meters above reduced level (mRL).

In low-lying areas, particularly along the Fortescue Marshes, Fortescue River and major creek systems, depth to groundwater is typically less than 10 m. At sites on the flanks of the Fortescue Valley groundwater levels are typically at depths of 20 m or more.

Throughout the region groundwater levels are a subdued reflection of topography. Maximum groundwater levels (approximately 430 mRL) were observed along the topographic highs associated with rocks of the Hamersley and Fortescue Groups, whilst groundwater levels were lowest in low-lying areas associated with creeks and the Fortescue Marshes and Fortescue River system. Groundwater levels in the vicinity of the Fortescue Marshes are below 400 mRL, which represents the bed of the Marshes. During the recent groundwater monitoring programme, water levels in these bores were above 400 mRL, and this is believed to be due to recharge in 2004 when the Marshes were seen as a large expanse of water.

4.5.1.1 Hydrogeology of the Fortescue Marshes

Insight into the hydrogeology of the Fortescue Marshes has been obtained from:

- water samples from the Marshes - these showed that they contained sub-potable water (TDS 7,500 mg/L) in spring 2004, but that the water becomes more saline towards summer (TDS 10,000 mg/L in October 2004) as water levels in the Marshes decline. More recently, in May 2005, a sample was taken from one of the few pools still present in the Marshes and the salinity value was 71,000 mg/L;

- bores installed in the area between Cloud Break and the Marshes - these indicate that, in this area, groundwater levels in both the alluvium and underlying basement material are currently two metres below ground level (mbgl). However, previous data have shown regional water levels recorded in stock bores suggest groundwater levels along the Fortescue Valley are typically 5 m or more below ground level (DoE AQWABase);
- groundwater samples, taken from bores between Cloud Break and the Marshes - these indicate that the alluvium intercepted contains water with a similar quality to that in the Marshes (i.e. saline);
- anecdotal evidence suggests that the Marshes completely dry out during sustained dry periods, when salt crystals form on the surface of the bed (G. Clark, *pers. comm.,* October 2004). In support of this, during September 2004, occasional salt deposits were observed on the flanks of the Marshes. Except for a few small pools, the Marshes have been dry since October 2004;
- groundwater levels in the vicinity of the Marshes, in the area close to Cloud Break, have been reported as being approximately 397 mRL (DoE AQWABase). Unpublished data suggest that groundwater levels along the Mount Newman railway, approximately 40 km west of Cloud Break, are approximately 410 mRL to 415 mRL. These groundwater level data indicate a groundwater catchment divide downstream of Cloud Break, with the Fortescue Valley acting as a groundwater discharge point. However, because of capillary action and evaporation, the discharging groundwater does not appear as surface water.

The available data set indicates that water levels in the alluvium on the plain are generally below the bed of the Marshes. However since August 2004 when the Marshes were filled with water several meters deep, recharge of the alluvium has occurred via the bed of the Marshes. This confirms the surface water in the Marshes forms as a result of rainfall rather than as a result of groundwater discharging. During flood events, salts deposited during previous drying episodes are redissolved, and the fresh water entering the Marshes becomes increasingly more saline.

Following a flood event, a portion of the ponded surface water will infiltrate causing water levels to rise beneath the Marshes, ultimately to ground surface (marsh bed) level. Continual evaporation will remove ponded surface water, after which the water table in the marsh bed sediments will decline to its former position under the combined processes of direct evaporation and groundwater flow to the Fortescue Valley. It is considered likely that the depth to water beneath the Marshes is, or closely approximates, the extinction depth (i.e. depth from which the groundwater starts to evaporate, leaving salts in the soil profile).

With the above concept, any change in groundwater level beneath the Marshes will have no impact on the occurrence of surface water ponding, or on the rate of seepage from the marsh bed into the water table. However where the groundwater level is lowered significantly, an increased amount of water would be required to fully saturate the profile, and this could reduce the duration of surface water ponding. In order to confirm this concept FMG has installed stage boards in the marsh and is monitoring water levels in bores along the northern flank of the marsh. The data from these studies will be used to better understand the relationship between surface water and groundwater.

The alluvium and, to a lesser extent, Marra Mamba aquifers on the flanks of the valley are recharged with fresh water during rainfall events. Given there is a hydraulic gradient; this water will drain towards the Marshes. Groundwater both below and close to the Marshes is saline, whilst that further away is fresh. A schematic diagram representing the process is given in Figure 8.

Approximately 30 km west of the proposed Cloud Break Mine lie the Goodiadarrie Hills, which consist of siliceous chert, formed as a result of chemical precipitation within the Fortescue Valley. The hills form a narrow restriction across the Marshes, preventing any western migration of groundwater away from the Marshes.

4.5.2 Project Hydrogeology

At Cloud Break there are two extensive aquifers (Figures 9, 9a – 9e); an alluvial aquifer within the Quaternary and Tertiary sequence, and the upper portion of the Marra Mamba formation where it is either mineralised or weathered. In addition, south of the pits, close to the Fortescue Marshes, there is evidence of Wittenoom Dolomite, which at this location is generally at depths of more than 50 m and would tend to contain saline water. The Wittenoom Dolomite is an important aquifer regionally, especially in the proposed Stage B water supply borefield at Mount Lewin, where the surface of this horizon was found to be weathered and occasionally karstic, and yielded large quantities of water. In comparison the unmineralised Marra Mamba generally consists of low-permeability shales.

The saturated thickness of the alluvial deposits is in excess of 60 m in the south, with the alluvium becoming unsaturated in the north. The mineralised Marra Mamba aquifer is typically 20 m thick and, except at higher elevations, is generally saturated. The unmineralised Marra Mamba is up to 100 m thick.

Analysis of test pumping data indicate that the values of transmissivity (and therefore permeability) are moderate. The data also confirm the heterogeneity of both the alluvium and mineralised Marra Mamba (Appendix B).

The results from the water quality analysis, down-hole geophysics and Time Domain Electromagnetics (TEM) survey show that the groundwater in the Cloud Break area has a highly variable electrical conductivity. In particular, groundwater close to the Marshes, in the alluvium, Marra Mamba and dolomite is hypersaline (TDS > 35,000 mg/L). North of the Marshes the water gradually becomes less saline, particularly in the alluvium, which contains almost fresh water (TDS < 2,000 mg/L) in the vicinity of the pits. The Marra Mamba has been shown to be saline (TDS 10,000mg/L - 35,000mg/L) close to the Marshes, but is also saline in the pits located in the south-west of the Project Area, where the deposit is reported to contain saline water.

The TEM survey suggests that there is saline water underlying the pits, but this has been inferred from interpretation of complex data. FMG has undertaken further sampling in the west of the Project Area where the saline water is most likely to be intercepted during mining. The samples were taken from bores drilled for the mineral investigation and confirm the depth of saline water below the pits and its maximum salinity. One bore immediately to the south of one of the pits had a salinity (as TDS) of 120,000 mg/L at 70 mbgl. Further sampling is proposed to obtain a better understanding of the water quality intercepted by the pits.

4.6 BIOLOGICAL ENVIRONMENT

4.6.1 Flora and Vegetation

4.6.1.1 Vegetation

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The entire Project Area lies within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts.

Vegetation at Cloud Break is a mosaic of low woodland with Mulga in valleys and hummock grasslands, low open tree steppe with Snappy Gum (*Eucalyptus leucophloia*) over *Triodia wiseana*, and Kanji (*Acacia pyrifolia*) over soft spinifex and *Triodia wiseana* hummock grasslands.

Surveys of the Project Area undertaken in October/November 2004 (with a follow up survey in May 2005) by Mattiske Consulting described 18 plant communities in the area (Appendix D). These community types consist of four communities near the creekline and drainage lines, six communities on the extensive flats and broad plains, four communities on the ranges, hills and hillslopes, and four communities on the fringes of the Fortescue Marshes (or samphire flats).

A description of each plant community is given below.

Community No.	Description
	Creekline and Drainage Lines
1	Open Woodland of *Eucalyptus victrix, E. camaldulensis* var. *obtusa* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides, Acacia tumida* over *Triodia longiceps, Chrysopogon fallax, Themeda triandra* and *Aristida* species.
2	Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura, A. citrinovirirdis*, *A. pruinocarpa* over *A. tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax, Stemodia viscosa, Blumea tenella, Themeda triandra* and species of *Triodia* and *Aristida*.
8	Closed Scrub to Tall Shrubland of *Acacia pruinocarpa, A. tumida, A. ancistrocarpa, A. maitlandii, A. kempeana, A. tetragonophylla* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Triodia epactia*, *Themeda triandra* and *Aristida* species.
9	Closed Scrub to Shrubland of *Acacia ancistrocarpa, A. maitlandii, A. kempeana, A. monticola* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Senna* species, *Triodia basedowii* and *Aristida* species.
	Flats and Broad Plains
3	Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura, A. pruinocarpa, A. tetragonophylla, A. tenuissima, Grevillea wickhamii* subsp. *aprica, Psydrax latifolia* over *Dodonaea petiolaris* and species of *Triodia* and *Aristida*.
4	Low Open Woodland of *Acacia aneura* var. *aneura, A. pruinocarpa, A. xiphophylla, A. victoriae* over *A. tetragonophylla, Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* var. *obovatus* and mixed Chenopod species of *Maireana* and *Sclerolaena*.
5	Low Woodland of *Acacia aneura* var. *aneura, Acacia pruinocarpa* over *Acacia tetragonophylla, Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* var. *obovatus* and mixed Chenopod and Poaceae species.
6	Low Woodland of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa* over *Acacia tetragonophylla, Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* var. *obovatus* and *Triodia epactia* and Poaceae species.
10	Low Open Woodland of *Acacia xiphophylla, A. victoriae, A. aneura* var. *aneura* over *A. tetragonophylla, Ptilotus obovatus* var. *obovatus, Senna* species and mixed Chenopod species of *Maireana* and *Sclerolaena*.
15	Low Open Woodland of *Acacia victoriae, A. xiphophylla* over *Ptilotus obovatus* var. *obovatus*, *Senna* species and mixed Chenopod species of *Maireana* and *Sclerolaena*.
	Ranges, Hills and Hillslopes
Community No. cont'd	**Description**
7	Hummock Grassland of *Triodia basedowii* with emergent patches of *Eucalyptus gamophylla, E. leucophloia, Corymbia deserticola* over *Acacia ancistrocarpa, A. sclerosperma, A. kempeana, A. arida, Grevillea berryana, G. wickhamii* subsp.

aprica, Calytrix carinata over *Goodenia stobbsiana* and mixed Poaceae species.

16 Hummock Grassland of *Triodia basedowii* with pockets of *T. epactia* and *T. lanigera* with emergent patches of *Eucalyptus leucophloia, Corymbia deserticola* over *Acacia ancistrocarpa, A. hilliana, A. acradenia, A. pyrifolia, Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* species.

17 Hummock Grassland of *Triodia basedowii* with pockets of *T. epactia* and *T. lanigera* with emergent patches of *Eucalyptus leucophloia, Corymbia deserticola* over *Acacia ancistrocarpa, A. pyrifolia, Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* and *Ptilotus* species.

18 Hummock Grassland of *Triodia angusta* with emergent patches of *Eucalyptus leucophloia* over *Acacia ancistrocarpa, A. pyrifolia, Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* and *Ptilotus* species.

Fringes of Samphire Flats

11 Hummock Grassland of *Triodia angusta* with patches of *Acacia victoriae, A. aneura* var. *aneura, A. xiphophylla* over *Atriplex codonocarpa, Eremophila cuneifolia* and mixed Chenopods.

12 Low Halophytic Shrubland of *Halosarcia auriculata* and *H. indica* subsp. *leiostachya* with associated Chenopod species of *Maireana* species and *Atriplex flabelliformis* with *Muehlenbeckia florulenta* with patches of *Acacia victoriae* and *A. sclerosperma* subsp. *sclerosperma*.

13 Low Halophytic Shrubland of *Halosarcia auriculata, H. indica* subsp. *leiostachya, H. halocnemoides* subsp. *tenuis* with patches of *Frankenia* species.

14 Hummock Grassland of *Triodia angusta* with patches of *Acacia victoriae* over *Atriplex codonocarpa* and mixed Chenopods and Poaceae species.

Significant Vegetation Communities

None of the vegetation communities were considered Threatened Ecological Communities pursuant to Schedule 2 of the *Environmental Protection Biodiversity Conservation Act 1999* (*EPBC Act*) or identified as threatened in English and Blyth (1997).

Species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than as Declared Rare Flora or Priority Flora. The Environmental Protection Authority (2004) in the Guidance Statement 51 stated that significant flora may include taxon that have

> "A keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
> - relic status;
> - anomalous features that indicate a potential new discovery;
> - being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);

- the presence of restricted subspecies, varieties, or naturally occurring hybrids;
- local endemism/a restricted distribution;
- being poorly reserved."

Plant communities or vegetation may be significant for a range of reasons, other than a statutory listing as a Threatened Ecological Community or because the extent is below a threshold level. The Environmental Protection Authority (2004) in the Guidance Statement 51 indicated that significant vegetation may include communities that have:

- "scarcity;
- unusual species;
- novel combinations 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 to regional total population of a species;
- being representative of the range of a unit (particularly, a good local and/or regional example of a unit in "prime" habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- a restricted distribution."

The application of the degree of significance may apply at a range of scales;

Of the plant communities identified by Mattiske Consulting (2005), the restricted communities near the fringes of the Samphire Flats (or Fortescue Marshes) are considered locally and regionally significant (communities 11, 12, 13 and 14). These communities are spatially restricted and form part of the nationally recognised Marshes (Section 4.4.3).

The Low woodland to open forest (plant community 2) is locally significant as it supports the Priority 1 species *Eremophila spongiocarpa* (ms). Similarly the Closed Scrub (plant community 9) and Low Open Woodland (plant community 10) are locally significant as they support the Priority 3 species *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) PN and the Priority 4 species *Eremophila youngie* subsp. *lepidola* ms respectively.

The Mulga woodlands (plant communities 4 and 5) are locally significant as they support the Priority 3 species (*Rostellularia adscendens* var. *latifolia*) (Section 4.6.1.2). The Mulga communities largely occur to the south of this region and therefore Mulga communities represented in this part of the Pilbara (communities 2, 3, 5 and 6) are considered locally significant as they occur on the edge of their main distribution zone.

Mulga Communities

The term 'Mulga' can be used to refer to the arid zone tree or large shrub *Acacia aneura* and its variants, or the vegetation communities where Mulga is the dominant overstorey species. Variation amongst Mulga occurs both within and between populations and often results in a very complex mosaic of mixed Mulga populations. The paper by Miller *et al.* (2002) goes into further detail on the possible genetic and biological factors responsible for this variation.

On hardpan plains Mulga can form groves across the direction of the slope in areas of water run-on and intergroves forming in areas of water run-off. The groves trap surface water sheet-flow and leaf litter, which in turn creates a more hospitable environment for seed germination and seedling establishment (Burnside *et al*., 1995). These groves tend to have higher plant and animal diversity, and accumulate higher levels of organic carbon and nitrogen, than the intergroves (Tongway and Ludwig, 1990). Shading of the soil by established trees will also reduce soil temperatures during the hot summer months, reduce evaporation of moisture from the soil, and reduce leaf transpiration. Mulga can aestivate (remain dormant) when drought occurs and resume growth four days after water becomes available (Miller *et al.*, 2002).

Land Systems containing Mulga communities in the Pilbara ranges are well defined by the Pilbara Ranges Project Rangeland Survey (Payne *et al.*, 2002) (Figure 11). Collectively, Mulga in the vicinity of the Chichester Ranges represents the northern limit of Mulga in WA. However, it should be recognised that approximately 121,145 ha of land systems containing Mulga communities exist north of FMG’s Project Area.

Vegetation Condition

The plant communities have been extensively modified on both the flats and plains within the Project Area by either grazing pressure or regular fires. The area has also experienced low rainfall in recent years, which has affected general vegetation condition.

Mattiske Consulting was commissioned by FMG to assess the condition of vegetation on the Cloud Break leases (see Appendix E). The condition of the vegetation communities was variable and depended largely on the frequency of fires and the extent of grazing pressure from cattle. However, in general the vegetation within the assessment area at Cloud Break leases was in ‘degraded to good’ condition (as defined by Keighery, 1994).

The survey area has been subjected to frequent fires in recent years including one in the north-eastern section of the leases. Different communities have responded differently to the impact of fire, largely as a result of the varying fuel load and different composition and structure of the vegetation communities.

The Cloud Break leases are grazed by both native and introduced species. Sections of the leases occur on Hillside and Mulga Downs pastoral stations and are subjected to regular cattle grazing. Impacts from cattle are mainly grazing of the palatable species and physical disturbance of the soil surface, resulting in changes to local drainage systems. Impacts tend to be greatest near bores and as the bores tend to be located in the southern fringes of the leases, this is where the highest impacts were observed. Impacts from grazing on the vegetation communities around the Fortescue Marshes were apparent during the May 2005 field trip.

4.6.1.2 Flora

A total of 234 taxa (including subspecies and varieties) from 106 genera and 41 families was recorded in the Project Area from both surveys. The most common families recorded were Poaceae (grasses), Mimosaceae, Chenopodiaceae, Malvaceae, Asteraceae (daisies), Myrtaceae and Papilionaceae (peas). Few annual and short-lived species were collected in the October/November 2004 survey, largely due to the dry seasonal conditions that occurred prior to the surveys. An additional 59 taxa were recorded in the May 2005 survey, although this was preceded by a low rainfall season.

Introduced species recorded were: *Bidens pilosa, Cenchrus ciliaris, Cenchrus setigerus* and *Malvastrum americanum*.

No plant taxon recorded in the surveys are gazetted as Declared Rare Flora pursuant to Subsection (2) of Section 23F of the *Wildlife Conservation Act 1950,* or listed as 'Threatened' under Schedule 1 of the *EPBC Act*.

The following Priority species were recorded by Mattiske Consulting during the two surveys:

- *Eremophila spongiocarpa* (ms) (Priority 1) – recorded in plant community 2, inhabits weakly saline flats;
- *Rostellularia adscendens* var. *latifolia* (Priority 3) – recorded in plant communities 4 and 5, occurring on flats and broader plains within the Project Area;
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) PN (Priority 3) – recorded in plant community 9, found in red clay in clay pans or on grass plains;
- *Eremophila youngii* subsp. *lepidola* ms (Priority 4) – recorded in plant community 10, occurring in well-drained stony sandy loam, semi-saline floodplains, mudflats, clay flats.

A map showing the recorded location of priority species in relation to the proposed Project is shown in Figure 10 (legend Figure 10a). This also shows *Sida* sp. Wittenoom (W.R. Barker 1962) that was recorded during Biota's field surveys of the Stage B rail corridor (Biota, 2004b).

4.6.2 Fauna

FMG commissioned Bamford Consulting Ecologists to conduct a fauna survey of the Project Area. This survey was conducted between 7 and 17 April 2005, with a follow-up species-specific survey between 18 and 29 May 2005. The complete reports of these surveys are presented in Appendix G and provide detail on the methodology and results of the surveys. Previous surveys undertaken in the vicinity of the Project Area for the Stage B Project were undertaken by Biota Environmental Sciences (2005) in July 2004.

Work carried out in the field included:

- systematic trapping for amphibians, reptiles and mammals;
- quantitative surveys for birds;
- spotlighting for nocturnal reptiles, birds and mammals;
- the use of mist nets and an ultra-sonic detector for bats;
- hand searching for reptiles; and
- recording of opportunistic sightings.

Weather conditions experienced during the field trips consisted of generally hot conditions (> 40ºC). There were a few very light showers that arose from localised thunderstorms but no large-scale rainfall events. Conditions preceding the trip had been hot and dry with no significant rainfall for almost a year.

The Cloud Break Project Area has a range of habitats that represent a transition from the samphire flats surrounding the Fortescue Marshes on the southern boundary to the Spinifex covered foothills of the Chichester Ranges to the north. In between lie areas of Spinifex plains, Mulga/Acacia woodlands with or without Spinifex understorey, that are dissected by *Corymbia* sp. dominated watercourses. Some areas appear to be in very good condition, whilst others are severely degraded by cattle, especially around watering points.

Trapping sites were selected to encompass both a geographical spread and a diversity of habitats and landforms (Figure 12). Wherever possible, sites were kept within the proposed fauna survey limits provided by FMG. However, two sites were placed some 500 m outside this area due to the importance of sampling this habitat type (which was present but inaccessible in the Study Area), and its accessibility at these locations.

The surveys revealed a rich vertebrate fauna that was suffering the impacts of drought conditions, with most species at low levels of abundance. Most of the proposed mining areas supported degraded, open Mulga woodland, in many cases impacted on by recent fires and ongoing livestock activities. The exceptions were the eastern-most deposit (OB5) which contained some excellent examples of drainage systems, with good stands of *Grevillea wickhamii*, and which offer good habitat for a range of bird species; and OB 1 which contained Mulga woodland in good condition. This site was rich in bird species and was noted as potentially good habitat for Bilby (*Macrotis lagotis*), although a follow-up survey by FMG did not record any Bilby at this site.

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) and the Western Australian *Wildlife Conservation Act 1950*. Bamford *et al.* (2005) recognises three levels of conservation significance :

- Conservation Significance (CS) 1: species listed under State or Commonwealth Acts;
- Conservation Significance (CS) 2: species not listed under State or Commonwealth Acts, but listed in publications on Threatened Fauna or as Priority Species by CALM;
- Conservation Significance (CS) 3: species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

Below is a summary of the results of the fauna surveys undertaken by Bamford *et al.* (2005). For further detail refer to the original report in Appendix G.

4.6.2.1 Amphibians

Eight species of amphibian are expected to occur on the Lease area. Only one species, the Desert Tree Frog (*Litoria rubella*) was recorded during the fauna survey. No amphibians of conservation significance are expected to occur on the Lease area.

4.6.2.2 Reptiles

There are 100 species of reptile that may occur in the Lease area, with 28 species recorded during the fauna surveys. No reptiles of conservation significance were recorded, although four species have the potential to occur in the Study Area and are listed below:

- Pilbara Olive Python (*Liasis olivaceus barroni*) (CS1: Vulnerable) may occur in rocky areas of the Lease area;
- Blind Snake (*Ramphotyphlops ganei*) (CS2: Priority 1) may be associated with moist gorges and gullies (Wilson and Swan, 2003);
- Skink (*Ctenotus nigrilineatus*) (CS2: Priority 1) may occur in spinifex at the base of granite outcrops. It has only ever been recorded at Woodstock, approximately 100 km to the north of the Study Area; and
- Skink (*Ctenotus* uber *johnstonei*) (CS2: Priority 2) has been recorded from the west of the Study Area (CALM Threatened Fauna Database) and was recorded in the FMG Stage B studies by Biota (2005). Although not recorded in the April/May 2005 surveys, it is likely that this species occurs around small outcrops on sandy and stony plains in the Study Area.

4.6.2.3 Birds

There are 121 species of bird that may occur in the Lease area, with 99 recorded during the current surveys. Quantitative bird surveys were undertaken at each trapping site (Figure 12) and opportunistic records and surveys were undertaken at other sites. Bird abundances were generally low, probably reflecting the prolonged dry conditions.

Eight species of conservation significance were recorded, or have the potential to occur, in the Cloud Break Project Area. These include the following:

- Night Parrot (*Pezoporus occidentalis*) (CS1: Critically Endangered) was recorded in the Lease area during the May 2005 survey. This is a highly significant sighting as there have been no confirmed reports of the Night Parrot in WA since the 1930s. Written accounts and details of the sighting are provided in the report titled, *Survey for the Night Parrot in the Project Area* (Bamford, 2005b) (Appendix G). A follow-up survey for the Night Parrot was conducted in May 2005. Although this survey did not locate any Night Parrots, it provided the opportunity to test various recording techniques which may be applied in future surveys to target this species;

- Peregrine Falcon (*Falco peregrinus*) (CS1: Schedule 4: Other Specially Protected Fauna), and Grey Falcon (*Falco hypoleucos*) (CS2: Priority 4) were both recorded. A pair of Grey Falcons was observed in eucalypt woodland along Sandy Creek. A single Peregrine Falcon was observed at Mingarwirriewirrie (Minga') Well and both species probably breed on cliffs in the area;

- two migratory species listed under the *EPBC Act*, Fork-tailed Swift (*Apus pacificus*) and Rainbow Bee-eater (*Merops ornatus*) are likely to be common in the Lease area;

- Australian Bustard (*Ardeotis australis*) (CS2: Priority 4) was recorded throughout much of the study site and at trapping Sites C, E, F and G during bird surveys, and was sighted opportunistically at trapping Site A. In general, the Australian Bustard was moderately common, and much of the Lease area is suitable habitat;

- Bush Stone-curlew (*Burhinus grallarius*) (CS2: Priority 4) was not recorded during the fauna survey, but the large areas of Mulga woodland in the Lease area would present ideal habitat for this species and it is considered as likely to occur;

- Star Finch (*Neochmia ruficauda subclarescens*) (CS2: Priority 4) was present in the Study Area, with 12 individuals observed at Minga' Well during the May 2005 survey. The record of this species was unusual this far east and may be due to the dry conditions.

4.6.2.4 Mammals

There are 47 species of mammal that have the potential to occur in the study area, with 25 recorded during this survey. As for other taxa, the abundance and diversity of mammals was low, possibly reflecting the dry conditions. The highest number of mammal species and individuals were captured at Site D, which consists of dense *Triodia* hummocks that appeared to offer excellent habitat for small mammals.

Eight species of mammal of conservation significance were recorded, or have the potential to occur, in the Lease area:

- Mulgara (*Dasycercus cristicaudata*) (CS1: Vulnerable) may occur in the Lease area. However, the absence of suitable sandy substrates means this species is unlikely to be present;

- Bilby (*Macrotis lagotis*) (CS1: Vulnerable) has been reported from near Kardarderrie Well on Mulga Downs Station. The sandy-loam soils around the periphery of the Fortescue Marshes may be particularly suitable for this species, and the species may be more widespread in other areas where the soil allows for burrow construction. During the May 2005 survey, seven burrows were located near Cockeye Bore in an area of spinifex and Chenopod shrubland on loam soil. It was most likely that some of these burrows were active;

- Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) (CS1: Vulnerable) has a geographically isolated population in the Pilbara, where it relies heavily on roost sites that support a suitable microclimate. It is highly unlikely that suitable roost sites occur within the Study Area, although the species may roost elsewhere and forage in the Study Area;

- Long-tailed Dunnart (*Sminthopsis longicaudata*) (CS2: Priority 4); Lakeland Downs Mouse (*Leggadina lakedownensis*) (CS2: Priority 4); Spectacled Hare-Wallaby (*Lagorchestes conspicillatus*) (CS2: Priority 3); and Ghost Bat (*Macroderma gigas*) (CS2: Priority 4) were not recorded during the fauna survey, but suitable habitat for each of these species exists in the Lease area;

- the distinctive pebble-mounds of the Western Pebble Mound Mouse (*Pseudomys chapmani*) (CS2: Priority 4) were recorded during this survey at Site E on a rocky hillslope and at Site D. A total of 5 mounds was found in the vicinity of Site D, two of which showed recent activity. This species may be widespread in the hilly areas to the north of the Lease.

4.6.3 Stygofauna

Stygofauna communities (groundwater-dwelling fauna) have been identified in the vicinity of most iron ore mines in the Pilbara (Johnson and Wright, 2001). The stygofauna sampling programme developed for the proposed Stage B Project has been expanded to include four additional sampling bores in the Cloud Break Project Area.

During the March 2005 sampling stygofauna programme FMG sampled four bores located within the Cloud Break area. The bores sampled were Mulga Bore (FMG25), Cook Bore (FMG26), Mingarwirriewirrie (Minga') Well (FMG28), and observation bore CBDD128 (FMG27) (Figures 13a to 13c). Additional bores from Cloud Break were included into the June 2005 sampling and included Malibu Bore (FMG31) and CB068 (FMG32) (Figures 13a to 13c). Both sampling programs were carried out by experienced stygofauna experts. A summary of the results from the Cloud Break stygofauna sampling programmes undertaken in March and June 2005, are provided in Table 2. While Wittenoom dolomite is though to be a favourable host habitat for styfofauna, however this unit was not intersected by the bores surrounding Cloud Break. Biannual sampling of bores will continue for two years (i.e. to the end of 2006), after which the need for future sampling will be re-assessed.

Table 2. Stygofauna Sampling Results 2005

Bore No.	Bore Name	Stygofauna Recorded	Notes
March 2005 Sampling Programme			
FMG25	Mulga Bore	No invertebrates	Abandoned mill. Requires casing and capping.
FMG26	Cook Bore	*Diacyclops humphreysi humphreysi* (29) *Pilbarus millsi* (43) *Parapseudoleptomesochra 'tureei'* (39)	Abandoned mill. Requires capping, but otherwise in good condition.
FMG27	CBDD128	No invertebrates	Requires casing. Water very turbid, but otherwise in good condition.
FMG28	Minga' Well	*Microcyclops varicans* (18) *Cypretta seurati* (4) *Strandesia* sp. 1 (20) *Stenocypris bolieki* (4) *Phreodrilus peniculus* (3)	Mill with adjacent tank. Well in good condition.
June 2005 Sampling Programme			
FMG25	Mulga Bore	No invertebrates	Abandoned mill. Requires casing and capping.
FMG26	Cook Bore	*Parapseudoleptomesochra 'tureei' (110)* *Diacyclops humphreysi humphreysi (110)* *Paramelitidae sp. 2 (20)* *Paramelitidae sp. 3 (15)*	Abandoned Mill, has recently been capped.
FMG27	CBDD128	No invertebrates	Requires Casing
FMG28	Minga' Well	*Microcyclops varicans* (18) *Osctracoda (23)* *Nematoda sp. 14 (4) sent for further ID* *Phreodrilus peniculus* (3)	In good condition
FMG31	Malibu Bore	No invertebrates	Cased with PVC
FMG32	CB068	No invertebrates	Drill hole requires casing.

CALM provided an indication of species significance in context with other species recorded during the Pilbara Biological Survey. During the June survey a regional bore, away from the influence of the mine and dewatering drawdown (FMG26) yielded potentially two new species of *Paramelitidae*. The species has similarities to species collected at Weeli Wolli but with slight variations in telson. These samples have been sent for further DNA analysis. No other stygofauna species recorded were considered of significance, however *Parapseudoleptomesochra 'tureei'* has only been recorded at one other site in the Pilbara and *Strandesia* sp. 1 at two other sites in the Pilbara. The high levels of turbidity in FMG25, FMG27 and FMG32 due to lack of casings is likely to have resulted in no fauna being recorded at these bores. These bores will be cased if they continue to be used for ongoing monitoring.

4.7 SOCIAL AND ECONOMIC ENVIRONMENT

Environmental Resources Management undertook a socio-economic assessment of FMG's Stage A and B Projects (Environmental Resources Management, 2004). The social setting in which the Project will be developed is similar and described in Appendix H. A summary is provided below.

4.7.1 Demographics

The estimated resident population of the Pilbara region was 39,676 in 2001 which is around 2% of the State's population. The vast majority of Pilbara residents are located in the western third of the region, which includes the towns of Port Hedland/South Hedland, Karratha, Newman, Tom Price, Paraburdoo, Roebourne, Wickham, Dampier, Onslow and Marble Bar. The eastern portion of the region is largely desert, and home to a small number of indigenous people. The closest town to the Project Area is Newman, approximately 120 km to the south-east.

Port Hedland/South Hedland is one of the largest towns in the Pilbara and is a focus for major resources development in the region. Table 3 shows the key population characteristics for WA, the Pilbara region, and townsites relevant to this Project. The key conclusions to be drawn from Table 3 include:

- Port Hedland/South Hedland is the main centre of population in the region;
- the local communities adjacent to the Project have a higher proportion of males than females in the workforce, compared with the State average. This is common in the Pilbara and reflects the gender distribution of resource-oriented employment in the region;
- age profiles for the local communities generally reflect the State average with the exception that there are significantly less people aged over 65 years, and significantly more under the age of 15 years, and the median age is lower in Port Hedland and Newman;
- there is a significantly higher proportion of indigenous people living in Port Hedland and Newman than the State average; and
- household sizes are significantly larger in Port Hedland and Newman than elsewhere in the State.

Table 3. Population characteristics of WA, Pilbara and Local Communities, 2001

Characteristic	State of W.A	Pilbara Region	Combined LGAs [1]	Port Hedland[2]	Newman[3]
Total Population	1,851,252	39,676	19,855	13,099	3,535
Total Males (%)	50%	56%	57%	55%	54%
Total Females (%)	50%	44%	43%	45%	46%
Mean Household Size	2.6	2.9	3	3.6	3.4
Age Characteristics					
% Pop. aged < 15 yrs	21%	24%	24%	25%	28%
% Pop. aged > 15 yrs	79%	76%	76%	75%	72%
% Pop. aged > 65 yrs	11%	5%	4%	4%	3%
Median Age	34	31	32	30	30
Indigenous Population					
Total number	58,496	5,736	3,418	1,829	165
% of total population	3%	13%	17%	14%	5%

Source: ABS Basic Community Profiles, 2001

Notes:
1 includes the combined Local Government areas (LGAs) for Port Hedland and Shire of East Pilbara.
2 represents the Urban Centre Locality of Port Hedland as defined in the ABS Basic Community Profiles, 2001.
3 represents the Urban Centre Locality of Newman as defined in the ABS Basic Community Profiles, 2001.

Population in the Pilbara decreased during the early to mid- 1990s before stabilising in the mid- to late 1990s during a period of resource investment. The population declined again as world demand for resources slowed in the wake of the Asian financial crisis. Census data for 2001 does not clearly show to what extent the current investment cycle has reversed the decline in resident population.

Resource projects are the main economic and employment generators in the region. In 2001, nearly a quarter of Pilbara employment was in the mining sector. Resource projects naturally impact on the social profile and communities of the towns that support them. The cyclical nature of many of these resources projects (i.e. peak workforce during construction phase, and a much smaller workforce during operations) tends to lead to a corresponding fluctuating economy and transient population for the small towns that service these projects.

Further, many of these operations use a fly in-fly out (FIFO) regime from Perth which is not considered by the Pilbara Area Consultative Committee to benefit the towns in the region. These regimes are of concern to the Pilbara Development Commission and some local governments. FIFO operations are associated with adverse social impacts, such as alcoholism, depression, and stress, on both the workers and their families (Appendix H).

4.7.2 Amenity, Cultural Assets

The region's main towns contain basic cultural and recreational facilities, and residents have access to a range of sporting and recreational activities that are supported by local, regional and state agencies. The region is culturally and environmentally diverse, and is well known for its heritage assets. There are a variety of natural attractions in the region, including the Karijini and Millstream/Chichester National Parks and the Dampier Archipelago.

4.7.3 Native Title

The Project impacts upon, from east to west, the Nyiyaparli (WC99/4), Palyku (WC99/16) and Martu Idja Banyjima (WC98/62) Native Title claims. All of these Native Title claims are currently registered under the *Native Title Act 1993*. The Native Title claims collectively represent the Aboriginal Traditional Owners of the land over which FMG proposes to mine in the Project Area

FMG has signed Protocols with all of the above Native Title claimant groups. The Protocols have established the procedure by which Aboriginal Heritage surveys and Native Title negotiations are conducted between FMG and the affected Native Title claimant groups.

4.8 ABORIGINAL AND EUROPEAN HERITAGE

4.8.1 Prehistory

The Chichester Range, the Fortescue Plain and the Hamersley Plateau lie within the Australian Arid Zone. A great deal of archaeological research has focussed on the Australian Arid and Semi-arid Zones in an attempt to determine the nature and timing of Aboriginal occupation of the area.

Today the Arid Zone covers some 4,600,000 km^2, or 60% of Australia. Its extent and severity have changed over the past 50,000 years or so, in response to climatic fluctuations, particularly during the height of the last glaciation (LGM) at about 18,000 years before present (BP).

Settlement of the Arid Zone is dated to the Pleistocene-early Holocene era between 10,000 and 12,000 years ago. Recent excavations of rock shelters in the region have produced Pleistocene dates ranging from 18,000 BP to 26,000 BP, and have consequently revealed that the initial (Pleistocene) Aboriginal occupation of the Arid Zone occurred at around 26,000 to 22,000 years BP and was at a time of increasingly dry climate which reached its nadir at around 18,000 BP. The increased aridity during the last glaciation caused reductions in the availability of water and food resources, which forced the abandonment of many arid areas until conditions improved in the mid-Holocene.

The development of settlement/subsistence models of the region by archaeologists suggests that the archaeological signature of semi-arid and arid regions would, be characterised by:

- many small sites associated with ephemeral water sources;
- a smaller number of larger sites, adjacent to more permanent water; and
- special purpose, task specific sites, such as stone quarries, located where conditions permit, such as around outcrops of siliceous stone.

During the mid- to late Holocene, a number of indicators of Aboriginal intensification have been identified by archaeologists. These include;

- an increase in site usage;
- an increased rate of site establishment;
- the use of marginal environments;
- the introduction of new tool types;
- specialised seed grinding and water procurement;
- storage and conservation techniques;
- increased complexity of exchange programmes; and
- increasingly complex social and ceremonial organisation.

The valleys of the Chichester Range contain rock engravings. Similar engravings are found elsewhere in the Pilbara, notably on the Burrup Peninsula adjacent to the towns of Dampier and Karratha. The number of motifs varies from a few simple tracks to hundreds of often complex engravings. A range of motifs occurs, with tracks and human figures common, but depictions of animals and weapons also occur.

There are two approaches to dating engravings: relative or absolute. Relative dating methods include the analysis of superimposition, style, and weathering or patination. Available methods of absolute dating include the dating of engravings in stratified situations, historical data (e.g. contact subject matter), and weathering (e.g. micro-erosion analysis).

4.8.2 Aboriginal Mythology

All engravings, particularly the human figures as well as other designs are of current significance to the Aboriginal Traditional Owners, who believe that they represent the physical manifestations of the ancestral beings that roamed the earth before humans occupied the land.

Natural features, within the Chichester Range and the Fortescue Plain, such as the Fortescue Marshes, creeks, springs, claypans, rock holes and rock shelters are also believed, by the Aboriginal Traditional Owners, to be physical manifestations of the ancestral beings. Stories and songs are told today about the travels and exploits of the ancestral beings along the Dreaming Tracks which represent the pathways travelled in the Dreaming.

4.8.3 European Impact

The Aboriginal Traditional Owners lived in relative isolation until European settlers took up pastoral leases in the region in the late 1900s, displacing and indenturing Aboriginal people as seasonal labourers. Aboriginal men were employed as shepherds and station workers, while women were engaged as 'domestics' at station homesteads. They received food and provisions in return for their services. Notwithstanding this impact, the Aboriginal Traditional Owners maintained their connection to the country through ritual, and hunting and gathering activities.

Ration camps were established by the Government around the turn of the century, in order to care for those Aboriginal people who were not in the employ of the stations. Increasingly poor conditions on the stations resulted in a series of strikes by the Aboriginal workers in the 1940s. The movement known as ‘The Strike’ was led by Aboriginal people mainly in the Port Hedland and Marble Bar areas.

The downturn in wool prices coupled with increased costs and land degradation resulted in the displacement of many Aboriginal people from the pastoral stations in the 1950s and 1960s. The Government introduced assimilation policies at this time. Many of the Aboriginal Traditional Owners moved off the stations, some forcibly, into the towns of Port Hedland, Marble Bar and Nullagine, where they lived in camps and reserves on the outskirts of the towns.

The Aboriginal Traditional Owners had limited employment opportunities. However, despite the hardships, the sense of community remained strong. When mining was established in the region in the 1950s and 1960s, with gold, tin and asbestos being exploited, many of the Aboriginal Traditional Owners worked at ‘yandeeying’ tin in order to survive.

During this early mining boom, the mining companies and the Government of the day had little regard for the protection of cultural heritage, or for consultation with the Aboriginal Traditional Owners in the region. Large areas of land were bulldozed to enable construction of port facilities, railway lines, roads, and housing, the latter to house the workers who came in from Perth and the eastern states.

Prior to the advent of the *Native Title Act 1993*, the involvement of Aboriginal people in the protection of their cultural heritage in the region was minimal. Consultation with Aboriginal people was not an essential prerequisite for compliance with the *Aboriginal Heritage Act 1972*, and their involvement was a matter of negotiation. However, since Native Title claims were lodged post-1994, the Aboriginal Traditional Owners have had the right to demand to be involved in the management and protection of their cultural heritage and to seek compensation for any loss of their Native Title rights and interests.

4.8.4 Aboriginal Heritage Surveys

Aboriginal Heritage surveys of the proposed and current exploration programme, and proposed mine areas, commenced late in 2003 and are ongoing. All surveys will be completed prior to construction of the Project. These surveys will include the use of archival research; a formal field survey for Aboriginal ethnographic and archaeological sites; as well as consultation with the Aboriginal Traditional Owners as representatives of the affected Native Title claimant groups.

The archival research required for Aboriginal Heritage surveys, involves a search of the Register of Aboriginal Sites conducted at the Department of Indigenous Affairs (DIA). The search allows access to Aboriginal site files pertaining to previously recorded sites within the area, and heritage survey reports detailing previous heritage surveys conducted in the region.

The objectives of the archival research are to:

1. ensure that any previously recorded Aboriginal sites which may be located within, or in close proximity to the railway corridor and/or mines are identified in advance;
2. gain an appreciation of the type of Aboriginal sites previously recorded in the region, to provide an indication of the site types likely to be encountered during the surveys; and
3. gain an appreciation of site patterning throughout the region, to provide an indication of the general distribution of sites and identify areas of high and low potential for sites in the region.

On the basis of previous Aboriginal ethnographic and archaeological surveys conducted in the region and consultation with the Aboriginal Traditional Owners, a number of different types of Aboriginal sites is expected to be encountered. Definitions of these sites are as follows:

- Artefact scatter - refers to a location where a range of activities has occurred such as the manufacture and maintenance of tools, and the processing of foods. Such sites will often contain a wider range of lithic materials than quarries and knapping floors;

- Ceremonial - refers to a location where the Aboriginal Traditional Owners have practiced and/or continue to practice ceremonial activities;

- Gnamma hole/water source - refers to a natural or artificial rock cavity which holds water after rain or is linked to the water table;

- Grinding patches - refers to patches of smoothed rock of varying size. In the Pilbara region these are believed to be seed grinding patches. Elsewhere, though, they are linked to ceremonial practices. Grinding patches are frequently associated with engraving sites throughout the Pilbara;

- Midden - refers to a location usually on the coast or adjacent to a creek which contains the remains of shellfish and bone;

- Modified tree - refers to a tree, which has trunks and/or limbs that have been modified by the removal of bark and/or wood. Aboriginal people removed (and continue to remove) wood and bark for material items such as shields and baskets, or to access native honey inside hollows in the tree;

- Mythological - refers to a location which may be a natural feature, such as a hill or waterhole, which has a name, story and/or song about a particular ancestral being(s) known to the Aboriginal Traditional Owners and which is of current significance to them;

- Quarry - refers to a location from which stone used to manufacture flaked or ground stone artefacts has been extracted;

- Reduction area (or knapping floor) - refers to a cluster of stone artefacts, which represent the remains of an episode (or episodes) of stone artefact manufacture.. Artefacts within a knapping floor can usually be conjoined back together; and

- Rock art - refers to art placed on a rock surface that may be created by additive (such as painting or drawing) or subtractive (such as abrading or engraving) processes.

It is a requirement of the professional anthropological and archaeological organisations (Anthropological Society of Western Australia Inc., the Australian Anthropological Society Inc., and the Australian Association of Consulting Archaeologists Inc.) that Aboriginal Traditional Owners participate in Aboriginal Heritage surveys. This ensures that the views of the Aboriginal Traditional Owners concerning ethnographic and archaeological sites are adequately represented and recorded during the conduct of surveys. The Aboriginal Traditional Owners who have participated in surveys to date were previously chosen by their respective Native Title Working Groups at formal meetings.

To date, FMG has commissioned the Pilbara Native Title Services (PNTS) to undertake the following Aboriginal heritage surveys with regard to the Cloud Break proposal:

1. preliminary ethnographic survey (by helicopter) of the proposed mines and the southern portion of the railway corridor (Chichester Range to the proposed Mindy Mindy mine and the Mt Nicholas mines);

2. a consultation meeting with senior Traditional Owners to define the spatial boundaries of the Mankarlyirrkurra ethnographic site complex;

3. specific work programme clearance surveys (ethnographic and archaeological) of the proposed Cloud Break, exploration drilling and hydrological drilling areas at Cloud Break, plus various campsites, access tracks and laydown areas. These surveys are ongoing.

The results of the preliminary ethnographic survey, and subsequent consultation meeting with senior Traditional Owners, has revealed that there are several ethnographic sites of significance to the Aboriginal Traditional Owners which FMG has agreed to avoid and protect. The main site is Millimpirinyha (the Fortescue Marshes).

The results of the ongoing work programme clearance surveys have revealed that there are ethno-archaeological sites (mainly stone artefact scatters) in the region which are presently being avoided during FMG's exploratory drilling programme.

4.8.5 European Heritage

A review of the databases of the Australian Heritage Commission (AHC) and Heritage Council of Western Australia (HCWA) indicated there were no sites of European Heritage significance within or near FMG's Project Area.

5. PROJECT DESCRIPTION

5.1 KEY PROJECT CHARACTERISTICS

The following table identifies the key characteristics of the Project.

Table 4. Key Project Characteristics

Project Component	Characteristics
Construction period Project life Export tonnage	6-12 months, commencing Q1 in 2006 12 years 10 - 30 Mtpa[1]
Cloud Break Iron Ore Mine	
Estimated resource Ore type Target grade Method of mining Total area of disturbance over LOM Total area of rehabilitation over LOM Average size of working open pit Average pit depth Stripping ratio Overburden produced Processing requirements Dewatering Requirements	500-600 Mt Marra Mamba Iron Ore ~60% Fe Open Pit with back filling as far as practicable 5,500 ha 5,500 ha 475 ha Ranges from 0 m to 70 m based on current exploration results Average 4:1 over LOM 1,275 Mt over LOM (340 Mt in external areas; remainder placed in pit) Years 1-6: higher grade material, crushed and screened at Cloud Break. Years 7-12: beneficiation of lower grade material at Christmas Creek beneficiation plant (plant included in Stage B Project and therefore not part of this assessment) Dewatering will produce excess water which will be temporarily stored in ponds located in an area earmarked for mining for the first six years and then transported to Christmas Creek for use in the beneficiation plant
Infrastructure	
Power	Provided and maintained by third party supplier
Water	Water will be required for dust suppression and general potable uses. This will be sourced from dewatering of the pits. A Reverse Osmosis (RO) plant may be required if dewatering water is not of sufficient quality for potable use.. The saline waste water from the RO plant will be disposed of in the dewatering storage pond.
Roads	Haul roads and service roads required to link mine to crushing plant and rail loadout.
Sewage	Package treatment and/or septic systems

Project Component	Characteristics
Workforce (approximate peak levels)	
Construction Permanent Accommodation	400 400 Construction personnel accommodated in on-site facilities. Operational personnel accommodated in on-site facilities and in Newman.

Note:

1. FMG's Projects will produce 45 Mtpa ore, with production from Cloud Break varying between 10 – 30 Mtpa depending on mine scheduling.

Key:

Fe – iron
ha – hectare
LOM – Life of Mine
m – metre
Mpta – million tonnes per annum
Mt – million tonnes

The proposed Project layout is shown on Figure 2.

5.2 EVALUATION OF ALTERNATIVES

5.2.1 Site Selection

Mine site selection is largely dictated by the location of the deposit. However, at Cloud Break, locations of the permanent overburden placement areas, crushing and screening plant, and supporting infrastructure, have been designed to take into consideration environmental, Aboriginal Heritage and engineering constraints.

One of the main constraints considered was surface hydrology. For example, to minimise haulage distance, it was originally proposed to locate the starter overburden stockpiles as close as possible to the starter pit, without sterilising any future resources. However, at Cloud Break this would have impacted on areas that are dependent on surface water sheet-flow. As a result, these starter overburden stockpiles were located beyond the northern end of the proposed pits to minimise the potential impacts on the existing drainage patterns. The overburden placement areas will be contoured so they are incorporated into the surrounding topography where practicable. In years 1 to 6 when high grade material is mined, there will be no rejects to dispose of and therefore only overburden will be returned to the mined out areas. When a beneficiation plant is constructed at Christmas Creek (assessed as part of the Stage B Project and therefore not part of the Project), rejects will be placed in the mined-out open pits at that location.

5.2.2 Mining Methods

In the northern areas of the deposit, the mineralisation is relatively close to the surface and gently dips to the south, and for this reason the most appropriate mining method is considered to be open-cut mining. This style of mining has a number of options which include developing a large shallow open pit with large adjacent overburden stockpiles; or developing the pit progressively, where a starter pit is opened (with overburden from the starter pit placed in a smaller overburden stockpile), and then the open pit is progressively backfilled and rehabilitated as the mining face progresses.

Progressive backfilling was selected, as this option presents a cost effective method of backfilling the pit with overburden during the life of the mine. The total ground disturbance is minimised as large waste rock dumps are not required external to the pits. Superior progressive rehabilitation practices can be utilised, as, in one operation, topsoil can be removed ahead of mining and placed directly onto final contoured backfilled areas.

Backfilling an open pit with overburden at the end of the life of the mine is not economically feasible, and the remaining open voids and large overburden stockpiles present a much greater mine closure issue. Mine voids tend to act as sinks for rainfall, surface water runoff, and groundwater if the water table is intersected. This water can become hypersaline through evaporation in the arid Pilbara climate, and may adversely impact on the water quality of the local and regional groundwater. Hydrogeological issues are discussed in greater detail in Section 6.6. Geochemical processes such as Acid Rock Drainage (ARD) may also occur if reactive material is exposed in a pit void or overburden stockpile, although this is not expected to be an issue for FMG's mining areas (Section 6.10.2).

5.3 THE PROJECT AREA

FMG's Cloud Break deposit is located in the Chichester Ranges. 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. Other minerals present are kaolinite (representing alumina, less than 5%) and free matrix quartz (representing silica, less than 10%). Remaining minerals, within the unit, average less than 1% of the total measured material and include apatite (representing phosphorous, average of 0.05%) and sulphates (measured as elemental sulphur, average of 0.04%). Mined material will also contain up to 10% contained water. Cloud Break is considered to contain non-reactive mineralogy due to the geological conditions under which it has been formed.

The mining programme envisaged for Cloud Break allows for the contract mining of 20 Mt of a higher grade (Direct Ship) material in the first year; then 30Mt, 25Mt, 20Mt, 10Mt, 14Mt in years 2 to 6 respectively (Table 5). Lower grade material will also be mined and stockpiled at the minesite during the first six years, as this material will be located around the high grade areas. From years 6 to 12, low grade material will be sent to Christmas Creek for beneficiation. This will comprise both the low grade material that has been stockpiled at Cloud Break and material will be mined from Cloud Break in years 6 to 12.

In order to facilitate strict product standards, the Cloud Break deposits will be developed in parallel with FMG's other mining deposits (not part of this Project). This will permit FMG to better control the physical and chemical composition of the ore presenting to the beneficiation plant. Ore that does not achieve customer specifications will be stockpiled to maximise the reserve extraction and to allow blending over longer periods of time.

It is evident from drilling and mapping work conducted to date that the Marra Mamba iron ore mineralisation in the Chichester Ranges is sitting close to the surface with minimal overburden. This will result in comparatively low stripping ratios, which will reduce the overall mining cost, as the physical volume of overburden is low. This, in turn further minimises overburden management requirements (removal, transport and placement). The active pit will be kept as small as practicable within safety constraints to minimise the distance that overburden must be transported for backfilling.

5.3.1 Mining Methodology

The mining model being developed by FMG has benefited from knowledge generated under the exploration programme and earlier feasibility studies for the Stage B mines (not part of this Project). There is now strong evidence for the adoption of a number of low risk mining methods as described below. Figure 14 shows the conceptual mining method.

5.3.1.1 Overburden Management

Overburden is the material overlying the ore body, excluding vegetation and topsoil. Topsoil and vegetation from pre-stripping operations will be used in progressive rehabilitation activities. The overburden will be used during rehabilitation of the mine to construct the post-mining landform. Over the life of the mine, the pits will be backfilled to the extent of available material, to at least above the water table.

During the start-up phase for a new pit (typically one to two years), it will be necessary to place the overburden in a permanent storage area that is not situated within the mine pit area.

Following the start-up phase, the overburden will be placed in the mined-out sections of the pit. The time between commencement of mining in an area and placement of overburden within the mine path will vary depending on the resource depth and thickness. It has been estimated that at Cloud Break this will be about two years. Based on current exploration information and mine path design, it has been estimated that 340 Mt of overburden will be placed in permanent storage areas near the pits, covering 500 ha in total.

The final design and therefore height of the permanent storage areas will be based on the surrounding topography in the specific area. Where practicable, local features will be incorporated into the design of these areas. The overburden storage areas will be rehabilitated and revegetated as part of FMG's standard procedures.

5.3.1.2 20 Mtpa Start-up

The ramp up of the Cloud Break mining operation will see a gradual build up to full production over the first few years in conjunction with operations at Christmas Creek. While the deposit does outcrop in the northern part of the Project Area, these areas are defined by natural crests and valleys, with sheer drops in some locations. A lower risk option is to commence mining further south where the deposit is more consistent. This is considered to be the most likely scenario. Figure 15 shows the conceptual mine schedule.

The conventional truck and shovel mining method will transport ore to semi-mobile sizers a short distance from the operating face. This can be either within the pit or at a pit rim location. One-way haul distance is likely to be less than 2 km to optimise the number of trucks to the digging unit, and tonnes produced. One-way haul distance may be more depending on whether crushers are pit rim (base case) or in-pit (less flexibility and higher risk). Ore will then be conveyed to the crushing and screening plant.

The overburden will be a short haul from the mining face to the pit rim and in-pit placement that precede the ore mining operation.

To achieve the 20 Mtpa product rate by the end of the first year of operation, it is planned to utilise several active mining locations to access ore as soon as possible from mining areas. To maintain this rate of advance there will also be several digging units pre-stripping waste.

Table 5. Proposed Mining Schedule for High Grade Material
(subject to confirmation in Definitive Feasibility Study)

Volumes Mined (Mt)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
High grade material (no beneficiation required)		20	30	25	20	10	14
Low grade material stockpile (beneficiation required)		30	43	35	28	16	21
Waste mined	142	208	168	135	64	124	96

Production of high grade material from this mining scenario will be combined with production from the Christmas Creek mine. Based on the current mining schedule, the beneficiation plant will be constructed at Christmas Creek (not part of this assessment) in Year 7. The mining schedule is still to be confirmed during the definitive feasibility study. Low grade material that has been stockpiled and newly mined will be transported to Christmas Creek for processing at the rate of 23 Mtpa.

5.3.1.3 Bulk Mining

Face shovels are suited to mining a face height between 10 m and 18 m, depending on the size of the shovel. They can be utilised in ore or waste, but the material type must be continuous or dilution will occur. This will be considered for removing the overburden.

Another method may be used, in combination with face shovel, where dozers push overburden onto apron plate feeders, then the material is loaded onto a conveyor system and transported to the final placement area.

5.3.1.4 Selective Mining

Excavators are suited to mining a face height between 3 m and 5 m. They can be utilised in ore or waste. The excavator will be in the 360 tonne class matched to 220 tonne dump trucks.

The optimum method of loading a truck is for the excavator to sit on the top of the bench being mined and load the trucks running on the bench below. The excavator can mine selectively if required, but at increased cost and reduced productivity.

Surface miners are being considered as an alternative method to operate in the narrower ore zones. These machines can cut to an accuracy of 0.1 metres and have the additional benefits of no drill and blast, or primary crushing requirements. Ore can be loaded directly to a dump truck.

There are three proposed methods of transferring ore from the mining face to final destination:

1. excavator and truck to load directly into large dump trucks (traditional method);
2. excavator and an in-pit crusher or sizer. Excavators will load directly into the hopper of a mobile crushing unit to then feed a conveyor system; and
3. surface miner and truck to load directly to conveyer loading points.

Excavator and Truck

This is the traditional method of operation. The excavator must be presented with continuous faces of the same material type (ore or overburden): otherwise contamination will occur. The bench height should be not less than 5 metres. A face height between 5 and 10 meters is considered sub-optimal, but could be mined economically. Less than 5 meters would create productivity issues resulting in a higher operating cost, depending on the start-up area. This approach is not considered ideal for ore mining due to the lack of continuity and thickness of the ore seams.

Excavator and Crusher/Sizer

With the advent of mobile sizers capable of high throughputs, the matching of an excavator and sizer is now possible. The constraints on the face height and material continuity are the same as for the excavator and truck outlined above. There is a slight decrease in cycle times as the hopper is in the same location each pass, allowing the operator to maintain a smoother loading cycle. Around 30 seconds is the nominal cycle time. The sizer will need to be moved a few times per shift depending on the horizontal advance of the excavator. Horizontal advance is mainly a function of face height.

Surface Miners

Surface miners are based on modified versions of road planers used in road construction. These machines are used widely in coal/lignite, gypsum and limestone applications around the world, particularly in parts of Europe and in India. They offer a number of advantages, most notably in being able to mine selectively. Wirtgen surface miners can feed cut material directly into haul trucks, reducing on-site requirements for loading tools. Because the material is cut, it does not have to be reduced in size by a primary crusher. At the same time, the machines leave an even floor behind the cut area, so that haul equipment can be used behind the advancing ore faces without concerns over potential loss of traction or tyre wear. Loading is by integrated conveyor directly into trucks.

5.3.1.5 Crushing/Sizing

There are three options for the use of a crusher/sizer and conveyor system:

1. in-pit crushing and sizing whereby the loading unit can load directly into a mobile crusher/sizer at all times;
2. fewer semi-mobile sizers that the dump trucks can load into. These sizers would be either on the pit floor or on the pit rim; and
3. primary crushers are not required for surface miners.

For the first option, each loading unit will have a dedicated sizer and conveyor system feeding a main conveyor. The crusher and sizers can be located back from the face or on the pit rim. High grade material and beneficiable material would be delivered separately on the conveyor to either the crusher/sizer, or to a beneficiable material stockpile as mining encountered different ore types. Dump trucks would haul to the crushers or loading points. The pit-rim crushers can be more robust than the smaller, more mobile direct feed sizers.

5.3.2 Backfilling Pits

Overburden and waste rock will be used to infill the open cut pits created during the mining process. Initial calculations have been undertaken to determine the amount of material that will be available for infilling, and therefore the extent of final void that will remain at any given area. Estimates of the waste to ore strip ratio have been made based on available data. It should be noted that the strip ratio will vary with time and across the mines. However, it has been assumed that the initial strip ratio will be in the range 3.5 to 4.5 and the strip ratio in final years will be approximately 6 units of waste to 1 unit of ore.

When material is removed during mining it expands as it is broken up, and air spaces form between the particles (this is known as a bulking factor). The bulking factor will vary from material to material with wet sand expanding by approximately 20%, and slate expanding by approximately 85% (Berkman, 1995).

To determine the material available for infilling, the following assumptions have been made:

- a bulking factor of 65% for overburden based on data from Berkman (1995);
- the stripping ratios (waste:ore) for years 1 to 6 vary from 3.5 to 4.5; and
- overburden from the first two years of operation will be placed in permanent storage areas not located within the mining area.

It is likely that the combined life of the pits will be approximately 12 years. Based on this pit life and the external overburden placement in the first two years, it can be estimated that there will be a volume surplus of 14% of material to be placed within the mined out pits. The additional waste material will be contoured in keeping with the original contours.

Where practicable the overburden from the next pit, that is developed, will be returned to the previous pit for infilling. Eventually as the final pit is completed a reasonably small excess will remain. This can be minimised by scaling back production operations in order to reduce operating area requirements on the pit floor, and move the advancing overburden placement closer to the mining face. The final excess will be above the water table and will be designed to resemble the surrounding topography as closely as practicable. 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.

5.3.3 Ore Transport from Mine

The high grade material will be loaded into 300 t road trains, and transported to the crushing and screening plant ahead of the rail loadout location. Appropriate moisture content management will be applied to minimise dust generation during transport and at the Port.

Low grade material requiring beneficiation will be initially stockpiled and then transported by rail to the beneficiation plant at Christmas Creek. In later years, beneficiated material will be blended with high grade material for transport by rail to Port Hedland to produce a product consistent with customer demands..

5.3.3.1 Beneficiation

It is proposed that initial mining at Cloud Break will target high grade material which will be crushed and screened to lump and fines size ranges. This material, which will not require beneficiation, will be loaded onto a railway transport system and taken to Port Hedland for ship loading.

Low grade material will be stockpiled at Cloud Break until a beneficiation plant is constructed at the Christmas Creek Mine as part of the Stage B Project. The low grade material will then be reclaimed from the stockpile and transported by rail to the beneficiation plant for processing.

The Stage B beneficiation plant will consist of:

- primary crushed ore stockpile - the conveyor from the primary crusher will feed into a buffer stockpile through a stacker. Feeders will extract the ore from under the stockpile for delivery to the secondary screening and crushing plant;

- secondary crushing and screening facilities - this facility will consist of screens and crushers connected by belt conveyors, which will recycle the oversize ores from the screens to the secondary crushers, and back to the screens;

- beneficiation modules - modules will include dry screening, wet screening, jigs, cyclones and thickeners to treat a variety of ore types (ENVIRON, 2005a).

Both the beneficiation plant located at Christmas Creek, and the railway for transport of ore to the beneficiation plant, have been assessed as part of the Stage B Project, and are therefore not part of the Project. Beneficiation of low grade material from Cloud Break, and therefore management of the rejects, will be undertaken as part of the Stage B Project. Water for beneficiation will also be provided as part of the Stage B Project, and has therefore not been included in the water requirement for the Project.

5.3.3.2 Ancillary Equipment

It is planned to utilise a standard fleet of ancillary equipment typical to an iron ore mining operation. This includes large dozers, front end loaders, medium to large diameter rotary drills, large graders, large capacity service, and fuel trucks and water carts.

5.3.3.3 Dewatering and Waste Water Control

The initial year of mining will be conducted in dry ground conditions. As the faces progress in a southerly direction, it is expected that groundwater will be encountered at approximately 400 mRL. Initially the groundwater is expected to be relatively fresh with Total Dissolved Solids (TDS) in the range of 1,000 to 3,000 mg/L. Water will be drained ahead of the advancing mining faces via the use of dewatering bores. The dewatering water will be used in the pit as a dust suppressant and pumped to the Crushing and Screening Plant at Cloud Break. After Year 3, dewatering volumes will exceed what the Project can use and will need to be disposed of. Water is also likely to become more saline as the Project progresses. It is proposed to store excess water in Minned out pits in areas that will be, or have been, disturbed for mining. However, the options of aquifer re-injection and in-pit disposal will be investigated further and are discussed in more detail in Section 6.6.2.

The water requirement of the Cloud Break Mine is estimated to be 1.3 to 2.7 GLpa in the first three years and continuing at 2.7 GLpa for life of mine. Investigations have demonstrated that sufficient water will be available for the Project’s non-potable water requirements from dewatering operations. Depending on the quality of the water an RO plant may be required to treat dewatering water for potable use. The saline waste water from the RO plant would be disposed of in the dewatering storage pond.

5.3.4 Power Supply

The power requirements for mining, processing and support facilities will be provided and maintained by a third party supplier. These providers will submit separate environmental proposals if gas pipelines and/or transmission lines are to be used. The Cloud Break power supply will form part of the 45 MW proposed in the Stage B PER.

Options under consideration for the Project and the Stage B Project include:

- a gas-fired power station, in an N+1 configuration (see footnote [1]), using gas supplied from the existing Onslow to Kalgoorlie gas pipeline operated by Goldfields Gas Transmission Company. The gas will be supplied from a new line to be constructed with the take-off located near the existing Newman Power Station takeoff;
- the existing Newman Power Station via a 132 kV overhead power line to the Chichester mine site(s). Alinta has provided a proposal whereby it would provide and own the transmission line and associated substations, with the point of supply being the 33 kV supply point at the mine site(s) HV substation.

5.3.5 Construction Activities

Construction of the Project will follow the sequence and management measures outlined in Table 6.

Table 6. Sequence of Construction

Construction Activity	Description
Detailed surveying	Engineering, environmental, community, archaeological and anthropological studies are used to determine areas which should be avoided, or which would require any special construction techniques or mitigation measures. A detailed survey of the Project layout will be undertaken to identify and locate special management areas.
Clear and grubbing	Front end loaders, graders, bulldozers and scrapers are used to progressively clear the mine pit, overburden and rejects storage, access roads and plant site footprint ready for construction to commence. During this process, sites of heritage significance and environmental sensitivity are fenced off, and topsoil and vegetation removed and stored separately for use during rehabilitation.
Temporary facilities	Temporary facilities will include accommodation facilities, offices, laydown areas, ablution facilities, mobile workshops, etc. Many of these facilities will be used repeatedly by the different contractors on site as the construction project progresses, and will be located in already disturbed areas where practicable.
Borrow pits	Borrow pits will be required to supply suitable construction material to raise and develop the foundation of haul roads, stock yard, ore crushing, screening and handling facilities, administration buildings and product conveyor etc. Borrow pits will be preferably located in areas designated for pit and over- burden stockpile locations, and will be temporarily rehabilitated (to a stable land form that is erosion resistant) if not immediately required during mining.
Bulk earthworks	Once initial clearing and grubbing has been completed, heavy earthmoving equipment such as graders, front end loaders, bulldozers, scrapers, dump trucks, water carts, compact rollers and loaders will be utilised in the construction of the foundation for the stockpiles, ore handling facilities, product conveyor and commencement of the mine pit.

[1] An N+1 configuration indicates sufficient power turbines for target power production plus one extra turbine for standby (in case of maintenance or failure of other turbines).

Construction Activity	Description
Pit preparation and initial mining	Overburden from the pits will also be used where practicable in site preparation works to minimise the need for additional borrow pits. In addition, initial pit development and ore extraction will commence, to develop Run of Mine (ROM) and ore stockpiles ready for plant commissioning and the first shipment of ore.
Foundations	Foundations require the excavation of the footings and the placement of reinforced concrete to form the foundations. Concrete will be sourced from a temporary batching plant located on site.
Structural steel erection	Structural steel erection comprises the construction of the primary and secondary crushing facilities, screens, overland conveyors, stacker and reclaimer beds, and train loader. Wherever structural erection can be prefabricated off-site, this will be undertaken to speed the process of on-site erection and minimise on-site disturbance.
Machinery (i.e. stackers and reclaimer)	Similar to the structural erection of the support facilities, wherever practicable the ore handling machinery will be prefabricated off-site and then pieced together on-site to speed up the process of erection and minimise on-site disturbance.
Services	Power, lighting, communications and water services will be developed progressively throughout the mine site construction phase.
Administrative and support buildings	Administrative buildings, control rooms, accommodation facilities and support buildings, such as amenities and ablution facilities, will be constructed progressively. With the exception of the accommodation facilities, the remaining facilities will be grouped and located as a central administrative hub, close to the centre of operations while maintaining a safe working distance from the pits.
Commissioning	Commissioning will comprise no-load commissioning of all machines, pumps, motors and support equipment without ore. Subsequently, load commissioning will be undertaken where all machinery and equipment is run under pressure/ load.
Demobilisation of construction crew, clean-up, rehabilitation and monitoring	Prior to departure, the supervising engineers will retain a small team of construction equipment and contractors to undertake final rehabilitation works including: • demobilising construction equipment and temporary facilities; • removing overburden and undertaking rehabilitation of any disturbed areas not required as part of operations. The ‘construction site’ will then be handed to the mining contractors for active operations and further mine development.

5.4 GENERAL

5.4.1 Ancillary Services

Potable water is likely to be provided from the dewatering bores in combination with a Reverse Osmosis (RO) plant. A dedicated potable water borefield may also be considered if water from dewatering becomes too saline. At the accommodation facilities, control rooms and maintenance facilities, packaged sewage treatment plants or septic systems will be installed.

The siting of temporary facilities required during construction will take into consideration the location of:

- significant flora populations or vegetation communities;
- significant fauna habitats or Threatened Fauna populations;
- sites of Aboriginal Heritage significance;
- proximity to water supplies;
- topographic constraints and potential impacts on the surface hydrology of the site; and
- areas prone to flooding.

Existing areas of disturbance will be used, if practicable, to minimise the extent of clearing required for temporary facilities.

5.4.2 Dangerous Goods

There will be two types of dangerous goods on the mine sites:

- hydrocarbons - including oils, greases, fuels (petrol and diesel), degreaser, and kerosene; and
- explosives - ammonium nitrate fuel oil (ANFO) and waterproof emulsions used as blasting agents.

Dangerous Goods will be stored and used in compliance with relevant legislation and standards (e.g. *Explosives and Dangerous Goods Act 1961* (soon to be updated), and Australian Standard AS 1940-1993 for the Storage and Handling of Flammable and Combustible Liquids. Bulk hydrocarbons will be stored in tanks within bunds which meet AS 1940.

On each site where hydrocarbons are stored or used, spill kits will be available and spill response plans formulated. Collection and disposal of hydrocarbon wastes, from maintenance facilities, will be based on the waste management regulations. A bio-remediation facility will be established on the mine sites for treatment of oily waste. All staff will be trained in the use of spill and cleanup equipment, and all relevant incident reporting procedures.

Train refuelling will be undertaken at the Port (as part of the Stage A Project) and, therefore, it is unlikely that operational activities will require the presence of any significant volume of dangerous or hazardous substances to be either stored or used on site, other than fuel for the mining fleet. All diesel storage vessels and facilities will be constructed and operated in compliance with relevant legislation and standards including the *Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations 1992*.

An explosives storage facility will be constructed with appropriate exclusion areas from other infrastructure, and in accordance with the relevant regulations.

5.4.3 General Waste Management

General waste management at the mine sites will be along the principles of:

1. Avoid - reduce the amount of waste generated at the site;
2. Re-use - re-use waste products without substantially changing their form;
3. Recycle - treat waste that is no longer useable in its present form and use the treated waste to produce new products;
4. Energy Recovery - adopt management practices that recover and use energy generated from waste;
5. Treatment and/or Disposal - adopt management practices that reduce the potential for environmental harm by appropriately disposing of waste, or treating and disposing of waste.

Waste that cannot be reused or recycled will be disposed of in landfill facilities, in accordance with relevant legislation and standards.

An education programme will be delivered to the workforce to raise awareness of waste management to help reduce waste generation and encourage reuse and recycling.

5.4.4 Fire Management

Fires are part of the natural Pilbara landscape as a result of lightning strikes (particularly during summer) and Aboriginal land management practices. The spinifex grasslands and Mulga stands are particularly prone to wildfires. Severe damage to the environment can occur when the frequency of fires is too high, fires are too hot, or fires are lit with the intent of causing damage to the environment and property, or as a result of negligence.

Generally, the common causes of fires at mines are:

- electricity - use or misuse of electricity on battery locomotives, power cables, trolley wires, motors, electric heaters and even light bulbs;
- deliberate or accidental activities - welding, burning, smoking, blasting operations, or accidental leakage of petroleum products on hot machinery;
- spontaneous combustion - when ventilation is not sufficient to carry away the heat of oxidation, e.g. slow oxidation of a pile of oily rags, old timber, enough heat can be generated for the material to spontaneously ignite;

- friction - such as that caused by overheating of brake bands, clutches, transmission gear boxes, and v-belt drives on equipment, vehicles and conveyors.

Construction activities can increase the risk of fire, particularly if there are inadequate fire protection measures in place (such as buffer zones free of vegetation around welding areas), or the workforce does not take appropriate care to prevent fires. FMG will prepare and implement a Fire Management Plan that will include work procedures for all welding and grinding work, personnel fire hazard procedures, fire response vehicles on site, and bushfire contingency for the life of the Project. FMG will use best practice spark suppression systems to reduce fire risk.

The construction and operational workforce will undergo Environmental Awareness training that will include fire protection and prevention measures, such as safe operating and waste disposal practices and restricted clearing within high fire risk areas.

5.4.5 Workforce and Accommodation

5.4.5.1 Construction

Accommodation facilities for the mine site construction workforce will be built adjacent to the proposed mine site. To provide permanent contractor accommodation, the facilities will be upgraded for administration, operations and maintenance personnel as construction work is completed.

Permanent common use buildings will generally be constructed of higher grade materials, whereas accommodation facilities will be transportable. The facilities will include their own sewage plant, and the treated grey water will be utilised for garden watering and dust suppression, within health standard requirements.

5.4.5.2 Operations

Operational personnel will be housed on-site during rostered days on, and in Newman on rostered days off. Mine contractor personnel will be employed as fly-in/fly-out (FIFO) but will be encouraged to be based in Newman. An airstrip will be constructed at Cloud Break and the disturbance has been calculated into the overall Project disturbance. The location of the airstrip is shown in Figure 2.

5.4.6 Access and Stock Management

Access will be via a road along the Newman-Port Hedland Highway, maintained by the Ashburton Shire or East Pilbara Shire, and then eastwards along a new track or upgraded pastoral track.

Some of these roads are subject to inundation for short periods in wet weather. The site access roads from Newman will be upgraded to enable access for personnel, equipment and materials to the mine sites. The roads not currently maintained by the Shire will be maintained by FMG.

Access roads will be constructed to enable access to the support infrastructure associated with the mine site.

Three major types of roads will be constructed:

1. general traffic roads - these roads, including mine general traffic roads, will connect the site access road and the operational centres (e.g. administration building, and accommodation at the site). These roads will be unsealed and built to a minimum width of approximately 7 m.

2. ore truck and mine access roads - these roads within the mine are to provide the safe passing of the ore trucks, and will be around 28 m wide. Roads without passing ore trucks will be about 12 m wide. All these roads will be unsealed and dust generation will be controlled by water trucks and/or alternative dust suppressant measures.

3. conveyor access tracks - these tracks will be used for maintenance vehicles to access to the conveyor. These will be unsealed and around 7 m wide.

These roads have been designed to minimise disruption to overland surface water flow.

An investigation will be undertaken into the existing airstrip at Cloud Break to determine whether it is suitable for daily plane flights for contractor FIFO personnel and emergency evacuations. If this strip is not suitable, it may be upgraded or a new airstrip may be constructed.

To reach an appropriate outcome, FMG will liaise with affected land holders regarding impacts on land access and land use. Management measures may include additional fencing and gates, cattle crossings, and land use agreements.

FMG will maintain all access roads constructed for the Project in a safe condition, and will contribute to the Shire maintenance programme for public roads leading to the Project Area.

In maintaining these roads, FMG will ensure that adverse hydrological impacts do not result following grading.

5.4.7 Inspection, Maintenance and Monitoring

FMG will manage the mine to ensure there are no unacceptable impacts on the environment as a result of its operations. Ongoing monitoring and community consultation will enable FMG to evaluate and modify its management measures.

Inspection work (both aerial and ground patrolling) associated with the mine will be conducted in accordance with all statutory requirements and the specific operator's inspection and maintenance programme developed for this Project. Inspection patrols will be scheduled on a regular basis and will be used to detect potential erosion areas, monitor sheet-flow management measures, weed germination or other conditions potentially requiring possible remedial measures.

Liaison with land holders will be maintained to ensure that they remain aware of the restrictions on working in the vicinity of the mine site and to gather early warning of any of their activities that may affect the Project.

Field operators will undertake regular inspections and maintain ongoing liaison with the community, pastoralists, tenement holders and other stakeholders. They will respond to maintenance requirements such as road repairs, erosion, noise, dust and weed control.

A comprehensive environmental monitoring programme will be developed in the Environmental Management Plan (EMP) and implemented prior to construction of the mine. The draft Construction EMP is presented as Appendix I. The general strategy will be to delineate those areas in the Project Area that are ecologically sensitive, and minimise disturbance as far as practicable. Monitoring frequency will vary with the sensitivity of the environment and will be detailed in the EMP.

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6. ENVIRONMENTAL IMPACTS AND MANAGEMENT STRATEGIES

6.1 ENVIRONMENTAL PROTECTION

6.1.1 Principles of Environmental Protection

The *Environmental Protection Act 1986* was amended in 2003 to include the Objectives and Principles of the Act as follows:

- precautionary principle;
- principle of intergenerational equity;
- principle of the conservation of biological diversity and ecological integrity;
- principles relating to improved valuation, pricing and incentive mechanisms; and
- principle of waste minimisation.

FMG will consider these Principles in designing, constructing, operating and decommissioning the Project. Some of the ways in which this will be achieved are outlined below.

6.1.1.1 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:

- *Careful evaluation to avoid, where practicable serious or irreversible damage to the environment; and*
- *An assessment of the risk-weighted consequences of various options."*

Prior to construction and operation of a project, a proponent can rarely be certain of all the potential impacts. The various baseline and impact assessments undertaken for the Project on the key environmental factors (Section 6.1.3) reduce this uncertainty, although management decisions must still consider the precautionary principle. Some examples of where this has been applied during the design phase of the Project are:

- the Risk Assessment of surface water and groundwater impacts on the Fortescue Marshes and refinement of the Project design based on these outcomes of the assessment (Sections 6.5.4 and 6.6.4);

- proposed management of dewatering discharge to ensure the worst case scenario can be managed (Section 6.6.2);
- design of the groundwater abstraction monitoring programme to allow early detection of adverse impacts on phreatophytic (groundwater dependent) ecosystems and implementation of measures to avoid deterioration of vegetation condition (Section 6.6.1);
- designated ‘no-go’ areas where there is a risk of impacting on Threatened Fauna (Section 6.3);
- species-specific monitoring and management plans (Section 6.3); and
- surface water distribution systems designed to ensure downstream ecosystems dependent on surface water sheet-flow are not adversely affected (Section 6.5).

6.1.1.2 Principle of 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.”

If not appropriately managed, the Project has the potential to result in impacts with adverse long-term consequences. Consideration of these impacts on future generations is therefore important.

FMG will be mining a finite resource which will require the disturbance of approximately 5,500 ha of native vegetation. It is acknowledged that both the geological formations being mined, and the overlying ecosystems, were formed over geological time. FMG has prepared a draft Rehabilitation and Revegetation Management Plan (Appendix J) which outlines the processes and strategies to progressively backfill and rehabilitate mined-out areas throughout the life of the Project. The aim of rehabilitation will be to create similar landforms, that support self-sustaining ecosystems comprising similar flora, vegetation associations and fauna species, to what was present prior to mining. The draft Rehabilitation and Revegetation Management Plan includes monitoring and a reporting programme to assess rehabilitation effectiveness against set closure criteria. Closure criteria for the rehabilitation and revegetation of mined areas will be discussed and agreed with the Regulators.

Management of other issues such as groundwater (Section 6.6), surface water (Section 6.5), weeds (Section 6.2.4) and Greenhouse Gases (Section 6.7) will be undertaken through the development of management plans. FMG will also consider potential long-term impacts from these issues, and how they can be avoided or managed to ensure environmentally sustainable outcomes.

FMG believes that by implementing the proposed management measures outlined in this document, the Construction EMP and the draft Rehabilitation and Revegetation Management Plan, it can develop the Project whilst ensuring that the health, diversity and productivity of the environment is maintained, or enhanced, for the benefit of future generations once mining of the Project is complete.

6.1.1.3 Principle of the Conservation of Biological Diversity and Ecological Integrity

> *"Conservation of biological diversity and ecological integrity should be a fundamental consideration."*

As noted above, approximately 5,500 ha of native vegetation and associated fauna habitats will be progressively disturbed over the life of the Project (i.e. over 12 years). There is also the risk of indirect impacts if appropriate management measures are not applied.

Biological diversity is considered at three levels:

- genetic diversity;
- species diversity; and
- ecosystem diversity (EPA, 2004).

Restriction (either in numbers, location and/or aerial extent) or a 'unique' or 'unusual' characteristic of any individual genetic makeup, species or ecosystem type, may make it more vulnerable to natural and anthropogenic threats. This genetic makeup, species or ecosystem type may therefore be considered of higher conservation value and should be afforded greater protection.

Ecological integrity refers to how well an ecosystem and its components function, and is the result of a delicate balance of numerous factors. Much of the area in which the Project is located has been affected by historic grazing activities, changes to fire regimes and recent drought.

FMG has undertaken baseline flora (Section 4.6.1) and fauna surveys (Sections 4.6.2 and 4.6.3) to gain an understanding of the biological diversity and ecological integrity of the Project and surrounding areas. While mining will affect targeted areas, FMG has committed to avoiding areas of high conservation significance and/or implementing special management measures. These measures offer protection of the Night Parrot and Bilby (Section 6.3), migratory bird species (Section 6.9.3) and the Fortescue Marshes (Sections 6.5.4 and 6.6.4). Implementation of the proposed Rehabilitation and Revegetation Management Plan (Appendix J) will ensure that over the life of the Project that biological diversity and ecological integrity will be progressively restored on completion of mining.

6.1.1.4 Principle Relating to Improved Valuation, Pricing and Incentive 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 incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems."*

Environmental management costs associated with the Project (including pollution control, waste minimisation and management, and rehabilitation and revegetation) during construction, operation and post-closure have been taken into consideration in the planning and financing of the Project.

FMG will take into account the life cycle costs of goods and services by providing for the recycling of waste where practicable, and the cost of waste management or disposal where recycling is not practicable.

FMG will establish cost-effective mechanisms to achieve its environmental goals for its projects. This may include incentives for environmental performance, research into the most effective ways (both environmentally and cost-wise) of achieving environmental goals, and encouraging employees, contractors and community to put forward innovative ideas to achieve these environmental goals.

6.1.1.5 Principle of Waste Minimisation

> *"All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge to the environment."*

Waste produced by the Project will be managed according to the following hierarchy in order to minimise waste and its discharge to the environment:

1. avoid creating waste;
2. re-use waste;
3. recycle waste;
4. recover energy from waste; and
5. treat and/or dispose of waste.

In selection of suppliers and materials for use in the Project, FMG will consider the life cycle of materials and products used, and how these are treated at the end of their useful life.

Specific waste management measures have been developed for the Project and are addressed in detail in Section 6.10. Management of water from pit dewatering is addressed in Section 6.6.2, potential generation of acid mine drainage is addressed in Section 6.10.2 and Greenhouse Gas emissions are discussed in Section 6.7.

6.1.2 Environmental Management System

FMG is currently developing an Environmental Management System (EMS) for all of its operations in the Pilbara. The Project will be addressed within the EMS and Environmental Management Plans (EMPs) will be developed and implemented for the construction and operation stages of the Project. The objective of the EMPs is to provide a working manual which will include specific procedures to eliminate or minimise the impact on the environment. The EMPs will identify the following:

- issues of concern;
- environmental objectives;
- proposed management techniques;
- proposed monitoring programmes;
- key performance indicators and completion criteria; and
- reporting requirements.

FMG has prepared the following EMPs for the Project which are presented with this document:

- Draft Construction EMP (Appendix I);
- Draft Rehabilitation and Revegetation Management Plan (Appendix J);
- Subterranean Fauna Management Plan (Appendix K); and
- Conceptual Mine Closure Plan (Appendix M).

6.1.3 Key Environmental Factors

The key environmental factors identified for this Project (ENVIRON, 2005b) are:

- biodiversity;
- sustainability;
- future conservation estate;
- terrestrial flora and vegetation;
- Declared Rare and Priority Flora;
- terrestrial fauna;
- Specially Protected (Threatened) Fauna;
- stygofauna;
- water courses and wetlands, in particular the Fortescue Marshes;
- groundwater (mine dewatering and water supply);
- Greenhouse Gas emissions;
- dust emissions - construction and operations;
- noise;
- waste management, including waste rock;
- acid mine drainage;
- decommissioning and rehabilitation;
- Aboriginal culture and heritage; and
- economic and social impacts.

The potential issues associated with these factors and proposed management measures are addressed in Sections 6.2 – 6.14.

There are a number of currently operating and proposed iron ore mines in the east Pilbara region and the assessment of the Project has considered the potential cumulative impacts of this Project and other mines in the same region. In particular FMG recognises the potential cumulative impacts of its Stage B mines already proposed in the foothills of the eastern end of the Chichester Ranges, and the Cloud Break Mine, located further west in the foothills of the Ranges. Management of cumulative impacts are addressed in Section 6.14.

6.2 FLORA AND VEGETATION

The EPA's objectives with regards to flora, vegetation and biodiversity in general are:

- *to avoid adverse impacts on biological diversity, comprising the different plants and animals and the ecosystem they form, at the levels of genetic, species and ecosystem diversity;*
- *to avoid, minimise, mitigate and offset direct and indirect impacts on the critical values of the Mulga woodlands (Chichester Ranges foot-slopes) and the Fortescue Marshes;*
- *maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities;*
- *protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950; and*
- *protect other flora species of conservation significance.*

The significance of an ecological impact is dependent on the status of conservation or reservation of the vegetation types and individual flora species potentially affected. It is also dependent on the intensity, nature and duration of the impact. Significant terrestrial vegetation and flora within the Project Area have been identified in Section 4.6.1 by a qualified botanist experienced in the Pilbara region (Mattiske Consulting).

The Project Area does not contain any Threatened Ecological Communities pursuant to Schedule 2 of the *EPBC Act 1999*,or identified as Threatened in English and Blyth (1997). However, there are a number of plant communities that are locally or regionally significant, some of which occur within the Project Area (Table 7).

Table 7. Locally and Regionally Significant Vegetation Communities within the Project

Plant Community Mapping Code (Mattiske Consulting)	Locally significant	Regionally significant
2. Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura, A. citrinoviridis, A. pruinocarpa* over *. tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax, Stemodia viscosa, Blumea tenella, Themeda triandra* and species of *Triodia* and *Aristida*	✓ Supports *Eremophila spongiocarpa* (ms) (Priority 1) Mulga on edge of main distribution	-
3. Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura, A. pruinocarpa, A. tetragonophylla, A. tenuissima, Grevillea wickhamii* subsp. *aprica, Psydrax latifolia* over *Dodonaea petiolaris* and species of *Triodia* and *Aristida*	✓ Mulga on edge of main distribution	-
4. Low Open Woodland of *Acacia aneur*a var. *aneura, A. pruinocarpa, A. xiphophylla, A. victoriae* over *A. tetragonophylla, Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* var. *obovatus* and mixed Chenopod species of *Maireana* and *Sclerolaena*	✓ Supports *Rostellularia adscendens* var. *latifolia* (Priority 3)	-
5. Low Woodland of *Acacia aneur*a var. *aneura, A.. pruinocarpa* over *A. tetragonophylla, Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* var. *obovatus* and mixed Chenopod and Poaceae species	✓ Supports *Rostellularia adscendens* var. *latifolia* (Priority 3) Mulga on edge of main distribution	-
6. Low Woodland of *Acacia aneur*a var. *aneura, A. pruinocarpa* over *A. tetragonophylla, Psydrax latifolia* and *P. suaveolens* over *Ptilotus obovatus* var. *obovatus and Triodia epactia* and Poaceae species.	✓ Mulga on edge of main distribution	-
9. Closed Scrub to Shrubland of *Acacia ancistrocarpa, A. maitlandii, A. kempeana, A. monticola* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Senna* species, *Triodia basedowii* and *Aristida* species.	✓ Supports *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) PN (Priority 3)	-
10. Low Open Woodland of *Acacia xiphophylla, Acacia victoriae, A. aneura* var. *aneura* over *A. tetragonophylla, Ptilotus obovatus* var. *obovatus, Senna* species and mixed Chenopod species of *Maireana* and *Sclerolaena.*	✓ Supports *Eremophila youngii* subsp. *lepidola* ms (Priority 4)	-
11. Hummock Grassland of *Triodia angusta* with patches of *Acacia victoriae, A. aneura* var. *aneura, A. xiphophylla* over *Atriplex codonocarpa, Eremophila cuneifolia* and mixed Chenopods.	-	✓ Occurs on fringes of Fortescue Marsh
12. Low Halophytic Shrubland of *Halosarcia auriculata* and *H. indica* subsp. *leiostachya* with associated Chenopod species of *Maireana* species and *Atriplex flabelliformis* with *Muehlenbeckia florulenta* with patches of *Acacia victoriae* and *Acacia sclerosperma* subsp*. sclerosperma.*	-	✓ Occurs on fringes of Fortescue Marsh
13. Low Halophytic Shrubland of *Halosarcia auriculata, H. indica* subsp. *leiostachya, H. halocnemoides* subsp*. tenuis* with patches of *Frankenia* species.	-	✓ Occurs on fringes of Fortescue Marsh
14. Hummock Grassland of *Triodia angusta* with patches of *Acacia victoriae* over *Atriplex codonocarpa* and mixed Chenopods and Poaceae species.	-	✓ Occurs on fringes of Fortescue Marsh

Vegetation communities mapped and Priority Flora recorded within the Study Area are shown on Figure 10 and discussed in detail in Appendix D. Figure 11 shows the Project Area overlaid on land systems to provide a regional context for the vegetation mapping.

The potential impacts outlined in the sections below could result from Project development, if appropriate management controls are not put in place.

6.2.1 Vegetation Clearing

Potential Impacts

Clearing of vegetation will be required for the mine pit areas, ore stockpiles, initial overburden placement areas, and for establishment of infrastructure such as the Mine Camp, workshop area, laydown areas, water bores and access tracks.

The Cloud Break Mine is expected to progressively clear up to 5,500 ha of vegetation within the Project Area over a 12-year period, as a result of mining and construction of associated facilities such as haul roads, conveyors and overburden landforms. It is anticipated that 340 Mt of overburden will be placed in landforms not within the pit areas in an area of approximately 500 ha. These areas will be designed and shaped to blend in with the surrounding landforms and will be progressively rehabilitated. The average area of a working pit will be approximately 475 ha.

Estimated areas of disturbance of plant communities defined by Mattiske Consulting (2005) are presented in Table 8.

Table 8. Proposed Disturbance of Vegetation Communities within the Project Area

Vegetation Community Mapping Code (Mattiske Consulting) (Refer to Section 4.6.1.1 for description)	**Total Area Mapped in Survey Area (ha)** [1]	**Area Impacted by on Project (ha)**
1	824.15	118.94
2	5,836.13	413.48
3	14,725.96	2213.20
4	6,432.77	401.85
5	289.78	0.00
6	466.97	0.00
7	1,402.54	79.80
8	1,147.02	79.06
9	1,173.94	227.87
10	15,539.91	448.69
11	273.32	0.00
12	154.98	0.00
13	271.85	0.00
14	9.99	0.00
15	231.28	21.07
16	1,971.08	245.76
17	4,632.35	1,015.94

Vegetation Community Mapping Code (Mattiske Consulting) (Refer to Section 4.6.1.1 for description)	**Total Area Mapped in Survey Area (ha)** [1]	**Area Impacted by on Project (ha)**
18	3.15	0.00
Total	**55387.17**	**5265.66**

Note: 1. The Study Area was restricted to the vicinity of the Cloud Break Leases, and areas of vegetation communities presented do not represent regional extent of vegetation communities.

Additional impacts on vegetation may result from other Project-related activities including off-road driving and fire (Section 6.2.5). Spinifex (*Triodia* spp.) is particularly susceptible to physical damage from vehicle movements and may take extended periods to recover.

Direct impacts on Mulga through clearing have been calculated and placed in a regional context by reviewing Agriculture WA rangeland mapping (Payne *et al.*, 2002). Two regional management units from the rangeland mapping have been defined which may be considered for assessment of impacts of the Project. They include:

- the Fortescue Marshes and surrounds, including all Mulga containing land systems within an approximate 12 km buffer around the perimeter of the Marshes, including both groved Mulga and other Mulga communities; and
- the Chichester Ranges footslopes, consisting primarily of groved Mulga systems and the thick band of Mulga fringing the Fortescue Marshes on its northern side (this unit is also a subset of the Fortescue Marshes surrounds).

Based on the rangeland mapping, the approximate size of the Chichester Ranges footslopes unit is 1,641 km^2, while the Fortescue Marshes and surrounds is 3,204 km^2. Arguments for the use of each management unit are as follows:

1. the larger Fortescue Marshes unit is a geomorphologically similar structure in that it fringes the Marshes and consists of flood plains on both sides, to the north flanking the Chichester Ranges and to the south flanking the Hamersley Ranges. Mulga groving exists both to the north and to the south of the Marshes;
2. the smaller Chichester Ranges footslopes unit (a subset of the Fortescue Marshes unit above) is believed by CALM to be in better condition than the remainder of Fortescue Marshes unit. However, Mattiske Consulting's Vegetation Condition Survey Report (Appendix E) indicates that within the Cloud Break Leases the area has been affected by fire, grazing and drought. Much of the area assessed ranged

From 'degraded'[2] to 'good' condition.

Table 9. Direct Impact on Mulga, as a Proportion of Chichester Ranges Mulga and Fortescue Marshes Mulga

(based on Rangeland Mapping, Payne *et al.*, 2002)

Mulga Management Unit	Area	Mulga Disturbance by Project	
Fortescue Marshes surrounds	320,400 ha	3,781 ha	1.2%
Chichester Ranges footslopes (subset of Fortescue Marshes surrounds)	164,100 ha		2.3%

Note 1. Refer to the Stage B PER (Section 6.3.1.1)

Total disturbance to Mulga containing land systems for the Project, therefore, accounts for approximately 1.2% within the larger Fortescue Marshes unit and 2.3% within the Chichester footslopes unit based on rangeland mapping. An indication of the cumulative impacts from all FMG's proposed mining developments on these units is discussed in Section 6.14.2.

Management Strategies

During the final design of the Project, further refinement will be undertaken, taking into account the locations of regionally significant vegetation types and populations of Priority Flora (Figure 10) with the objective of avoiding these units where practicable (see Section 5.2 for evaluation of alternatives).

During pre-construction activities, care will be taken to minimise disturbance to vegetation. This includes preferentially using existing tracks and access routes and utilising previously disturbed areas where practicable.

Prior to clearing, sites will be the subject of a targeted survey for Threatened Flora species or vegetation types of high conservation significance. Additional surveys will be carried out in areas not previously adequately surveyed (such as borrow pits). Permanent vegetation monitoring plots will also be established and monitored prior to, during, and after mining activities. Vegetation clearing prior to, and during construction of the Project will be kept to a

[2] Vegetation condition definitions:
Pristine - pristine or nearly so, no obvious signs of disturbance;
Excellent - vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species;
Very Good - vegetation structure altered, obvious signs of disturbance (e.g. repeated fires, some aggressive weeds, dieback, logging, grazing).
Good - vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it (e.g. very frequent fires, aggressive weeds at high density, partial clearing, dieback and grazing);
Degraded - basic vegetation structure severely impacted upon by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management;
Completely Degraded - structure of the vegetation is no longer intact and the area is completely or almost completely without native species (e.g. crops, 'parkland cleared').

minimum, within engineering and safety requirements. Topsoil and cleared vegetation will be respread over disturbed areas as soon as practicable after clearing, although stockpiling cleared vegetation and topsoil will be undertaken for short periods if direct return of topsoil is not feasible. Topsoil stockpiles will be clearly marked and will not exceed 2 m in height to maintain biological activity in the soil, and preserve the seed source.

During operation of the mine, detailed maps will be produced displaying the areas to be cleared. Any clearing outside the defined areas will require prior approval from FMG's Environmental Section and/or Government Departments, if required.

A draft Rehabilitation and Revegetation Management Plan developed for the Stage B and Cloud Break Projects has been included in this document (Appendix J). This plan includes use of provenance collected native seed if propagation from topsoil is not sufficient, characterisation and management of topsoil, and the respreading of cleared vegetation. Monitoring will also be carried out, with any rehabilitation failure subject to additional treatment to a suitable standard (Section 6.11.3).

FMG will consider a combined offset package for the direct impacts of the Stage A, Stage B and Projects on Mulga groves or other vegetation of conservation significance, in consultation with CALM and academic experts.

6.2.2 Disruption to Surface Hydrology

Potential Impacts

The majority of the proposed mining areas are located on the foothills of the Chichester Ranges and the broad areas of very gently sloping alluvial plains, which are subject to sheet-flow. Mulga groves occur on the plains and are reported to be dependent on both direct rainfall and sheet-flow for providing soil moisture and nutrients (Anderson and Hodgkinson, 1997) (Section 4.6.1.1). The interruption and diversion of such flow, during construction and operation of the Project, has the potential to cause degradation of Mulga grove/intergrove areas, if not managed appropriately, by either restriction of water flows downstream of the Project Area or ponding upstream.

To determine the extent that grove/intergrove mulga communities are dependent on sheet-flow and the potential impact from sheet-flow restriction, assistance was sought from both the Mulga Research Centre (Department of Environmental Biology at Curtin University of Technology) and the Ecosystem Research Group (School of Plant Biology at the University of Western Australia). These research establishments have undertaken extensive investigations and are familiar with other Australian research into Mulga communities. Based on discussions, numerous factors affect the ecology of the grove/ intergrove mulga communities, but no quantitative data is available to define the upstream catchment area (or sheet-flow) required to sustain the mulga communities.

Management Strategies

Section 6.5 outlines the management strategies based on the potential hydrological impacts. The following briefly discusses those management strategies.

A redistribution system will be installed in areas that contain sensitive vegetation (primarily Mulga) to maintain sheet-flow downstream of mining areas. This is a particular consideration for the extensive grove/intergrove Mulga communities located west of Sandy Creek (Figure 6). This aspect of the drainage design will be finalised to the satisfaction of CALM and the DoE prior to mining in this location.

6.2.3 Erosion

Potential Impacts

Clearing of vegetation has the potential to lead to increased rates of erosion. Susceptible substrates within the Project Area include the clays and heavier soils underlying the Mulga communities of the Fortescue Valley. This is particularly important given the potential for increased siltation of the Fortescue Marshes downstream of the proposed Project.

Management Strategies

Areas prone to erosion will be avoided if practicable during construction, or promptly stabilised to ensure that erosion impacts do not have adverse impacts on the downstream vegetation. During the operation of the mine, erosion protection devices (such as rip-rap pads) will be installed in high risk areas as appropriate.

Management of erosion and silt loads in surface run-off from the mining areas is outlined in Section 6.5.1. In addition, off-road driving will be strictly prohibited in all parts of the Project Area (except where authorised) to reduce the potential for increased erosion.

6.2.4 Introduction and/or Spread of Weed Species

Potential Impacts

A total of four introduced species was recorded in the Cloud Break Project Area, including *Bidens pilosa, Cenchrus ciliaris, C. setigerus* and *Malvastrum americanum*. Earthworks, topsoil and overburden transportation, vehicle movement and other factors have the potential to introduce additional weeds to the area and to spread existing populations of introduced flora within the development areas. The number of introduced species is likely to increase markedly if additional studies are undertaken after seasonal or cyclonic rainfalls (Mattiske Consulting, 2005; Appendix D). Other introduced species previously recorded in the region by Biota (2004b) include:

- Ruby Dock *(*Acetosa vesicaria*);
- Kapok *(*Aerva javanica*);
- Mexican Poppy *(*Argemone ochroleuca* subsp. *ochroleuca*);
- Beggar's Ticks *(*Bidens bipinnate*);
- Feathertop Rhodes Grass or Windmill Grass *(*Chloris virgata*);
- The cucurbid *(*Citrullus colocynthis*);
- Awnless Barnyard Grass *(*Echinochloa colona*);
- Whorled Pigeon Grass *(*Setaria verticillate*);
- Indian Weed *(*Sigesbeckia orientalis*); and
- Common Sowthistle *(*Sonchus oleraceus*).

Management Strategies

Prior to construction commencing, a Weed Hygiene and Management Plan will be prepared to the satisfaction of CALM and the Agricultural Protection Board (APB), and implemented throughout the life of the Project. This Plan will be developed in conjunction with FMG's Stage B Project. The Plan will include appropriate vehicle inspection and hygiene measures, targeted control of more aggressive weed species, progressive rehabilitation to reduce the influx of weed species, and monitoring of disturbed areas. Active management of particular weed species may be required following rehabilitation.

Off-road driving will be strictly prohibited in all parts of the Project Area (except where authorised). All staff and contractors will be informed of this and other general environmental issues, as part of an on-site induction programme.

6.2.5 Fire

Potential Impacts

Fires are part of the natural Pilbara landscape as a result of lightning strikes (particularly during summer), and Aboriginal land management practices. The level of impact on vegetation associated with potential increased fire frequency is dependent on the structure of the affected vegetation. The increased fire risk is primarily associated with construction activities and management measures will be in place to reduce these risks (see Section 5.4.4).

The hummock grassland associations which dominate the stony hills of the mine areas are typically very flammable, but are also adapted to fire and recover relatively quickly. Increased frequency of fires can lead to changes in floristic composition and a prevalence of early successional stages of vegetation (the climax vegetation is prevented from developing; Biota and Trudgen, 2002).

There is evidence to suggest that Mulga communities may be killed by hot fires. The Mulga woodlands and tall shrublands that dominate the plains around the Marshes are susceptible to damage from fires, particularly if there is also strong grazing pressure or other stresses presented by modification to the existing hydrological regime. The Project Area has been subjected to frequent fires including one, recently, in the north-eastern section of the leases (Section 4.6.1.1).

Management Strategies

FMG will develop and implement a Fire Management Plan in conjunction with FMG's Stage A and B Projects. Fire management is also addressed as part of the Construction EMP (see Appendix I). The objective of management measures outlined in these plans will be to reduce the risk of unplanned fires and provide contingency measures to minimise any impacts in the event that a fire starts. This will include measures to address normal construction activities including the use of heavy plant and equipment in dry vegetated areas, welding, grinding, and other activities with the potential to start fires. The fire management plan will also address management of fuel loads on-site to reduce the risk of hot fires, which may kill Mulga and other vegetation communities.

The workforce will undergo Environmental Awareness training that will include an aspect on fire protection measures and emergency response in case of fire.

6.2.6 Dust

Potential Impacts

The proposed Cloud Break Mine will be located in an arid area which has naturally high background dust levels.

Potential dust sources from the Project include:
- construction and mining;
- crushing and sizing;
- transport; and
- cleared areas.

Dust generated during the construction, operation and maintenance of the Cloud Break Mine areas has the potential to smother vegetation, affecting its ability to photosynthesise and generally resulting in poor vegetation condition. In the case of very heavy coatings of dust, vegetation may die.

Management Strategies

Management of dust is dealt with in detail in Section 6.8.

FMG intends to keep dust emissions to a minimum during construction and operation of the Project to ensure that dust does not create a hazard or nuisance to the human or natural environment. This will include engineering design solutions to minimise dust generation and/or fugitive emission escape, and optimising ore moisture content. Additional dust suppression measures (such as water sprays on haul roads and loading stockpiles) will be implemented if other dust avoidance and management measures are insufficient.

Progressive rehabilitation of working areas will stabilise soils and reduce the potential for dust. A Dust Management Plan will be developed for the Project in conjunction with the Stage B Project.

6.2.7 Groundwater Drawdown

Potential Impacts

Hydrogeological modelling undertaken for the Project indicates that existing groundwater levels within the Cloud Break pit areas will be need to be drawn down by a maximum of 70 m over the life of the mines to ensure dry conditions for mining activities. Groundwater drawdown contours from pit dewatering are shown in Figures 16a to 16c.

Phreatophytic (groundwater-dependent) vegetation communities are expected to occur within

FMG's project Areas. Mattiske Consulting identified selected tree species and larger shrubs in creek and drainage line communities, and on the flats and broad plains. The fringes of samphire flats containing *Halosarcia* spp., *Maireana* spp. and *Atriplex* spp. are also considered partially phreatophytic. Biota Environmental Sciences identified species such as River Red Gums (*Eucalyptus camaldulensis*), Cadjeput (*Melaleuca argentea*) and Coolibah (*E. victrix*) as potential phreatophytes (Biota, 2004c).

Within the Cloud Break Project Area groundwater drawdown will generally be between 0.5 m and 5 m outside the areas proposed to be disturbed for mining. A number of vegetation communities potentially containing phreatophytic species may occur within this drawdown zone. Data from AQWABase suggest that seasonal groundwater level variations may be up to 5 m (e.g. in the vicinity of the Marshes). Groundwater drawdowns less than this are therefore considered unlikely to affect phreatophytic species, unless drawdown is sudden, or vegetation is already subject to other stresses (e.g. drought). Barrett and Associates (2005) undertook an evaluation of the likely impact of dewater drawdown on vegetation communities this has been included as Appendix F.

Depth to groundwater was investigated at the margins of the Marshes and was found to be approximately 5 m below ground level (at the end of the dry season). Groundwater levels immediately underlying the Marshes are likely be significantly shallower, as evidenced by the presence of samphires. In the western area of the Project, groundwater drawdown levels may be lowered by up to 0.5 to 1 m within the fringes of the samphire flats surrounding the Marshes and up to 5 m in an area at the north-west extremity of the operation (Figure 16c).

While the potential for some adverse impact from temporary drawdown cannot be ruled out, it would appear to be within the range of fluctuations that are likely to occur within natural cycles of flooding and aridity. Samphires are likely to survive naturally occurring falls in root architecture and through residual soil moisture. In the event that reductions in groundwater levels are prolonged, samphires are equipped with various physiological mechanisms to survive. The degree to which they are able to do this will be dependant on environmental factors soil and water salinity (Barrett 2005).

When soil moisture levels drop and salt concentration increases, samphires often develop a reddish hue. This colouration is indicative of the accumulation of metabolites to combat adverse leaf water potentials (G. Barrett, *pers. comm*.). In conjunction with soil moisture levels, this feature is a useful mechanism by which to monitor any unanticipated impacts through comparison with samphires in areas not affected by groundwater drawdown.

Management Strategies

As outlined in Section 6.6.1 FMG will implement measures to reduce the risk of impacting phreatophytic vegetation during pit dewatering this includes:

- a groundwater monitoring programme,
- revision of the numerical groundwater models;
- vegetation condition monitoring in areas where phreatophytic vegetation has been identified to observe vegetation where groundwater levels have declined; and
- vegetation condition monitoring in the Fortescue Marshes outside the Project Area.

6.2.8 Terrestrial Flora

Potential Impacts

All native flora are protected under the *Wildlife Conservation Act 1950.* However, a number of plant species are assigned an additional level of conservation significance based on the limited number of known populations and the perceived threats to these populations. Species of the highest conservation significance are designated Declared Rare Flora (DRF), either extinct or presumed extinct. Species that appear to be Rare or Threatened, but for which there is either insufficient information to properly evaluate their conservation significance, or they are variously threatened to a lesser degree than DRF, are assigned to one of four Priority flora categories.

Rare or Threatened Flora species may also be protected at the Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*).

No plant taxon recorded in the surveys is gazetted as DRF pursuant to Subsection (2) of Section 23F of the *Wildlife Conservation Act 1950*, or listed as Threatened pursuant to Schedule 1 of the *EPBC Act* (Mattiske Consulting, 2005; Appendix D).

Priority flora species recorded by Mattiske Consulting within the Study Area are summarised below:

Species	**Vegetation Community**
Eremophila spongiocarpa (ms) (Priority 1)	2
Eremophila youngii subsp. *lepidola* ms (Priority 1)	10
Rostellularia adscendens var. *latifolia* (Priority 3)	4, 5
Themeda sp. Hamersley Station (M.E. Trudgen 11431) PN (Priority 3)	9

In addition, *Sida* sp. Wittenoom (W.R. Barker 1962) (Priority 3) was previously recorded in the Cloud Break area during flora surveys for FMG's Stage B rail corridor (Biota, 2004b).

None of the Priority flora found in the Study Area were located within the proposed area of disturbance.

Other flora of Conservation Significance found in FMG's other project Areas in the Chichester Ranges include:

- *Abutilon trudgenii* ms. (Priority 3);
- *Goodenia nuda* (Priority 3); and
- *Hibiscus brachysiphonius* (Priority 3).

Potential impacts to significant flora arising from the Project are similar to those outlined previously and include:

- physical disturbance (Section 6.2.1);
- disturbance to surface hydrology (Section 6.2.2);
- introduction and/or spread of weed species (Section 6.2.4);
- fire (Section 6.2.5); and
- dust (Section 6.2.6).

Management Strategies

Prior to clearing, sites will be the subject of a targeted survey for Threatened Flora species or vegetation types of high Conservation Significance. Additional surveys will be carried out in areas not previously adequately surveyed. The locations of significant vegetation communities and Threatened Flora will be taken into consideration in the final design of the Project. While the location of the mine is dictated by the location of the deposit, the associated infrastructure can generally be located to avoid areas of higher conservation value.

Management measures, that will be implemented to ensure the Project does not adversely impact the conservation status of significant communities or threatened species, may include research into propagation of Threatened Flora for use in rehabilitation of the mining area, reducing the risk of spreading weeds and managing the risk of fire.

The management measures designed to minimise impacts on vegetation communities will assist in the protection of significant flora (Sections 6.2.1 to 6.2.7).

6.3 FAUNA

The EPA objectives with regards to fauna are to:

- *maintain the abundance, species diversity and geographical distribution of terrestrial fauna; and*
- *protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act 1950.*

Potential Impacts

The April 2005 survey of the Project Area revealed a rich vertebrate fauna that was suffering the impacts of drought conditions. Despite the low abundance of most species, there was still a good diversity of species from most taxa.

The majority of proposed pits inspected are located in degraded Mulga woodland, with little or no understorey, that has experienced frequent recent fires (Section 4.6.1). The majority of the areas of good habitat that were surveyed are unlikely to be impacted on by the proposed mining activities.

River systems and water sources commonly have higher densities of birds and a greater diversity of species than many other habitats. Of the areas inspected within the proposed pits, sampling site OB 5 in the east of the Cloud Break Project Area (Figure 12) contained some excellent examples of drainage systems with good stands of *Grevillea wickhamii,* which offer good habitat for a range of bird species. There are a number of drainage lines (approximately 63 ha) in the vicinity of OB 5 (vegetation communities 1, 2 and 9) which will be disturbed during mining. These drainage lines also extend upstream, and downstream of the proposed mining area. Drainage lines will be diverted around pits areas and re-established on the downstream side of the pits. The disturbance will not occur all at once but over a 12-year period. Mined areas will be progressively rehabilitated as mining progresses, so that the remaining landscape resembles, as closely as practicable, pre-mining conditions. It is acknowledged that revegetated areas will take some time to re-establish and provide habitat values similar to what was present prior to mining.

The area surrounding sampling site OB 1 contained Mulga in better condition than elsewhere in the Study Area in vegetation community 3. This site was rich in bird species including some species virtually absent from the rest of the study sites (Hooded Robin, Red-capped Robin). This habitat was also potentially good for Bilby (*Macrotis lagotis*) (although subsequent searches by FMG personnel failed to located any evidence of Bilby in this area) and less so Mulgara (*Dasycercus cristicauda*). Of the 14,726 ha of vegetation community 3 recorded within the Study Area, approximately 2,213 ha (about 15%) will be progressively disturbed over the life of the Project (Table 8). Vegetation community 3 is also likely to extend beyond the areas surveyed in the vicinity of the Cloud Break Project Area.

Fauna may be directly impacted upon by activities such as earthworks (particularly ground-dwelling and burrowing animals), noise, blasting vibrations or indirectly through the loss of habitat and food sources. However, fauna populations are generally transient and not necessarily restricted to specific locations. Increased vehicle movements will also increase the risk of road kills. Significant habitats, such as those which provide nesting refuges or water sources, may be disturbed during the Project, although these will be avoided where practicable.

Native fauna species which are Rare, Threatened with extinction or have high conservation value are specially protected by law under the State *Wildlife Conservation Act 1950,* and in addition, many of these species are listed under the Commonwealth *EPBC Act 1999*.

Migratory wader species are also protected under this Act. The national List of Migratory Species consists of those species listed under the following International Conventions:

- *Japan-Australia Migratory Bird Agreement* (JAMBA);
- *China-Australia Migratory Bird Agreement* (CAMBA); and
- *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention).

Evidence of the following species listed under the State or Commonwealth Acts were recorded within the vicinity of the area:

- Peregrine Falcon (Other Specially Protected Fauna, WA *Wildlife Conservation Act 1950*);
- Night Parrot (Critically Endangered, *EPBC Act 1999* and WA *Wildlife Conservation Act 1950*);
- Rainbow Bee-eater (Migratory species, *EPBC Act 1999*);
- Bilby (Vulnerable, WA *Wildlife Conservation Act 1950* and *EPBC Act 1999*).

In addition there may be other species listed under the State or Commonwealth Acts that may be present within the Project Area, but have not been recorded (Section 4.6.2).

Management Strategies

Implementation of the management measures to limit and/or control vegetation clearing and progressive rehabilitation will also reduce the impacts on fauna communities (Section 6.2.1). Every effort will be made to reinstate landforms and vegetation communities suitable to support the faunal assemblages that were present prior to mining.

FMG will ensure hydrological impacts either from groundwater abstraction or interference with surface flow from Project construction are avoided or minimised to maintain habitat condition (see Sections 6.5 and 6.8).

Employees will undergo Environmental Awareness training that will highlight measures the workforce will be required to undertake to reduce the potential impacts on native fauna populations. This will include implementation of ‘no firearms’ and ‘no pets’ policies on the site, avoidance of known significant fauna habitat sites, reducing the fire risk, and complying with speed limits within the Project Area. All personnel (including contractors) will be required to undertake competency based training, which requires individuals to demonstrate a high level of Environmental Awareness.

Specific measures to minimise the impacts on fauna will include:

- limiting speeds to 50 kph during the day and 40 kph at night near areas of high wildlife activity (e.g. close to water sources) within the Project Area, to reduce the risk of road kills and dust generation from the roads;
- educating employees to recognise significant fauna (e.g. Bilby, Olive Python, Spectacled Hare-Wallaby, Night Parrot);
- ensuring employees and contractors report road-killed fauna, and any sightings of fauna suspected to be significant will be reported to CALM; and
- discouraging and controlling, where appropriate (in conjunction with adjacent land holders and the Department of Agriculture), feral fauna, particularly cats and foxes.

The Project will be designed to minimise disturbance and/,or avoid significant fauna habitats where practicable. Specific management measures will be implemented to ensure that the Project does not adversely impact the conservation status of the Threatened species. FMG will develop specific management plans for Night Parrot and Bilby, both of which have been recorded near (but not in) the Project Area. These management plans will be developed in consultation with CALM and DoE and will focus Project design on avoiding known habitats of these species, minimising human contact with these animals, and researching the species' biology and habitat.

Specific management measures for Threatened species include:

- creating 'no-go' zones in the areas where samphire meets Spinifex, with driving curfews in sensitive areas at night and dusk to reduce the risk of road kills of significant fauna such as Night Parrot;
- minimising night driving in potential habitat for the Pilbara Olive Python;
- monitoring existing Bilby and Pebble Mound Mouse populations within or near the Project Area;
- surveying any sandy or sandy-loam habitats that support spinifex that are likely to be developed within the Project Area, and may support Mulgara or Bilby;
- undertaking further research into the biology and ecology of the Night Parrot; and
- implementing the management plans developed for significant species.

6.4 STYGOFAUNA

The EPA objective for the Project with regards to stygofauna is to:

- *maintain the abundance, diversity and geographical distribution of subterranean fauna.*

Potential Impacts

Any saturated gravel deposits, calcrete, mineralised Marra Mamba and dolomite along the Fortescue River, and other creeks, have the potential to support stygofauna (groundwater-dwelling fauna). Groundwater levels will be lowered in some of these deposits during mine dewatering and there is potential for stygofauna communities to be affected in these areas.

Stygofauna communities have been identified in the vicinity of most iron ore mines in the Pilbara (Johnson and Wright, 2001). Stygofauna sampling conducted for the Project has recorded stygofauna in two shallow bores within the Project Area. Two potentially new species of *Paramelitidae* were recorded within Cook Bore (FMG26) (Section 4.6.3). Further DNA sampling is being carried out on these samples. Cook Bore is away from the influence of the mine and will not be affected by dewatering.

It is likely that stygofauna also occur at other sites within the Project Area, possibly in the calcrete aquifer close to the Marshes. However the calcrete aquifer at this location is thought to contain saline water. Stygofauna are less likely to occur in the alluvium to the north of these bores due to the tight pore spaces where the calcrete is absent, but may exist where mineralised Marra Mamba occurs below the water table.

Mulga Bore (FMG 25), Minga' Well (FMG 28), CBDD128 (FMG 27), Malibu Bore (FMG31) and CB068 are located within the predicted groundwater drawdown zone following pit dewatering activities. Figures 13a to 13c show the location of stygofauna sampling bores compared with dewatering drawdowns over five, 12 and 20 years (a maximum drawdown of 2.5 m is predicted at Minga' Well after 20 years). It is considered unlikely that such a small change in groundwater levels will impact on stygofauna populations, as this is less than the seasonal change in water levels, which can fluctuate by up to 5 m. However larger drawdowns in the vicinity of the pits may result in dewatering of stygofauna habitats in the Marra Mamba.

Management Strategies

FMG has developed a Subterranean Fauna Management Plan in consultation with CALM for its proposed mining operations, which have been expanded to incorporate the Project (Appendix K). The first step in this Management Plan is understanding the distribution of stygofauna through a sampling programme. Details of the sampling programme are provided in the plan. Sampling will be undertaken bi-annually for two years. Management strategies to minimise potential impacts on stygofauna populations and reporting mechanisms will be undertaken in accordance with this Plan.

6.5 SURFACE WATER

The EPA objectives for the Project with regards to surface water are to:

- *maintain the integrity, functions and environmental values of watercourses and sheet-flow; and*
- *maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC /ARMCANZ, 2000).*

The potential impacts of the Project on surface water were assessed by Aquaterra (Appendix B), and a summary is presented below.

6.5.1 General Surface Water Impacts

Potential Impacts

The main impacts on surface water from the proposed Project would be interruption to the existing surface water flow patterns. This could result in a potential reduction of surface water runoff volume and quality in the downstream environment. The proposed Project layout shown in Figure 6 intersects a number of ephemeral drainage lines and sheet-flow areas. In, particular, the grove/intergrove Mulga communities, which are partially dependant on sheet-flow runoff may potentially be impacted upon. These communities are spread through the general Project Area with their main concentrations on the lower flanks of the Chichester Ranges adjacent to the Fortescue Marshes (Section 4.6.1.1).

The Pilbara landscape is subject to extreme climatic events such as high rainfall intensities and storms associated with cyclonic activity. The risk of erosion and sedimentation can therefore be high, particularly on already disturbed or degraded lands.

Specific impacts from mining of pits, and permanent overburden placement areas are addressed in Sections 6.5.2 and 6.5.3 below. Stockpiles of low grade material mined in years 1 to 6 will predominantly be located in-pit, and surface water runoff from these areas will be managed within the pit surface water management system. Surface water will be diverted around the stockpile area near the rail loading facility, and this area will be internally draining so that increased sediment loads from these areas are not released off-site. These stockpiles are therefore expected to have an insignificant impact on the surface water runoff volumes within the catchment, and have no impact on the surface water runoff quality in the downstream environment.

Haul roads and other infrastructure are also likely to interrupt surface water flows and, if not appropriately managed, could result in downstream impacts. FMG and its consultant C. Muller Consulting have undertaken trials to investigate mechanisms for distributing surface water sheet-flow downstream of infrastructure corridors. This was primarily undertaken to assess the effectiveness of spreader levees for the Stage B rail corridor, but is also applicable to haul roads and other infrastructure corridors proposed for the Project. The trials were conducted with a range of graded crushed rock to determine optimum material and dimensions for levee bank construction, and investigated the susceptibility of spreader levees to erosion and damage by heavy water flows and cattle.

These trials demonstrated that in mulga flats, discharge from culverts can be effectively re-distributed so as to re-establish sheet flow. Regular inspection and maintenance will be required to ensure they continue to perform as designed for the life of the infrastructure.

In flat areas, water will temporarily build up on the upstream side of the levees. The duration of any such ponding can be expected to increase if silt loads raise the effective sill height of the levee. Unless there is general flooding of the entire area, any ponding should drain away within a few hours of discharge ceasing, and should therefore not adversely affect any vegetation. However, the extended period of inundation may impact on the trafficability of roads.

Management Strategies

The engineering design of the Project will incorporate site-specific surface water controls including diversion and dispersion mechanisms, and also erosion and sedimentation controls.

The following general strategies will be implemented to minimise surface water impacts from the Project:

- where feasible, upstream surface water flows will be diverted around the Project structures into adjacent or downstream defined surface water flow pathways. Where sheet-flow zones are located immediately downstream from the Project, diverted surface water will be discharged over spreader mechanisms to encourage the flows to slow and disperse;
- stockpile areas will be bunded, as appropriate to contain surface water runoff and used within the Project (e.g. for dust suppression);
- areas of major erosion hazard will be identified and avoided where practicable, or specific management measures will be implemented to reduce the erosion risk;
- construction on or near natural drainage pathways will be planned for the dry season where practicable;
- temporary stabilisation measures will be used in high erosion risk zones such as creek beds, and embankments re-instated;

- disturbance will be kept to the minimum necessary for safe working conditions; and
- vehicle movements will be kept to the minimum necessary, and existing tracks used where possible.

For infrastructure corridors such as haul roads in areas subject to surface water sheet-flow, where there is sensitive vegetation downstream, levee structures will be constructed as close to the rail/road as practicable to rapidly re-spread water and so minimise any area potentially affected by drainage shadow. To maintain a trafficable surface adjacent to a levee, the road may be built slightly higher than the surrounding land, with culverts that pass under the road, or the road surface dipped to natural surface level and stabilised floodways constructed.

C. Muller Consulting also recommended that:

- spreader structures consisting of a ditch and levee be constructed along the contour, as near as practicable to the road/rail;
- levees be constructed of clean rock material screened in the range 75 – 125 mm;
- levees be constructed between 700 mm and 1,000 mm wide, and at least 200 – 300 mm high; and
- short return levee walls be constructed at each end of the levee.

6.5.2 Open Pit Areas

Potential Impacts

The proposed Cloud Break mining areas are located on the lower flanks of the Chichester Ranges and their development will interrupt existing surface water flow patterns. There are a number of small ephemeral creeks within the Project Area, some of which will be disturbed by the open pits. With the proposed pit locations, the upstream pit perimeters will typically be located in defined creek flow zones, whereas their downstream perimeters will typically be located in sheet-flow zones.

During a runoff event, the Pilbara creek systems discharge water with naturally high turbidity and sediment loads (WRC, 2000). In proximity to the pits, diverted flows may increase the naturally high sediment and turbidity loadings. However, these potentially elevated levels will dissipate with distance from the pit area.
Pits will be opened sequentially (Figure 15) and the maximum area of the working pit will be 475 ha. Pits will be backfilled with overburden and waste rock, and where practicable, similar landforms created to what was present prior to mining, although reinstated drainage patterns will most likely be different from pre-mining drainage patterns.

The potential impact of runoff water volume loss to the Fortescue Marshes due to the proposed mining areas is considered to be minor. This can be illustrated by a comparison of the area collectively intercepted by the active mining areas with the catchment area of approximately 31,000 km^2. During the mining phase, assuming that a quarter of the Project Area is being actively mined at any one time (a conservative estimate, as FMG will minimise its open areas), this will represent approximately 0.04% of the total catchment area for the Fortescue Marshes. Whilst this temporary reduction in catchment area does not represent a significant catchment loss to the Marshes in the context of natural seasonal variability of catchment yield, it is recognised that, if not appropriately managed, the proposed extent of active mining area may result in localised hydrological impacts.

Management Strategies

Surface water protection bunding will be constructed around the pit perimeters, comprising a combination of bunding and diversion channels, to prevent external surface water from entering the pit area. However, as pits will be excavated in stages, this surface water protection bunding may also be developed in stages. Where feasible, upstream surface water flows will be diverted around the pit development areas and directed into adjacent defined surface water pathways. Where adjacent defined surface water flow pathways are not present, diverted water will be directed around the pit areas to join existing downstream flow pathways.

Where sheet-flow zones are located immediately downstream from the pit areas, diverted surface water will be discharged over a rip-rap (rockfill) pad to encourage the flows to slow and disperse. The conceptual layout for diversion of runoff around the open pit areas is shown in Figure 17.

Where diversion of upstream surface water runoff around the pit perimeter is not feasible due to topography, the external runoff water will be ponded against external bunds and removed by pumping to avoid flooding nearby vegetation, or allowed to dissipate by evaporation and seepage. Alternatively, the upstream surface water runoff will be allowed to discharge into the pit area (within engineering safety constraints). In-pit sumps and pumps will be designed to manage any external surface water entering the pit, together with in-pit stormwater volumes. It is proposed that the in-pit water will be used in the Project (e.g. for dust suppression), following treatment via sediment ponds.

Where a sheet-flow zone containing a groved Mulga community is located immediately downslope from an open pit area and external surface water runoff is collected in the pit, it is proposed that some of the collected in-pit water will be used to irrigate this sheet-flow zone. However, as sheet-flow only occurs following a major rainfall event, this irrigation system will only be used following such an event. The proposed irrigation system will comprise a separate mobile pump feeding water to a movable spreader pipework system. Irrigation will not be applied to grove/intergrove areas that are approved to be cleared by future mining activities. Sediment ponds will treat surface water collected in the pits prior to any irrigation discharges to the downstream environment. With this treatment, the potential impact to runoff water quality in the downstream environment is expected to be insignificant.

During the mining process, it is proposed that the pit areas will be progressively backfilled to the extent of available backfill material. It is estimated that sufficient overburden and waste rock will be available to completely backfill pits, due to the bulking factor (Section 5.3.2). Upon completion of mining, it is proposed to backfill the pits such that a whole pit area can drain to the downstream environment where practicable. This would be achieved by backfilling the pit to a level above the lowest elevation on the pit perimeter and then ensuring that the finished pit surface is continuously draining to this area. The backfilled pit surface will be finished with a layer of fine-grained material and topsoil prior to rehabilitation. Some portions of the pits may be preferentially backfilled during the mining process, to enable upstream (external) surface water runoff to pass through the pit area, rather than be diverted around the pit footprint (within engineering safety constraints).

During the mining phase, the potential impact arising from sheet-flow interruption will be managed by a combination of diverted external surface water runoff being discharged over a rip-rap pad to encourage the flows to slow and disperse, and by in-pit collected surface water runoff being irrigated over the downstream zone. Upon completion of mining, the rehabilitated backfilled pit area would drain to the natural downstream environment. With these management works, impacts to a groved Mulga community located immediately downstream from a pit development area would be minimised.

6.5.3 Overburden Placement

Potential Impacts

During the initial mining phases, overburden will need to be placed in permanent storage areas away from the mine footprint until sufficient area is mined to commence backfilling. Generally, these overburden placement areas will be established in the higher elevation areas upstream from the open pits where drainage is characterised by defined creek flow paths. Therefore the proposed waste area locations will avoid the lower elevation sheet-flow zones. As active mining areas will be located immediately downstream, the overburden placement area has a reduced potential to impact on the downstream environment.

The reduction in surface water runoff volume within the catchment due to the overburden placement areas will be minimal, as most external surface water will be redirected around these areas and redistributed downstream. Internal runoff from the overburden placement areas will be collected and discharged via sediment basin interceptors to the downstream environment. Increases in the surface water sediment load downstream of the overburden placement areas will therefore be minimal.

Management Strategies

As for the open pit areas, surface water bunding will typically be constructed around the perimeters of the overburden placement areas (in a similar fashion as shown in Figure 17) diverting surface water flows into defined surface water pathways either adjacent or downstream from the overburden placement areas. Where appropriate, rip-rap pads will be provided in key areas along the edges of the diversion bunding to slow and redistribute runoff.

Where due to topography diversion of upstream surface water runoff around the bund perimeter is not feasible, external runoff water will pond against the overburden placement area and be dissipated by evaporation and seepage. In these locations, the overburden placement areas will likely form part of the surface water protection works for the downstream pit.

Depending on the nature of the material, the overburden landforms may have a top surface which is dished in the centre to be internally draining, thus reducing runoff and the potential for erosion down the waste area faces. If constructed in this manner, the collected runoff water on the top surface will dissipate by evaporation and seepage. Alternatively, surface water runoff from the overburden placement areas will be drained from the top surface and batters to the downslope sides and then directed through sediment basins, to reduce sediment loadings and turbidity, prior to discharging to the downstream environment.

For long-term closure, overburden placement areas will be formed to blend in with the existing topography, and covered in topsoil (or other growth media) prior to revegetation. Rip-rap pads will be provided, as appropriate, at the exit from the overburden placement areas to slow and redistribute runoff to the downstream environment.

6.5.4 Fortescue Marshes

Potential Impacts

The Fortescue Marshes is an extensive intermittent wetland occupying an area around 100 km long by typically 10 km wide located on the floor of the Fortescue Valley. The Fortescue Marshes has been identified as a 'Nationally Important Wetland' and is listed as an 'indicative place' on the Register of National Estate due to its importance as a habitat for migratory birds.

Following significant rainfall events, runoff from the 31,000 km^2 upper Fortescue River catchment drains to the Marshes. For smaller runoff events, isolated pools form on the Marshes opposite the main drainage inlets, whereas for larger events the whole marsh area may flood. The Fortescue Marshes is approximately 3.0 km from the nearest Cloud Break pit area, and the proposed mine development is well above any recorded flood storage level in the Marshes.

A Risk Assessment of the potential impacts of FMG's Stage B Project on the Fortescue Marshes was conducted in October 2004. Considering the similar regional setting and activities proposed for the Project, the general findings of this Risk Assessment can be applied to the Project.

The scope of the Risk Assessment included the impact on the Fortescue Marshes ecosystem from disruption to surface water flows, and potential impacts on water quality or habitats, due to the introduction of foreign materials or by-products into the area as a result of the mining process.

Initially, the impacts were assessed on the basis of no specific control measures being in place (defined as "inherent risk"), which was followed by a re-evaluation of the expected risk with the proposed management procedures and safeguards in place (defined as the "residual risk").

The development of a mining project in the upper Fortescue River catchment was considered to present a medium inherent risk to the Fortescue Marshes, due to the potential loss of volume of surface water and increased sedimentation loading. However, whilst the proposed Project may alter the hydrological regimes at a local level, the Project is not expected to result in any significant reduction in surface water flows into the Fortescue Marshes, as the active mining area will represent a very small percentage of the total catchment area (0.04%), and pits will be progressively mined and backfilled throughout the life of the Project. The residual risk of loss of surface water flow volumes into the Marshes was therefore considered low.

Any surface water runoff from pit areas, overburden placement areas and haul roads (where feasible) will be treated via sedimentation basins prior to release to the downstream environment. Any area where potential polluting substances (e.g. hydrocarbons) are stored or handled will be bunded, and internal drainage collected and treated (Section 5.4.2). The residual risk of the Project adversely affecting the quality of surface water runoff draining to the Fortescue Marshes is therefore considered low.

Provided the recommended management measures are implemented, the Project is not expected to result in significant impacts on vegetation communities, in the vicinity of the Fortescue Marshes, that rely on surface water sheet-flow.

Management Strategies

In general, the Risk Assessment considered that the residual risks of mining, in the upper Fortescue River catchment, on the Fortescue Marshes were low for all of the identified environmental issues, including surface water impacts. Many of the impacts with an inherent risk rating of 'medium' were reduced to 'low' primarily as a result of the distance of the Project from the Fortescue Marshes (at least 3 km).

FMG recognises the potential for localised impacts on surface water drainage from the Project. Surface water management measures to be implemented to manage localised impacts and reduce the residual risk to the Marshes will include:

- diversion of surface water run-off around the mining areas;
- dispersion of surface water flow in sheet-flow zones downstream of the Project following significant rainfall events;
- use of surface water collected in the pits within the Project;
- use of sedimentation basins and oil-water interceptors to treat surface water prior to release to the downstream environment;
- development of contingency plans including the potential to discharge water collected in the pit to the environment downstream of the pits;
- implementation of the progressive rehabilitation programme to reduce sediment loading; and
- management of drainage around haul roads to minimise upstream and downstream surface water impacts.

6.6 GROUNDWATER

The EPA's objectives for the Project with regards to groundwater are:

- *to maintain (sufficient) quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected; and*
- *to maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the Australian \and New Zealand Water Quality Guidelines (ANZECC/ARMCANZ, 2000).*

6.6.1 Groundwater Drawdown from Pit Dewatering

Potential Impacts

Dewatering is required to lower groundwater levels below the base of each of the pits (in the alluvium and Marra Mamba formations) to enable access to ore required to meet the proposed mining schedules. Abstraction of groundwater during dewatering of the pits will result in a cone of groundwater depression extending out from the pits.

Aquaterra has modelled the predicted extent of the cone of depression using a numerical model. For this Project, Aquaterra has used results from the groundwater investigations undertaken specifically for the Cloud Break study and studies undertaken for the Stage B Project. This included test pumping of bores in the alluvial, calcrete, dolomite and Marra Mamba aquifers at Christmas Creek and Cloud Break and the proposed water supply borefield at Mt Lewin. The modelling methodology and assumptions made are presented in Aquaterra's report as Appendix C.

Dewatering requirements and groundwater levels have been modelled for a period of 20 years. This includes six years mining of high-grade material and six years mining of low-grade material. During both these periods dewatering is required in advance of mining. On completion of mining the model predicts that dewatering is required to prevent the pits from flooding during backfilling with waste material (which is assumed to take a year). After 13 years, the modelling assumes that all dewatering will be turned off and there will be a gradual recovery of water levels.

Maps showing predicted groundwater drawdowns during the life of the Project are presented in Figures 16a (five years), 16b (12 years) and 16c (20 years, i.e. seven years after cessation of dewatering).

Key predictions are:

- after five years, the cone of depression has a maximum depth of approximately 50 m and extends to within approximately 1 km of the boundary of the Fortescue Marshes;
- after 12 years (the end of mining), the cone of depression extends to a depth of 70 m and the 0.5 m drawdown contour extends close to the Marshes, but not below it;
- after 20 years, the deeper parts of the cone of depression have begun to recharge to a maximum of 30 m. The cone of depression extends close to the Marshes, but it is not predicted to impact on the hydrological regime of the Marshes.

Impacts on Phreatophytic Vegetation

Phreatophytic vegetation (i.e. groundwater-dependent vegetation communities) within the predicted groundwater drawdown zones was investigated by Barrett and Associates (Barrett 2005). The potential impacts of pit dewatering on phreatophytic vegetation are discussed in Section 6.2.7.

Impacts on Stygofauna

Any saturated gravel deposits, calcrete, mineralised Marra Mamba and dolomite along the Fortescue River and other creeks have the potential to support stygofauna (groundwater-dwelling fauna). Groundwater levels in some of these deposits will be affected by mine dewatering proposed for the Project and this has the potential to impact on stygofauna communities in these deposits (Section 6.4). Figures 16a to 16c show that the cones of depression from dewatering extend as far as Minga' Well, where stygofauna were recorded. At this location a drawdown of approximately 2.0 m is predicted, which is unlikely to significantly impact on stygofauna populations, as this variation is less than the seasonal change in water levels. However larger drawdowns in the vicinity of the pits may result in dewatering of stygofauna habitats (if they exist) in the Marra Mamba. Sampling undertaken to date indicates that stygofauna recorded in the Project Area are not restricted to the Cloud Break area (Section 4.6.3). Monitoring and management measures outlined in the Subterranean Fauna Management Plan (Appendix K) will be implemented.

Abstraction of Saline Water

Saline water underlies the Fortescue Marshes and extends towards the Cloud Break pits. This saline water dips below a layer of fresh water, of increasing thickness, towards the pits (Figures 9a – 9e). There is also a general trend of more saline water in the west of the Project Area than in the east. Thus the quality of the water abstracted during dewatering will vary from pit to pit. Dewatering the alluvium and Marra Mamba will result in the water becoming less fresh over time as water is abstracted from the more saline basement aquifers, and saline water close to the Marshes is induced to flow towards the centre of the cone of depression.

Aquaterra's report discusses the salinity of abstracted water as dewatering of the pits progresses (Appendix C). Once dewatering commences, varying volumes of water will be abstracted from different aquifers. Numerical groundwater modelling has indicated that the average water salinity of the abstracted water is likely to increase with time from 3,000 mg/l initially to 6,000 mg/l (equivalent to 10 mS/cm) at the end of mining. Water quality at the west end of the pits is forecast to be approximately 20,000 mg/l.

Impacts on Station Bores

Where the cones of depression from the water supply borefield and dewatering extend to station bores, there is the potential that yields from those bores will be reduced. Furthermore, there is likelihood of saline water moving towards the proposed cloud break pits. If this occurred and was not effectively managed, it could contaminate nearby station bores.

Cumulative impacts

During this assessment, Aquaterra has considered the cumulative impacts from the Cloud Break and Stage B Projects. Cumulative impacts would occur if the cones of depression from the dewatering at Cloud Break overlapped with the cones of depression resulting from the dewatering at Christmas Creek and the abstraction from the borefield.

Aquaterra report (Appendix C) confirmed that the cones of depression from the two Projects do not overlap, therefore it is concluded that there are no cumulative impacts.

Management Strategies

Detail on management of pit dewatering is presented in Aquaterra's report in Appendix C.

Whilst sufficient data have been obtained to undertake a preliminary assessment of the potential impacts of the Project on groundwater, it is recognised there is a need for further work, prior to licensing and construction of the dewatering bores. Further work is proposed to improve the assessments of dewatering requirements in the pits. This will involve the drilling of additional test bores in the alluvial deposits at Cloud Break. Each test bore will be test pumped using a submersible pump. The analysis of the data will provide improved estimates of the hydraulic characteristics of the saturated material, and is expected to be completed by the end of October 2005. In addition FMG is continuing to sample water quality in mineral bores across the Project Area.

The results of these investigations will be used to improve the Cloud Break numerical groundwater model, providing more robust estimates of dewatering requirements and salinity of the abstracted water.

Further work undertaken on the groundwater model will include model sensitivity assessment, and uncertainty analyses. The current model will be refined as more field data becomes available.

FMG will develop a Vegetation Monitoring and Management Programme (as part of the Dewatering Management Plan) which will include permanent vegetation monitoring plots to be monitored prior to, during and after borefield operations, to ensure that any impacts on potentially groundwater-dependent vegetation are adequately managed. Measures will include, but not be limited to:

- the construction of groundwater bores to monitor water levels in the alluvial and basement aquifers along creeks where vegetation might be effected, prior to commencement of abstraction;
- sampling of groundwater in the vicinity of Cloud Break to monitor changes in salinity in the alluvial aquifer during dewatering;
- development of improved numerical groundwater models and annual calibration of these models, so that future drawdowns, for the life of the Project, can be identified in a timely manner before potential impacts occur;
- assessment of vegetation condition in groundwater drawdown areas (commencing prior to abstraction); and
- if groundwater monitoring and vegetation condition assessments indicate a decline in tree condition due to drawdown, consideration of irrigation systems to support selected communities outside the proposed mining areas.

The results of vegetation monitoring within the groundwater drawdown zone will be reported in the Annual Environmental Report, which is submitted to the DoE and the DoIR.

FMG has developed a Subterranean Fauna Management Plan in consultation with CALM for its proposed mining operations, which incorporates the Project (Appendix K). The first step in this management plan is understanding the distribution of stygofauna through a sampling programme to be undertaken bi-annually for two years. Management strategies to minimise disturbance to stygofauna populations (such as managing dewatering rates) and reporting mechanisms will be undertaken in accordance with this Plan.

Monitoring of several station bores has commenced in the vicinity of the Project. If operating station bores become saline as a result of pit dewatering for the Project, mitigation measures may include deepening of affected bores or provision of alternative water supplies to the pastoral lessee.

FMG proposes continuation of water quality sampling of station bores in the vicinity of the Project. Down-hole geophysics may be used to accurately determine if movement of the saline interface is occurring.

6.6.2 Dewatering Discharge

Potential Impacts

Aquaterra has undertaken an initial estimate of dewatering requirements for the Cloud Break pits (Appendix C). This has identified that there will be an excess of water from the dewatering operation not required for the operations water supply, and therefore will require appropriate management.

The proposed mining schedule for the first six years will target high-grade material which does not require beneficiation. As a result there will be little demand for water other than for dust suppression, moisture control and camp supplies. In subsequent years, low-grade material will be mined which will be processed at the Stage B beneficiation plant at Christmas Creek. The demand for water at Christmas Creek will not increase above that already proposed for the Stage B Project.

The numerical modelling has indicated that water abstracted during dewatering will remain fresh enough for use in the ore-beneficiation plant. The volume of water predicted to be discharged is given in Table 10.

Table 10. Volumes of Water to be Discharged from Pit Dewatering

Year	Average (ML/d)	Total (ML/a)
1	4.3	1569.5
2	7.1	2591.5
3	16.8	6132
4	4.8	1752
5	23.2	8468
6	22.5	8212.5
7	11.9	4343.5
8	32.3	11789.5
9	17.4	6351
10	4.9	1788.5
11	20.0	7300
12	6.8	2482
13	0.1	0

Management Strategies

The DoE is responsible for licensing discharge of water to the environment and recommends a hierarchy of disposal mechanisms.

1. The preference is that water should be discharged into the aquifer from where it was abstracted (this could be, for instance, via bores or potentially via discharging water into a mined pit from where it will seep away).
2. If this is not feasible, then water should be discharged to another aquifer system (such as via slotted pipes buried into a shallow aquifer).
3. If this is not possible, the water could be discharged, in a controlled manner, to a suitable receiving body.
4. If none of these is possible then, as a last resort, consideration will be given to uncontrolled discharge of the water.

A number of options for disposal of the excess water from dewatering at Cloud Break have been considered. These are discussed in Aquaterra's report in Appendix C and summarised in Table 11. It is important to note that FMG will, whenever possible, use excess water from the dewatering for camp water supplies (up to 2,000 mg/L TDS) and dust suppression (up to 10,000 mg/L TDS).

FMG proposes to store the excess water in a series of storage ponds (Figure 18). It is proposed that six ponds, each 500 m by 1,000 m will be excavated in three pits at the eastern extreme of Cloud Break. These ponds will be 5 m deep on average. Water from the dewatering will be discharged into the pond and leakage will occur from the base. Rainfall and evaporation will also impact upon the volume of water in the ponds. At the end of year 6 it is calculated that the total volume of water stored in the ponds will be 6 GL, which is sufficient to provide more than half the demand of the ore-beneficiation plant for a year. The predicted salinity in the ponds at the end of the 6^{th} year is 10,000 mg/L. On commencement of ore beneficiation, the stored water will be transmitted to Christmas Creek for use in the process plant, thus reducing the water demands on the Mount Lewin Borefield (described in the Stage B PER).

After the 6^{tth} year of mining, it is proposed that all the water abstracted during dewatering will be transmitted directly to the ore-beneficiation plant, again reducing the demands on the Mount Lewin Borefield.

Table 11. Summary of Dewatering Disposal Options

Option	Reliability (High/Medium/Low)	Cost		Investigation Costs (High/ Medium/ Low)	Environmental Consequences (High/Medium/Low)	Compatibility with DoE Hierarchy (Preferred/Neutral/ Least Preferred)	Manageability (Easy/Medium/Difficult)	Overall Rank
		Capital (High/Medium / Low)	Operating (High/Medium/Low)					
Re-injection of groundwater into the alluvium	Medium It will be difficult to recharge aquifer because of the shallow groundwater table. Changes in water quality may impact on station bores. Water quality from the re-injection may be different to the water in the receiving aquifer, resulting in encrustation of the bore linings.	Medium Requires construction of bores, pipeline and associated infrastructure. Re-injection system will not need to be pressurised.	Medium Power costs will depend upon distance between dewatering sites and re-injection bores. Maintenance of bores will be significant on-going expense.	Medium	Medium: Impacts on station bores and phreatophytic vegetation caused by temporary mounding of fresh water and then mounding of saline water. Moderate Greenhouse Gas emissions.	Preferred Lies between 1 and 2 on the DoE hierarchy.	Medium Changes in salinity of discharge water likely to affect effectiveness of injection system.	Medium
Re-injection of groundwater into the dolomite	Low It will be difficult to re-inject into dolomite because it is already saturated. The dolomite is an extensive aquifer, but it only occurs close to or below the marsh. Water quality from the re-injection may be different to the water in the receiving aquifer, resulting in encrustation of the bore linings	High Requires construction of bores, pipeline and associated infrastructure in the Fortescue Marshes. Re-injection system will need to be pressurised.	High Injection will need to be pressured, adding to power costs. Infrastructure may be damaged during flood events. Maintenance of bores will be significant on-going expense.	High	High Bores, pipes etc will have to be completed above ground resulting in visual impact on the marsh. Moderate/High Greenhouse Gas emissions.	Preferred Lies between 1 and 2 on the DoE hierarchy.	Difficult Infrastructure may be damaged during flood events. Changes in salinity of discharge water likely to affect effectiveness of injection system.	Low
Re-injection of groundwater into the Marra Mamba	High Marra Mamba is only partially saturated, therefore there is significant available storage Changes in water quality may impact on station bores. Water quality from the re-injection may be different to the water in the receiving aquifer, resulting in encrustation of the bore linings	Medium Requires construction of bores, pipeline and associated infrastructure Re-injection system will not need to be pressurised.	Medium Power costs likely to be similar to re-injection into alluvium. Maintenance of bores will be significant on-going expense.	Medium	Low/Medium Potential for brackish water to be injected into Marra Mamba, which is likely to contain fresh water at present. Possible increase in salinity in station bores. Moderate Greenhouse Gas emissions.	Preferred Lies between 1 and 2 on the DoE hierarchy.	Medium Changes in salinity of discharge water likely to affect effectiveness of injection system.	Medium/High

Option	Reliability (High/Medium/Low)	Cost		Investigation Costs (High/ Medium/ Low)	Environmental Consequences (High/Medium/Low)	Compatibility with DoE Hierarchy (Preferred/Neutral/ Least Preferred)	Manageability (Easy/Medium/Difficult)	Overall Rank
		Capital (High/Medium / Low)	Operating (High/Medium/Low)					
In-pit disposal	Medium Requires a pit to be fully mined before this option can be used. Subject to the capacity of the selected pit. Could not be used in the first few years of mining, as no mined pit would be available.	Low/Medium No bores required. Discharge method consists of a large diameter slotted pipe laid in a bed of permeable material (gravel).	Low/medium Power and maintenance costs likely to be low.	Medium	Low Water is being injected back to original aquifers. Possible effect on phreatophytic vegetation near the pit if groundwater mound approaches ground level Moderate Greenhouse Gas emissions.	Preferred Number 1 on DoE hierarchy	Easy But only feasible once an initial pit void has been created.	Medium/High Subject to suitable pit void being available.
Evaporation pond	High Effectiveness of this option is not affected by changes in water quality. Needs suitable site located away from possible inundation from creeks and the Fortescue Marshes.	Medium/High Careful engineering design and construction required preventing land control leakage of water, which will become increasingly saline as evaporation occurs.	Low Low power and maintenance costs. Geotextile membrane should be suitable for life of mine. Costs of rehabilitation will be significant.	Low	Low Initial void would be created which could be backfilled on completion. Low/Moderate Greenhouse Gas emissions. Careful design of monitoring and containment required to prevent escape of saline water to the environment. Large excavation required.	Neutral Does not score on DoE hierarchy, but generally not preferred by regulators. Difficult to licence. Likely to have low environmental impact.	Medium Assuming suitable site can be found. Would require careful ongoing management to ensure containment of saline water.	High
Shallow infiltration	Medium Unclear if there are suitable sites for discharging large volumes of water. Subject to damage during flooding.	Medium Requires installation of buried French Drains along creeks Cost dependent upon permeability of host material (and thus length of drains to be installed)	Medium Drains tend to become damaged during cyclones. Power costs likely to be low.	Medium	Medium Impact of installation on vegetation may be extensive. Low/Moderate Greenhouse Gas emissions.	Neutral Scores 3 on DoE hierarchy.	Medium	Medium Suitable locations for sites not yet determined.
Surface water outflow	High Fortescue Marshes has dimensions large enough to store likely water volume	Low Requires only discharge pipe work and baffles to prevent erosion.	Low Power costs low	Low	High Semi-permanent body of fresh water formed, May impact on vegetation and fauna. Low Greenhouse Gas emissions.	Least Preferred Scores 3 or 4 on DoE hierarchy DoE likely to licence only as a last resort.	Easy Uncontrolled discharge means little management required.	Low Environmental issues likely to be too great.

Option	Reliability (High/Medium/Low)	Cost		Investigation Costs (High/ Medium/ Low)	Environmental Consequences (High/Medium/Low)	Compatibility with DoE Hierarchy (Preferred/Neutral/ Least Preferred)	Manageability (Easy/Medium/Difficult)	Overall Rank
		Capital (High/Medium / Low)	Operating (High/Medium/Low)					
Sale and transport	Low Requires a market. Which may be only temporary, if at all.	Not Known Depends on method of transport and distance.	Not known Depends on method of transport and distance	Low	Not Known Depends on method of transport and distance.	Preferred Does not score on DoE hierarchy, but likely to be preferred.	Low Depends on market, which may be short-term and unreliable.	Low No market at present

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6.6.3 Mine Closure

Potential Impacts

The Mine Closure Plan involves the backfilling of waste material into the pits. At Cloud Break this material will consist of overburden and waste rock. Once the material is replaced into the pit it will have a similar permeability to the surrounding pit wall materials and the original ore body (although greater porosity as the material has been loosened through mining), and therefore in the long-term, groundwater levels are expected to return to approximately their pre-mining level. FMG has committed to backfilling pits to the extent of available material (at least to above the water table) and it is not anticipated that there will be any pit voids.

It is considered that the Mine Closure Plan proposed by FMG will mean that there will be no long-term impact on the hydrogeology of the pit areas.

Management Strategies

Backfilling the pits to the pre-mining level with waste rock and overburden is expected to be adequate to manage the potential long-term impacts of mine closure on the hydrogeology of the Project Area. FMG has developed a Conceptual Mine Closure Plan (Appendix M), which will be modified as the Project develops. Prior to completion of mining at Cloud Break, FMG will be required to submit a more detailed Mine Closure Plan to the Regulators for approval (Section 6.11.2).

Should Mined out pits be used for discharge of saline water from dewatering operations, closure of these ponds will be undertaken in accordance with accepted management practices at time of closure. This may involve capping of the ponds with low-permeability material to reduce percolation, and then covering these with sufficient rock or overburden material to prevent capillary rise of salt, before being covered with topsoil and revegetated.

6.6.4 Fortescue Marshes

Potential Impacts

The potential impacts on the Marshes from the dewatering and borefield water supply have been assessed based on the conceptual model for the Marshes.

There are two potential impacts on the Marshes from groundwater abstraction for the Project that need to be considered:

- will surface water in the Marshes form less frequently than it does at present?
- will the Marshes dry out more quickly than at present?

The Fortescue Marshes are considered to be a surface water feature which relies on runoff after rainfall. Evaporation from the water table results in groundwater levels being maintained approximately 5 m below the base of the Marshes. Therefore, changes in the hydrogeological regime are not expected to result in the Marshes being filled less frequently than at present.

Figure 8 shows an unsaturated layer below the bed of the Marshes. The volume of water draining from the Marshes into this layer is limited by the available storage within that unsaturated zone. If drawdowns from the dewatering and/or water supply borefield were to extend below the Marshes, then the available storage would increase and would have the potential to increase the volume of water draining from the Marshes. In order to confirm this concept FMG has installed stage boards in the Marshes and is monitoring water levels in bores along the northern flank of the Marshes. The data from these studies will be used to better understand the relationship between surface water and groundwater.

The groundwater modelling indicates that the cone of depression from the dewatering of Cloud Break will extend close to the Fortescue Marshes but not beneath it, and therefore irrespective of whether the alluvium below the Marshes becomes saturated or not, the Marshes are unlikely to be affected by drawdowns from the dewatering.

Given the importance of the Marshes, a Risk Assessment was undertaken for the Stage B PER, which considered the potential impacts on the Marshes resulting from changes in groundwater levels. The results are included in a separate report (minRISK, October 2004). However a summary of the potential risks is provided below. It is important to recognise that although the Risk Assessment undertaken for the Stage B PER was specifically used to assess the risk to the Marshes from the dewatering at Christmas Creek and from the proposed borefield, the results are equally relevant to the Cloud Break assessment.

Fortescue Marshes Risk Assessment

The potential impacts on the Marshes from pit dewatering and saline water were listed and the risks assessed using a model based on AS/NZS 4360: 1999 “Risk Management” and utilising risk criteria specifically developed from the guidelines within HB 203: 2000 “Environmental Risk Management”.

The calculation of risk and definitions used in the Risk Assessment are shown in Table 12.

Table 12. Risk Matrix Used for Qualitative Risk Assessment

	Consequence

Likelihood	Catastrophic	Major	Moderate	Minor	Insignificant
Almost certain	E (1)	E (3)	E (6)	H (10)	H (15)
Likely	E (2)	E (5)	H (9)	H (14)	M (19)
Possible	E (4)	E (8)	H (13)	M (18)	L (22)
Unlikely	E (7)	H (12)	M (17)	L (21)	L (24)
Rare	H (11)	H (16)	M (20)	L (23)	L (25)

Definitions		
Measures of Likelihood		
A	Almost certain	It is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Could occur
D	Unlikely	Could occur but not expected
E	Rare	Occurs only in exceptional circumstances
Measures of Impact		
1	Catastrophic	Death, toxic release off-site with detrimental effect, huge financial loss
2	Major	Extensive injuries, loss of production capability, off-site release contained with outside assistance and little detrimental impact, major financial loss
3	Moderate	Medical treatment required, on-site release contained with outside assistance, high financial loss
4	Minor	First aid treatment, on-site release immediately contained, medium financial loss
5	Insignificant	No injuries, low financial loss, negligible environmental impact
Level of Risk		
E (1-8)	Extreme Risk	Immediate action required
H (9-16)	High Risk	Senior management attention needed
M (17-20)	Moderate Risk	Management responsibility must be specified
L (21-25)	Low Risk	Managed by routine procedures

For the purposes of the Risk Assessment the Marshes was defined as the area within the Australian Nature Conservation Agency (ANCA) boundary. A list of potential impacts on the Marshes was developed and impacts and likelihoods estimated. The results are presented in Table 13 below.

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Table 13. Inherent Risks to the Fortescue Marshes (minRISK, October 2004)

Activity	Issue	Impact	Consequence	Likelihood	Inherent Risk Rating	Inherent Risk Score [2]
Mine dewatering	Groundwater drawdown	Drawdown affecting water levels in the Marshes and therefore vegetation.	Minor (2)	Unlikely (D)	**L**	**21**
Mine dewatering	Groundwater drawdown	Drawdown affecting Stygofauna.	Insignificant (1)	Rare (E)	**L**	**25**
Mine dewatering	Groundwater drawdown	Drawdown affecting yields from stock bores within Marshes boundary.	Insignificant (1)	Rare (E)	**L**	**25**
Mine dewatering	Groundwater drawdown	Aquifer drawdown impacting on drying cycle.	Minor (2)	Possible (C)	**M**	**18**
Mine dewatering	Groundwater discharge	Effect of disposal of saline water produced during pit dewatering[1]	Insignificant (1)	Rare (E)	**L**	**25**
Mine dewatering	Groundwater discharge	Flora loss from pipeline failure releasing saline water	Insignificant (1)	Rare (E)	**L**	**25**

Notes:

1. This issue has been re-assessed for the Cloud Break PER and has been addressed previously in Section 6.6.2.
2. The inherent risk score is calculated from Table 12. For example a low score indicates extreme to high risk, whilst a high risk score indicates a medium to low risk.

Management Strategies

A series of management and mitigation measures was developed as part of the Risk Assessment to reduce the potential groundwater impacts on the Fortescue Marshes. These are summarised in Table 14, with the residual risk rating (i.e. risk after management measures have been implemented).

Table 14. Mitigation Measures to Manage Impacts on the Fortescue Marshes

Potential Impact	Mitigation Measure	Residual Risk	Residual Risk Number [2]
Drawdown from dewatering affecting water levels in the Marshes and therefore vegetation.	Installation of groundwater monitoring bores between the pits and the Marshes Monitoring and measurement of those bores Development, and annual calibration, of a groundwater impact model Third party hydrological reports Timely development of contingency plans for an alternative abstraction borefield if the model and/or monitoring data predict an impact	L	23
Drawdown from the dewatering affecting stygofauna.	Not required – initial risk considered insignificant Subterranean Fauna Management Plan (See Section 6.4)	L	25
Drawdown from the dewatering impacting on the drying cycle of the Marshes.	Installation of groundwater monitoring bores between the pits and the Marshes Monitoring and measurement of those bores Development of and annual calibration of a groundwater impact model Third party hydrological reports.	L	21
Effect of disposal of fresh and saline water produced during pit dewatering	Regular sampling from the dewatering bores Installation of deeper water quality monitoring bores Mixing of saline water with fresh water for use in the ore beneficiation process Use of Mined out pits to dispose of excess water Provision of alternative supplies of water for station bores Development of alternative disposal plans	L	25
Flora loss from pipeline failure releasing saline water	Bunding, pipeline pressure monitoring and inspections	L	25

Note:

1. The residual risk score is calculated from Table 12. For example a low score indicates extreme to high risk, whilst a high score indicates a medium to low risk.

Provided the above measures are implemented, no unacceptable impacts on the Fortescue Marshes are predicted as a result of groundwater abstraction for the Project.

6.7 GREENHOUSE GAS EMISSIONS

The EPA objective with regards to Greenhouse Gas emissions is to:

- *minimise Greenhouse Gas emissions for the Project and reduce emissions per unit product to as low as reasonably practicable, and mitigate Greenhouse Gas emissions in accordance with the Framework Convention on Climate Change 1992, and with established Commonwealth and State policies.*

Potential Impact

The Greenhouse effect is a natural phenomenon that warms the earth and enables it to support life. However, since the industrial revolution, the amount of Greenhouse Gases in the atmosphere has increased dramatically, resulting in increased global warming. The six Greenhouse Gases specifically covered by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and nitrous oxide (N_2O) (Commonwealth of Australia, 1998). To compare warming potential of the different gases, their impact is usually expressed in terms of CO_2 equivalents, where the potential of each to lead to heating in the atmosphere is expressed as a multiple of the heating potential of CO_2 (i.e. t CO_2e).

In the construction and operation of the Project, Greenhouse Gases will be released to the atmosphere by:

- combustion of diesel fuel for the mining vehicles;
- combustion of fuel (assumed to be natural gas) to meet the Project's power requirements;
- combustion of diesel fuel for the transportation of the mined ore to Port Hedland; and
- decomposition of cleared vegetation and release of carbon from the soil.

An estimate of the annual Greenhouse Gas emissions was based on the methodology outlined in:

- AGO Factors and Methods Workbook, August 2004, Australian Government, Australian Greenhouse Office;

- Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003 for
  - Energy (Stationary Sources);
  - Energy (Transport); and
  - Land Use, Land Use Change and Forestry.

An estimate of the average annual Greenhouse Gas emissions associated with the Project is presented in Table 15. Assumptions used to calculate these emissions are also provided in the Table.

Table 15. Estimated Annual Greenhouse Gas Emissions for the Project

Activity	**Assumptions**	**Average tonnes CO_2e per year during the Project**
Power consumption	• 45 MW power station for FMG's Cloud Break and Stage B Projects • 81,234 MWh per year required for Project	90,495 *(17,547)* [1]
Mobile equipment and vehicle fuel consumption	• 40.7 ML per year automotive diesel oil • 1.02 L diesel per tonne of ore mined	109,944
Transport of product from mine to port	• assessed as part of Stage A	0
Vegetation clearing for mine	• clearing 5,500 ha over 12 years • 27 t carbon per hectare above-ground biomass • 70 t carbon per hectare in soil • no revegetation offsets calculated [2]	72,786
Total		**273,224** ***(200,276)*** [1]

Notes:
1. Estimated CO_2 emission if natural gas-fired power station used.
2. On the advice of AGO, revegetation of areas cleared after 1990 cannot be used to offset Greenhouse Gas emissions from clearing.

Assuming an average annual production of 28.7 Mtpa ore over 12 years from the Cloud Break Mine, this equates to approximately 9.5 kg CO_2e per tonne of ore produced. This value reduces to 7.0 kg CO_2e per tonne of ore produced if calculations are based on natural-gas power generation, which is considered the most likely scenario. However, as vegetation and soil breaks down, there will continue to be loss of carbon to CO_2 from biomass decay over a 10-year period, and from soil carbon release over a 25-year period beyond the life of the project. Taking this into account, an average of additional 43,310 tonnes CO_2e per year will continue to be released for a 25 year period after the mining has ceased.

Revegetation offsets were not included in the calculations based upon advice from the Australian Greenhouse Office. However, in reality this estimate of CO_2 emissions from decomposition of vegetation and soil carbon release will be offset by progressive revegetation of cleared areas throughout the life of the mine which will reduce the total emissions of Greenhouse Gas from the Project (i.e. re-established vegetation will absorb CO_2).

A comparison of total emissions calculated for similar projects in the region is presented in Table 16.

Table 16. Comparison of Greenhouse Gas Emissions for Recent Iron Ore Proposals

Project		**Units**	**Reference**
Robe River West Angelas Project	10-13	$kgCO_{2e}$/t of ore shipped	Robe River, 1998
BHP Mining Area C Project	12	$kgCO_{2e}$/t of ore shipped	BHPBIO, 1997
Hamersley Iron Nammuldi Silvergrass Iron Ore Project	9-12	$kgCO_{2e}$/t of ore shipped	Hamersley Iron, 2000
FMG Stage A (port + N-S rail only)	5.9 *(4.2)* [1]	$kgCO_{2e}$/t of ore shipped	ENVIRON, 2004
FMG Revised Stage B Project (mine + E-W rail)	11.4 *(8.8)* [1]	$kgCO_{2e}$/t of ore shipped	
FMG Cloud Break (mine only)	9.5 *(7.0)* [1]	$kgCO_{2e}$/t of ore shipped	

Notes:
1. Estimated CO_2 emission if natural gas-fired power station used.

It is likely that the methodology or emission factors used to calculate the emission figures for the other projects were different, as the guidance references used to calculate FMG's emissions were published after the assessment of the Robe River, BHPBIO Mining Area C and HI Projects. Also, the calculations were based on the assumption that the vegetation proposed to be cleared was 'forest', as no category is provided in the methodology guidelines for the less dense shrubland, grassland, and open woodland vegetation forms present in the Pilbara (see Section 4.6.1.1). This assumption would result in an overestimation of predicted Greenhouse Gas emissions. It is also unclear whether the other projects considered revegetation offsets. Cumulative impacts from Greenhouse Gas emissions from FMG's projects are discussed in Section 6.14.5.

Management Strategies

FMG will commit to minimising Greenhouse Gas emissions as far as practicable. During construction and subsequent operation of the Project, the land area and total amount of biomass cleared will be minimised. Cleared vegetation will be stockpiled for use in rehabilitation, to provide mulch and a seed source to assist revegetation. Cleared areas will be progressively rehabilitated as mining progresses and this will offset Greenhouse Gas emissions to some extent. The construction and operations phases of the Project will be designed to minimise Greenhouse Gas emissions through minimising vehicle movements, duplication of activities and use of natural resources.

In designing the Project, FMG will, where practicable, select the most energy efficient technology available. Once operational FMG will monitor Greenhouse Gas emissions and continue to look for ways to improve energy efficiency and reduce Greenhouse Gas emissions, as part of continual improvement. Renewable energy sources will be used where appropriate (e.g. solar panels for power in remote areas).

6.8 DUST

The EPA objectives with regards to dust are to:

- *protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems; and*
- *ensure that particulate/dust emissions, from FMG's activities meet appropriate criteria and do not cause environmental or human health problems.*

Potential Impacts

The proposed Cloud Break Mine will be located in an arid area which has naturally high background dust levels. Other than vehicles travelling along unsealed roads and pastoral activities, there are currently no anthropogenic sources of dust in the vicinity of the Project Area.

Potential dust sources from the Project include:

- construction and mining -
  dust will be generated during construction and mining from clearing of vegetation and earthmoving activities including blasting (if required);
- drushing and sizing -
  primary crushing and sizing will be undertaken either on the pit floor or the pit rim, with a lower potential for off-site dust impacts if crushing is undertaken in-pit;
- transport -
  dust is likely to be generated from movement of vehicles on unsealed roads, loading and unloading of overburden and ore, ore transfer points and lift-off from conveyors, haul truck trays and open rail wagons; and

- cleared areas -
  areas cleared for mining operations such as haul roads, laydown areas and active mining areas will be prone to dust lift-off under windy conditions unless these areas are able to be stabilised (e.g. through water sprays, sealants or progressive rehabilitation).

The iron ore mineralisation from the Cloud Break Mine is from the Marra Mamba and is similar to other Marra Mamba ores currently exported from the Pilbara. High grade material, which does not require beneficiation, will be mined and transported in the first six years. Ore will be 'conditioned' prior to transport to Port Hedland to ensure the moisture content is sufficient to minimise dust generation. During years 6 to 12, low grade material will be mined and beneficiated. Beneficiation is a wet process and therefore the potential for dust generation from the final product is expected to be low.

The nearest settlements to the Project are:

- Marillana Station – 31.5 km;
- Bamboo Springs – 34.8 km;
- Mulga Downs Outcamp (not residential) – 18.8 km;
- Warrie Outcamp (not residential) – 8.3 km; and
- Hillside Outcamp (not residential) – 20.4 km.

None of these settlements is close enough to the Cloud Break Leases to be affected by dust from the Project.

The closest operational area to the Mine Camp will be the overburden storage area located approximately 1.12 km to the southeast of the Camp. Apart from initial ground disturbance and construction of the storage area, this will be progressively rehabilitated in the first few years of mining. The secondary crusher and loading stockpile will be located approximately 2.18 km southeast of the Mine Camp.

Dust generated during the construction, operation and maintenance of the proposed Mine areas has the potential to negatively affect surrounding vegetation, but this is considered to be a minor and localised impact (see Section 6.2.6).

Management Strategies

Standard dust suppression measures will be implemented across the Project Area during construction and operation to minimise impacts on surrounding vegetation. These may include:

- locating amenities to the east and south-east of high dust sources, since westerly and north-westerly winds are uncommon throughout the year (assuming that climate data for Cloud Break is similar to that of Newman). The Project layout (Figure 2) shows the Mine Camp located east of the majority of the mining areas, although a few pits are located to the south and south-east of the Camp at a distance of greater than 1.5 km. The loading stockpile is approximately 2 km to the southeast of the Mine Camp. Potentially high dust sources are therefore considered sufficiently distant to not adversely affect the amenity of the Mine Camp. However, strict dust control measures will be implemented in these areas, particularly under south-easterly winds;

- incorporating dust control measures into Project design (e.g. covers on transfer points, enclosing parts of machinery which create high dust levels, and installation of sprinklers at stockpile areas) where appropriate;

- using dust avoidance and suppressant measures to minimise deposition of dust on vegetation;

A Dust Management Plan will be developed which incorporates appropriate dust control measures during construction and operation of the mine, such as:

- the use of dust suppression measures on high traffic areas such as access roads, haul roads and laydown areas (e.g. water carts, or other non-water soil stabilisers);
- minimisation of vegetation clearing, and ensuring that areas no longer required during current operations are progressively rehabilitated;
- optimisation of vehicle movements;
- daily visual inspections of construction areas and active mining areas to ensure dust control measures are implemented and are effective;
- regular assessment of the condition of the vegetation and the impacts of dust deposition; and
- ambient dust monitoring where appropriate.

6.9 NOISE AND VIBRATION

The EPA objective for the Project with regards to noise is to:

ensure noise impacts emanating from construction and operation activities comply with statutory requirements and acceptable (and appropriate) standards.

Lloyd Acoustics was commissioned by FMG to investigate the potential noise impacts of the

Project. The results of the noise assessment are presented in Appendix N and summarised below.

The computer modelling programme SoundPlan 6.2 was used to predict the noise propagation from the mine and the Stage B railway to the surrounding areas. For the operational scenarios the programme was selected to use the CONCAWE algorithms. The CONCAWE methodology deals with the influence of wind and stability of the atmosphere. Noise from blasting was calculated using equations developed by Orica Explosives Australia.

As the Project will operate 24 hours a day, the night time noise criteria were considered the most critical. Detail on the noise criteria defined in the *Environmental Protection (Noise) Regulations 1997* and the Western Australian Planning Commission's *Draft Statement of Planning Policy: Road and Rail Transport Noise* are presented in Appendix N.

6.9.1 Operational Noise

Issue

The results of the noise modelling for operational noise are presented in Table 17, and shown in Figure 19.

Table 17. Predicted L_{A10} Night-time Noise Levels

Receiver Location	**Predicted Noise Levels for Initial Mining Phase**	**Most Stringent Noise Level Criteria (Noise Regulations)**
Marillana Station	7 dB(A)	35 dB(A)
Mine Camp	34 dB(A)	65 dB(A)
Fortescue Marshes	36 – 40 dB(A)	-
Warrie Outcamp (not residential)	24 dB(A)	-

The results of the operational noise predictions show that under EPA default meteorological conditions, the worst affected premises (Marillana Station) will receive a noise level of L_{A10} 7 dB. This level is significantly below the assigned night-time noise levels under the *Environmental Protection (Noise) Regulations 1997* and is unlikely to be audible. Higher noise levels (L_{A10} 24 dB) are predicted at Warrie Outcamp, however, this is a remote camp and is not considered to be a residence.

The predicted noise level to the Cloud Break Mine Camp is L_{A10} 34 dB. As the Mine Camp is associated with the proposed mine, it is considered to be an industrial premises under the Regulations and the assigned noise level is therefore L_{A10} 65 dB. Thus, compliance is achieved and the Mine Camp will have an acceptable level of amenity.

Management Strategies

FMG will develop a Noise and Vibration Management Plan for the Cloud Break and the Stage B Projects. Low-noise plant and equipment will be used where practicable during construction and operations of the Project. No other specific management measures are expected to be required to achieve compliance with the *Environmental Protection (Noise) Regulations 1997*.

6.9.2 Blasting Noise

Potential Impacts

Noise modelling indicates that the predicted blasting noise levels show that the unconfined blasts result in the highest noise levels (Table 18). For the initial operations at Cloud Break, the most affected residence is Marillana Station with predicted noise levels of 113 dB $L_{Linear\ peak}$. Higher noise levels (126 dB $L_{Linear\ peak}$) are predicted at Warrie Outcamp, however, this is a remote camp and is not considered to be a residence.

Table 18. Predicted Blasting Noise Levels

Receiver Location	Predicted Linear Peak Noise Level (dB) for Unconfined Blast	Predicted Linear Peak Noise Level (dB) for Confined Blast
Mine Camp	139	116
Fortescue Marshes	139	115
Marillana Station	113	90
Bamboo Springs	111	88
Mulga Downs Outcamp (not residential)	117	94
Warrie Outcamp (not residential)	126	103
Hillside Outcamp (not residential)	117	94

The Noise Regulations require airblast noise levels to be under 125 dB $L_{Linear\ peak}$ during the week and 120 dB $L_{Linear\ peak}$ on Sundays, however, 9 in any 10 consecutive blasts (regardless of the interval between each blast), when received at any other premises, are not to exceed:

- 120dB $L_{Linear\ peak}$ between 0700 hours and 1800 hours on Monday to Saturday inclusive; or
- 115dB $L_{Linear\ peak}$ between 0700 hours and 1800 hours on a Sunday or public holiday.

The predictions show that for the assumed charge mass, the blasting levels are below the regulations at all noise sensitive premises. Airblast noise will be slightly higher although this is not considered a ‘premise’ under the regulations. Although the Mine Camp is not considered to be a noise-sensitive premise, management of blasts will ensure that the impacts on employees stationed there is minimised.

Management Strategies

FMG will implement specific blast management procedures where appropriate which may include:

- blasting under favourable meteorological conditions;
- modifying blasting practices to minimise noise propagation to the Marshes and Mine Camp;
- conducting noise monitoring in the vicinity of the Marshes; and
- monitoring impacts on birds utilising the Marshes during breeding times.

6.9.3 Effect of Noise on Birds

The Australian Government Department of Environment and Heritage notes that research into the effects of noise on animals is relatively scarce. Most studies have been undertaken in Europe or America, with particular reference to military operations. Although many of the studies were inconclusive, it is known that a large number of animals have adapted to the presence of humans and the noise generated by humans. The animal's initial reaction to a new noise source may be fright and avoidance, but if other sensory systems are not stimulated (for instance sight or smell), the animal learns quite quickly to ignore the noise source. Further detail of the findings of research into noise impacts on different bird species is presented in Appendix N.

Based on this research, it is concluded that there is likely to be some short-term disturbance, from the Project, of birds and other fauna in the vicinity of the Fortescue Marshes, although birds are quick to adapt to a changing environment and should resume normal activities in a short period of time. It is likely that the majority of fauna will become accustomed to the noise levels and that the only impacts might be localised effects on certain populations.

Despite this, FMG will develop a Noise and Vibration Management Plan and monitor the effects of blasting on birds as described below. In terms of transportation and operational noise, the research suggests that an adverse impact to the wildlife from these noise sources is unlikely.

Management

The measures, outlined above in Section 6.9.2, to minimise blasting noise will be implemented to reduce the risk of adverse impacts on birds which may utilise the Fortescue Marshes.

6.10 WASTE MANAGEMENT

The EPA objectives with regards to waste management for the Project are to:

- *ensure that disposal/management of wastes do not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards; and*
- *minimise the risk to the environment resulting from potentially acid forming materials.*

The inappropriate management of waste can result in an increase in the use of natural resources, increased disposal costs and an increased risk of pollution to surface water, groundwater, soil and air, and a danger to human health. Therefore, FMG will develop a Waste Management Plan to manage the potential impacts from the waste streams that will be generated by its operations (Cloud Break and Stage B Projects).

The main waste streams associated with FMG's mining operations will be overburden and general waste.

6.10.1 Overburden

Potential Impacts

Overburden is considered to be the material that is covering the ore body, excluding vegetation and topsoil. Although this material must be removed prior to mining, it is considered an important component of the rehabilitation process. The overburden is used to construct the post-mining landform. On start-up of a mining area, overburden material will be placed in a permanent surface storage area. This is necessary to establish a safe and stable mine area. Once sufficient area of mined-out pit is available, the overburden will be used to backfill the pits and shape the landform similar to pre-mining contours, where practicable. FMG will aim to minimise the size of the off path storage areas and thereby maximise the amount of material available to reconstruct the final landform within the mine path. Detail of the proposed overburden storage facility is provided in Section 5.3.1.1.

The final design and therefore height of the permanent off path storage areas will be based on the surrounding topography in the specific area. Where practicable, local features will be incorporated into the design of these areas. The overburden storage areas will be rehabilitated and revegetated as part of FMG's standard procedures (refer to the draft Rehabilitation and Revegetation Management Plan in Appendix J).

Management Strategies

During the start-up phase of an area, overburden will be placed in a surface storage area. This facility will be contoured to blend with the surrounding environment and create a free-draining, erosion-resistant structure. The facility will then be capped with topsoil or other growth media. If propagation of native vegetation from the topsoil is insufficient, direct seeding using provenance species will be undertaken.

Following the start-up phase the overburden will be placed within the mine pit to establish the post-mining landform. Where practicable, this will resemble the pre-mining land form and will be covered by topsoil from newly stripped areas (Section 6.11.1).

6.10.2 Acid Mine Drainage Potential

The EPA objective with regards to management of potentially acid forming materials is:

- *to minimise the risk to the environment resulting from potentially acid forming materials.*

Potential Impacts

Geochemical characterisation of rock types at the Cloud Break Mine for acid forming potential and multi-element composition was carried out by Graeme Campbell and Associates Pty Ltd (GCA, 2005). This report is presented in Appendix O. Testing has indicated that overburden sampled from the Cloud Break deposits is geochemically benign and unlikely to create Acid Mine Drainage (AMD) problems. In addition, geochemical analyses indicated that the assayed samples contained low levels of environmentally significant elements.

Based on the test-work results undertaken by GCA (2005), it is concluded that, with the exception of the Roy Hill Shales, the regoliths and waste-bedrocks to be produced during open-pit mining should be classified as non acid forming (NAF), due to negligible amounts of sulphide minerals. Enrichments in minor elements should only be slight and soluble salt contents should be low to moderate. The Roy Hill Shales (especially black shales) are classified as potentially acid forming (PAF). However, based on economic evaluations, open-pit mining is not likely to extend deep enough for the Roy Hill Shales to be intersected.

In brief, assuming that the Roy Hill Shales remain undisturbed *in situ*, no geochemical concerns are foreseen for the mine-waste materials to be produced during open-pit mining of the Cloud Break Deposit.

Bores installed for dewatering will extend through the mineralised Marra Mamba and into the underlying formations. The top of the Jeerinah Formation is marked by the Roy Hill Shales, which have the black shale lithology described above. Where the deposit lies directly on the Roy Hill Shales then some dewatering of the shale will occur. However, the geological sections (Figures 20a to 20f) show that, generally, the deposit lies on Nammuldi Member shales and BIF, therefore it is likely that limited dewatering of the Jeerinah will be needed.

The black shales lithotype chiefly comprises micropores due to its clay matrix. In the event that dewatering lowers the water table sufficiently to drain the black shales, the primary pore spaces within the black shales would remain near saturated and therefore protect the pyrite against oxidation. Any oxidation of exposed pyrite grain surfaces should be largely restricted to secondary pore spaces such as is produced through fragmentation from blasting in the overlying pits.

Based on the available information, the likely magnitude of the various weathering processes that may occur within the cone of groundwater depression is uncertain, although it is thought that any remobilisation of acidity following cessation of dewatering activities would be modest. FMG will monitor bores within the cone of depression to determine if dewatering activities are impacting on the black shales (Jeerinah Formation). If monitoring suggests that the cone of depression is extending into the Jeerinah Formation, additional modelling (such as oxygen diffusion modelling) will be undertaken to determine the extent of impact and how best to manage this.

Management Strategies

Should the Roy Hill Shales occur within the groundwater cone of depression through pit dewatering, then further investigatory work such as oxygen-diffused modelling, and monitoring, would be needed to assess the magnitude of localised pyrite-oxidation within the dewatered shales and develop appropriate management measures.

Should acid-generating materials be encountered (although unlikely), a management plan will be developed. This will include the material being placed and covered to prevent exposure to rainfall and infiltration, and subsequent transport of mine drainage.

6.10.3 General Waste

Potential Impacts

General waste expected to be generated at the four mine sites includes:

- construction waste;
- maintenance waste (e.g. hydrocarbons, tyres, scrap metals);
- spill clean-up waste;
- sewage and grey water from site amenities and on-site accommodation facilities; and
- miscellaneous waste (e.g. putrescible wastes, old equipment).

Appropriate management of these waste streams will be required to ensure there is no pollution of the environment, or risk to human health.

Management Strategies

FMG will produce a Waste Management Plan prior to construction. As part of this Plan, FMG will implement a procurement policy which minimises waste generation.

In line with best practice environmental management principles, FMG will implement the following waste management hierarchy, during the construction and operational phases of the Project:

1. Avoid	Reduce the amount of waste generated at the site. Such measures could include: • bulk purchasing of consumables; • standardising the size and type of materials purchased; • minimising the use of disposable products; • consideration of waste generation during process design; and • regular maintenance of equipment;
2. Re-use	Re-use waste products without substantially changing their form (i.e. using effluent from sewage treatment plants in the Stage B beneficiation plant, re-filling printer ink cartridges, and mulching of vegetative wastes);
3. Recycle	Recycle waste that is no longer usable in its present form and using it to produce new products (i.e. segregation and storage of scrap metal, oil, plastics, aluminium cans, glass and paper for periodic collection for transport to an off-site recycling facility);
4. Energy Recovery from Waste	Adopt management practices that recover and use energy generated from waste (i.e. off-site burning of waste oil for energy; and high temperature incineration of workshop wastes);
5. Treat and/or Dispose	Adopt management practices that reduce the potential for environmental harm by disposing of waste, or treating and disposing of waste. Such measures could include: • composting/vermiculture; • biotreatment of contaminated soils; • blending or mixing waste; and • disposal to inert and putrescible landfills.

An Environmental Awareness Training programme will encourage waste reduction, re-use and recycling. Waste that cannot be re-used or recycled will be disposed of in approved landfill facilities (either on-site or off-site), in accordance with relevant legislation and standards.

Recyclable materials

Recyclable materials will be separated on site. A local waste management and recycling contractor will be used to collect and remove waste from site, re-using and recycling waste wherever practicable. FMG currently recycles material at its exploration sites.

Hydrocarbons and hazardous wastes

During construction and operations, FMG will ensure that hydrocarbons and other potentially polluting substances are correctly stored according to Australian Standards, and will implement procedures for correct transport, storage, handling, spill prevention and emergency response procedures to minimise the risk of contamination from inappropriate waste disposal.

Oil drums, oil filters and batteries will be collected and stored appropriately prior to removal by a licensed contractor. Workshops will be constructed in such a manner as to allow the safe and efficient storage of these wastes.

Material to landfills

Field landfills will be used for putrescible waste and inert non-recyclable material only and will not be used for the disposal of waste oil or other hazardous wastes. Waste will be covered regularly to minimise wind-blown litter, odour, and animal scavenging. Field landfills will be managed in accordance with the Department of Environmental Protection (DEP)'s Code of Practice for Country Landfills (DEP, 1996a) and Landfill Waste Classifications (DEP, 1996b).

Sewage and grey water

Sewage treatment plants will be located at major accommodation areas, where the generation of waste water is sufficient to warrant the operation of such a facility. This facility will be a package treatment system and/or septic system. Waste water from sewage treatment will be treated where practicable to a standard approved by the Health Department of WA and recycled for use by the Project. Depending on the treatment plant selected, sewage sludge may not be produced in large quantities. If sludge is produced by the sewage treatment plant it will be buried in mine backfilling operations, or removed to an approved landfill facility once the sludge has been dried.

Temporary remote construction camps will have stand-alone systems to manage sewage. This may include, but not be limited to, septic tanks, composting and/or waterless toilets. If septic tanks are used they will be pumped out as required by licensed waste disposal contractors. The final treatment option selected will minimise the amount of effluent requiring off-site disposal.

6.10.4 By-products

Potential Impacts

Wherever possible, FMG will seek to value add to its product through further processing of waste. This can result in the generation of economic by-products, with little or no adverse incremental environmental impact, as greater amounts of valuable product can be extracted from the equivalent mining and disturbance area. Should the opportunity arise, FMG will pursue the extraction of economic by-products from the Project. At this stage the extraction of by-products is not planned. Should this position change in the future, a separate approval will be sought.

6.11 REHABILITATION AND MINE CLOSURE

The EPA's objective with regards to decommissioning and rehabilitation is to:

- *ensure, as far as practicable, that decommissioning and rehabilitation achieve a stable and functioning landform which is consistent with the surrounding landscape and meets other environmental objectives including biodiversity.*

It is recognised that mining is a temporary land use which should be integrated with, or followed by, other forms of land use. Rehabilitation of mines will be aimed towards a clearly defined future land use for the area. If the revegetation and rehabilitation of an area does not achieve the agreed completion criteria, future land uses may be impacted upon. For example pastoral areas may not be able to carry the same number of stock, or there may be a requirement for continued maintenance.

6.11.1 Progressive Rehabilitation

A draft Rehabilitation and Revegetation Management Plan has been developed for the Project and is presented in Appendix J.

The mine sites will be progressively rehabilitated throughout the life of the mine. Similarly the initial overburden stockpiles will be rehabilitated once they are no longer required (expected to be after the first two years of operations). It is predicted that sufficient overburden and waste rock will be available to completely backfill mined-out pits. Whilst the final pits' post-mining landform may be below the pre-mining landform, no deep voids will be left by the Project. Further detail of the volume of material available to backfill mined-out pits is provided in Section 5.3.2.

Rehabilitation trials will be undertaken throughout the life of the Project to investigate the likely success for revegetation using different methods, and addressing the issues of water relations, weed invasion, and changes in topography and soil structure.

Rehabilitation activities will include:

- ripping of compacted areas;
- re-establishment of a stable landform with erosion protection where necessary for long-term stability;
- construction of a post-mining landform that resembles the pre-mining landscape as closely as practicable;
- reinstatement of surface drainage patterns similar to that which were present pre-construction (except where these have been covered by initial overburden placement areas;
- replacement of topsoil;
- spreading of vegetation debris to return organic matter to the area, and provide an additional seed source; and
- additional seeding and planting of seedlings if regeneration from topsoil is insufficient.

Areas of temporary disturbance following construction will be rehabilitated once these are no longer required. The aim is to re-establish a stable landform and promote the regeneration of a self-sustaining ecosystem.

Remediation works may be required if rehabilitation is unsuccessful in certain areas. This may include repair of eroded areas, weed control, and seeding or planting of areas where vegetation has not established from natural seed sources in the applied topsoil and mulch.

The rehabilitation programme will include development of rehabilitation and revegetation completion criteria in consultation with key stakeholders. Criteria will define when a rehabilitated area can be considered self-sustaining, or indicate a continuous positive trend towards a stable community. Regular monitoring will be carried out to determine rehabilitation success (Appendix J).

6.11.2 Mine Closure

Detail on the future closure and rehabilitation of the proposed mine sites is presented in the Conceptual Mine Closure Plan in Appendix M, of which key points are summarised below.

The Project is expected to have a life of 12 years. The open pits will be constructed and operated in a staged manner, and will be progressively rehabilitated during operations.

Mine closure will include the safe dismantling and removal of infrastructure; the appropriate disposal of waste materials; backfilling and/or contouring mining areas where appropriate; and site rehabilitation to return the environment to a safe stable landform that is capable of supporting a self-sustaining ecosystem comprising local plants and animals not incongruous with the background environment. Detailed procedures and completion criteria will be established in accordance with the applicable legislation and standards at the time of closure, and will be documented in the detailed Mine Closure Plan.

FMG will develop a comprehensive Life-of-Mine Closure Plan within two years of commencement of mining activities. The Plan will consider the following:

- confirmation of closure objectives;
- stakeholder consultation programme;
- closure aspects risk register;
- revised closure design criteria;
- closure standards and preliminary completion criteria;
- brief description of progressive closure methodology;
- closure research and monitoring plan;
- basis for financial provisioning; and
- revised closure schedule.

FMG will revise and update the Life-of-Mine Closure Plan at least every two years during the operational life of the Project.

6.11.3 Monitoring

Rehabilitated areas will require ongoing monitoring to assess the effectiveness of the rehabilitation and remedial works. Baseline monitoring will commence prior to disturbance for mining activities, and will be continued at control sites throughout the life of the Project. Monitoring during operations will assist FMG in assessing the effectiveness of progressive rehabilitation of the pits and initial overburden placement areas. Monitoring will indicate where remedial works may be required, including repair of eroded areas, weed control, and seeding or planting of areas where vegetation has not become established. This monitoring will be used to improve rehabilitation methods over the life of the mine, and develop appropriate closure criteria for different parts of the Project. Monitoring may be continued for a nominated period following completion of mining (usually until closure criteria are achieved).

The Rehabilitation and Revegetation Monitoring Plan will include development of rehabilitation completion criteria to determine when a rehabilitated area can be considered self-sustaining, or indicate a continuous positive trend towards a stable community.

6.12 SOCIOECONOMIC ISSUES

6.12.1 Socioeconomic Context

The EPA objective for the Project with regards to socio-economic issues is to:

- *ensure a net benefit to the local community potentially affected by the Project.*

The regional social setting for the Project is described in Section 4.7. The nearest residences to the proposed mining areas are:

- Marillana Station – 31.5 km;
- Bamboo Springs – 34.8 km; and
- Mulga Downs Outcamp – 18.8 km

The social and economic context of the Project presents a number of opportunities and risks which FMG will consider in planning for the Project. A summary of the key risks and opportunities for the Pilbara Iron Ore and Infrastructure Project are presented in ERM (2004) (Appendix H) and are considered relevant to the Project.

Potential Impacts

Potential impacts associated with the development of the Project include:

- additional demands on unfunded local community service provision;
- wage inflation and local price inflation (including housing) due to increased demand for housing and employment attraction schemes;
- supplier organisation and community dependency on FMG operations for their sustainability;
- increase in the relative poverty of the indigenous community due to wage inflation of industry employees and contractors;
- added pressure on social and medical services; and
- increase in anti-social behaviour and illegal activities.

These risks are associated with a range of activities throughout the pre-construction, construction, operation and decommissioning phases of the Project as described below.

Pre-Construction

The Project activities that have the potential to give rise to socio-economic impacts at the planning and pre-construction stage include:

- project approvals and negotiations (including Native Title negotiations);
- public communications about the Project;
- procurement; and
- changes to land tenure.

The potential impacts that may occur in this phase will be generated by community awareness of the Project and the interactions with stakeholders in relation to project approvals and negotiations over land tenure and Native Title Rights. In particular, the Project may generate investment confidence in the region, and locally. This has the potential to be both a positive and a negative impact. Positive impacts will result from the development of additional local business through expansion or new start-ups in addition to multiplier effects. Negative impacts may occur where poor investment decisions are made, potentially on the basis of false expectations about Project benefits.

Construction

The potential impacts for this phase of the Project will relate to the mobilisation of the workforce and procurement of goods and services. These activities have the potential to have significant positive impacts in terms of employment, economic activity and business development. Project activities that have the potential to give rise to impacts at the construction stage include:

- procurement;
- mobilisation of construction workforce;
- construction of temporary work camps;
- earthworks and blasting activities;
- general construction activities; and
- creation of an area around construction activities that excludes the public.

The majority of the construction workforce for the Project (about 400 personnel) will be accommodated on site. Given the restricted capacity of the local construction industry, it may be that relatively few construction workers will be residents of the Ashburton Shire or East Pilbara Shire. If this is the case, the positive local impacts arising from wages spending, will be small. The ability of local people to acquire the skills required by FMG during the construction phase, will determine to a large extent, the benefits felt by the existing community during this phase.

Due to the remoteness of the Project, construction activities are unlikely to create a nuisance with noise, vibration (from blasting) (Section 6.9) and dust (Section 6.8). In areas where pastoral activities occur or where indigenous people use the lands, construction of the Project may restrict or modify these activities. However, FMG is in close consultation with the pastoral lease holders and traditional owners to ensure potential impacts are managed in an agreed manner.

Operation

Project activities that may result in socio-economic impacts at the operational stage include:

- payment of royalties and taxes;
- procurement;
- mobilisation of the operational workforce;
- accommodation in residential areas (e.g. Newman);
- training;
- power use; and
- water use.

The impacts of the Project will result from the payment of royalties and taxes which will have impacts at both the State and Commonwealth level. The benefits of these royalties and taxes will be felt broadly through Government expenditure/reduced borrowing.

Procurement and employment related to mining operations will predominantly be felt at State and local levels. State level impacts will be largely economic benefits associated with the export of iron ore. The Project is expected to result in about 400 jobs during operation. FMG's operational workforce will be predominantly non-FIFO and will be accommodated on-site during rostered days on, and in new or existing residences in the town of Newman during rostered days off. Discussions with Local and State Government departments have been ongoing regarding permanent accommodation in Newman. Accommodation will be available on site for contractor personnel, although contractors will be encouraged to consider accommodation in Newman for extended stays. FMG has been consulting with a number of Local Government departments, housing development companies and real estate agents regarding the provision of housing for its workforce[3].

Training activities associated with the Project have the potential to create benefits for local communities.

Decommissioning

FMG expects the Project to have a 12-year project life. However, the Stage B mining Project is expected to continue for 20 years or more. On completion of mining operations (should no further resources be developed), demobilisation of the operations workforce may

[3] FMG is aware through its consultation that the housing vacancy rates reported by ERM are based on 2001 Census Data and that since then vacancy rates have decreased. This is being factored into FMG's Housing Plan.

result in socio-economic impacts such as a decline in local population, with impacts on goods and services provided in town, particularly those directly supplying the Project. The mine sites will be decommissioned and rehabilitated so that the land may be returned to pastoral or other (e.g. conservation) use.

Management Strategies

The key opportunities relate to economic development and infrastructure provision in the Pilbara including:

- contribution to economic development of the Pilbara Region through local procurement and multiplier effects of income;
- creation of opportunities for sustainable indigenous employment; and
- additional investment in services infrastructure.

FMG has developed a range of policy goals and commitments to address some of the risks and realise opportunities as follows. FMG will:

- facilitate community involvement in company planning processes and decision making;
- use a predominantly non-FIFO operational workforce;
- develop a Housing Plan to ensure quality and equitable housing for employees whilst minimising negative impacts on existing communities;
- develop a Vocational Training and Education Centre (VTEC) to provide meaningful training opportunities for indigenous people who would like to work for FMG with guaranteed employment on completion;

- maintain a focus on regional capacity building through:
  - offering local employment opportunities;
  - implementing education and training programmes for a local workforce; and
  - using local suppliers and establishing partnerships with local businesses where commercially practicable.

FMG will continue to liaise with stakeholders who have an interest in this region to enable FMG to assess the potential socio-economic risks and opportunities and appropriate management measures (see Section 7).

Closure of the mine will be undertaken in accordance with an approved Mine Closure Plan that will take into account management of socio-economic impacts during closure and post-closure. The Conceptual Mine Closure Plan which is presented in Appendix M outlines the framework for mine closure. This plan will be adapted to consider the specific closure requirements of each mine, and will be further developed during the life of the Project.

Ongoing stakeholder liaison will enable FMG to further assess potential risks and opportunities and mitigation measures.

6.12.2 Impacts on Pastoral Activities

Potential Impacts

The Cloud Break mining development has the potential to impact on pastoral leases by limiting stock movements, minimising access to pasture, and compromising vehicle access on the pastoral station.

Management Strategies

FMG will continue liaising with affected pastoralists regarding impacts on land access, land use, and stock access to pasture, to reach an appropriate outcome. Management measures may include additional fencing and gates, cattle crossings and land use agreements.

On completion of mining, public access will be restored except where the risk to the public would be unacceptable.

6.13 ABORIGINAL HERITAGE

The EPA objectives with regards to Aboriginal Heritage are to:

- *ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972;*
- *ensure that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations within the area.*

Native Title and Aboriginal Heritage

FMG has established a protocol of regular meetings with the affected Native Title Working Groups established by the three Native Title claimant groups that are impacted on by the proposed Mine. These meetings are facilitated by the Pilbara Native Title Services (PNTS) and are held in a co-operative manner enabling FMG to present information on a range of matters associated with the proposed development of the Mine. The matters discussed at these meetings include the timing and conduct of Aboriginal Heritage surveys, negotiation of the Native Title agreements, as well as employment and contracting opportunities.

Protection of Aboriginal Sites

As detailed in Section 4.8, the Chichester Range and the Fortescue Plain are known to contain a rich diversity of Aboriginal sites. Those located near the Project are shown in Figure 21.

FMG will ensure that Aboriginal sites are located, recorded and protected wherever possible. The Aboriginal Heritage surveys commissioned by FMG to date have revealed that there are archaeological sites of significance to the Aboriginal Traditional Owners within the land covered by the proposed Project. However, FMG has been able to avoid impacts on significant ethnographic sites to date. FMG will avoid disturbing Aboriginal sites (particularly ethnographic sites) in the final design of the Project, although it is acknowledged that it may not be possible to avoid impacting all known archaeological sites.

The results of the Aboriginal Heritage surveys, that are currently occurring and which will be commissioned for final mine design in the near future, will be used to identify the location, nature and significance of any Aboriginal sites. Final layout of the Mine will take into account the location of any Aboriginal sites.

The long term management of Aboriginal sites within the Project Area will necessitate the involvement of the Aboriginal Traditional Owners in the development and application of an appropriate Cultural Heritage Management Plan (CHMP). The CHMP which will cover the Cloud Break and Stage B Projects will be in place prior to construction and will apply during the operation. and subsequent decommissioning and rehabilitation. of all aspects of the Project by FMG and its contractors. Agreed management measures will be implemented by FMG in consultation, and with the participation of, the Aboriginal Traditional Owners.

The proposed CHMP will ensure that Aboriginal Monitors are employed by FMG and/or the construction contractors to oversee the construction of the Project infrastructure within the relevant Native Title claims. This will ensure that no known Aboriginal sites are inadvertently impacted upon, and to ensure that changes to the physical environment do not affect Aboriginal Heritage and culture. Additionally, the CHMP will contain procedures for the protection and mitigation of any Aboriginal sites that are uncovered during construction (human burials, stratified deposits), as well as procedures for the physical management of Aboriginal sites in close proximity to the construction (fencing and signposting engravings) as necessary.

Should FMG need to disturb an Aboriginal site or disturb the physical environment in a way which affects Aboriginal Heritage and culture, then consultation will occur with the Aboriginal Traditional Owners of the affected Native Title claimant group. This consultation will ensure that disturbance is kept to a minimum and any mitigation of the site is undertaken under the supervision, and with the participation, of the Aboriginal Traditional Owners. Any resultant salvaged material (stone artefacts) will be stored in a culturally appropriate Keeping Place.

Use of Land by the Aboriginal Traditional Owners

Aboriginal people used and occupied the land covered by the Project prior to European settlement of the Pilbara region. This use and occupation of the land is evidenced by the existence today of Aboriginal communities such as Wiliyarmarra and Youngaleena on the Mulga Downs pastoral lease as well as Jigalong and various communities in and around the towns of Port Hedland, Marble Bar, Nullagine, Newman and Tom Price. Evidence of the long-term occupation and use of the region by the Aboriginal Traditional Owners is reflected in the richness and variety of the Aboriginal sites that are found in abundance throughout the region.

Represented by their particular Native Title claimant groups, the Aboriginal Traditional Owners of the land covering the Project Area have registered three Native Title claims to ensure that their stated Native Title rights and interests within their traditional country are recognised at law. These rights and interests include the use and occupation of the land for traditional purposes such as ceremonies, hunting, fishing and procuring ochre and bush foods.

FMG acknowledges that there are specific areas of land that the Aboriginal Traditional Owners wish to protect to ensure that they are available for their ongoing traditional use and enjoyment. These places will be identified during consultation with the Aboriginal Traditional Owners to ensure that any potential impacts during the construction and development of the Project are kept to a minimum. One example is the desire of the Nyiyaparli Aboriginal Traditional Owners to be able to continue to access the Mankarlyirrkurra ethnographic site complex to the east of the proposed Project. FMG will ensure that the proposed CHMP will take into consideration the need for the Aboriginal Traditional Owners to continue to have access to significant ethnographic sites within imposed health and safety requirements.

Where the presence of the Project is likely to have an adverse impact on access to food, medicinal and other natural resources by the Aboriginal Traditional Owners, FMG will discuss management measures with these people, and will ensure that these measures are also enshrined within the proposed CHMP. Management measures may include providing alternative access to resources, using native plant species traditionally used for food in the rehabilitation of disturbed areas, or assistance to the Aboriginal Traditional Owners in other ways.

FMG will implement the proposed management measures outlined in Sections 6.2, 6.3 and 6.6 to minimise the impacts on vegetation, fauna and water supplies respectively. Mitigation of socio-economic impacts in general on both the local Aboriginal and non-indigenous community are discussed in Section 6.12.

6.14 CUMULATIVE IMPACTS

In addressing the Principles of Environmental Protection (Section 6.1.1) FMG is required to consider the potential cumulative impacts of the Project and other projects in the region, in particular FMG's Stage B Project.

The EPA's objectives for the Project with regards to cumulative impacts include:

- *to assess the cumulative impacts of the Project and similar iron ore projects in the area; and*
- *to ensure, as far as practicable, that the proposal meets or is consistent with the sustainability principles in the National Strategy for Ecologically Sustainable Development (Commonwealth 1992).*

The assessment of cumulative impacts has considered the principles of 'sustainability'.

6.14.1 Principles of Sustainability

The definition for sustainability that has been widely adopted is outlined in the World Commission on Environment and Development's Brundtland Report (World Commission on Environment and Development (WCED), 1987) as:

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

There are at least three aspects to sustainability which are interrelated: social sustainability, economic sustainability and environmental sustainability. It has been said that a sustainable society depends upon a sustainable, stable economy which in turn depends on the global ecosystem, the health of which is vital to all (WCED, 1987).

Australia's National Strategy for Ecologically Sustainable Development (NSESD) defines ecologically sustainable development (ESD) as

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

The Core Objectives of the NSESD are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The Guiding Principles of the NSESD are:

1. decision-making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations;
2. 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;
3. the global dimension of environmental impacts of actions and policies should be recognised and considered;
4. the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised;
5. the need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised;
6. cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms;
7. decisions and actions should provide for broad community involvement on issues which affect them.

In 2003, the Western Australian Government also released a State Sustainability Strategy “Hope for the Future” (Government of WA, 2003) which outlines six broad goals for sustainability that envisage how sustainability can be applied across the whole of government. These goals include:

- ensuring that the way we govern is driving the transition to a sustainable future;
- playing our part in solving the global challenges of sustainability;
- valuing and protecting our environment and ensuring the sustainable management and use of natural resources;
- planning and providing settlements that reduce the ecological footprint and enhance our quality of life;
- supporting communities to fully participate in achieving a sustainable future; and
- assisting business to benefit from and contribute to sustainability.

In addition, the strategy sets out a vision for the State’s mining industry which includes some key future actions:

- work towards assessment of projects using sustainability criteria;
- foster local community involvement (particularly Aboriginal communities, pastoralists and local shires);
- establish a transparent process to enable community awareness of the day-to-day regulatory system for the resources industry; and
- implement strategies that support the use of local employment in mining ventures, particularly using regional centres as employment hubs, and encourage mining companies to maximise their purchasing of goods and services within regions.

FMG understands that it needs a balanced approach to the way it operates. FMG's planning takes into account all of the above objectives and principles to pursue the goal of sustainable development, such that no objective or principle should predominate over the others.

Whilst FMG's Cloud Break and Stage B Projects involve the mining of a finite resource, and use of fuel resources that will one day be depleted, the way in which the Project is constructed, operated and decommissioned can be undertaken in a manner which meets the Guiding Principles of the NSESD and the State Sustainability Strategy. In order to implement the principles of sustainability, FMG will develop a Sustainability Strategy which addresses its contribution to global impacts such as Greenhouse Gas emissions and focuses on managing impacts across the triple bottom line of Social Capital, Economic Wealth, and Environmental Assets. This Strategy will include such things as:

- establishing sustainability principles in purchasing and contracting;
- ensuring efficient energy and water use;
- minimising waste and encouraging recycling; and
- providing for industry and community partnerships.

It is important to note that the scope of the originally proposed Stage B Project has been reduced since the release of the Stage B PER (ENVIRON, 2005a) which therefore reduces the extent of the potential cumulative environmental impacts. The changes to the Stage B Project are currently being addressed through the Response to Public Submissions process, and are noted where relevant below.

6.14.2 Land Clearing and Biodiversity

6.14.2.1 Vegetation and Clearing

The proposed total area of land clearing for the Project and the revised Stage B Project in the Pilbara Bioregion is presented in Table 19. The revised Stage B project has reduced the proposed area of disturbance by approximately 4,932 ha.

Table 19. Estimated Area of Disturbance of FMG's Mining Projects

Project	Original Disturbance	Revised Project Disturbance	Reduction in Disturbance
Project	6,000 ha	5,500 ha	500 ha
Revised Stage B Project	17,107 ha	12,175 ha	4,932 ha

Nearly all of this disturbance will occur within the Fortescue Plains subregion of the Pilbara Bioregion.

Significant Vegetation

Within the vicinity of FMG's Projects several vegetation communities of high conservation significance were identified. These include the samphire flats which fringe the Fortescue Marshes (Mattiske Consulting, 2005a) and a Mulga-dominated vegetation community on seasonally-wet broad drainage areas (Fa10) identified by Biota (2004b). The Project and the revised Stage B Project will not directly impact upon these vegetation communities, and FMG has developed management measures to reduce the risk of indirect impacts on these communities from the proposed mining developments (Section 6.2).

Mulga Clearing

Seven other Mulga-dominated vegetation communities identified by Biota (2004b) for the Stage B Project were also considered of conservation value as they were regionally restricted and in very good condition. To place the proposed cumulative impacts on Mulga communities within the Fortescue Plains subregion into a regional context, an assessment of the direct impacts on Mulga-dominated land systems was undertaken, based on Rangeland Mapping by Payne *et al*. (2002). The management units used to assess the regional impacts of FMG's projects are defined in Section 6.2.1, and are a subset of Mulga-dominated land systems within the Fortescue Marshes area and Chichester Ranges footslopes.

Table 20. Cumulative Direct Impact on Mulga, as a Proportion of Chichester Ranges Mulga and Fortescue Marshes Mulga

(based on Rangeland Mapping land systems descriptions containing Mulga, Payne *et al*., 2002)

Management Unit Sizes (based on Rangeland Mapping)				
Unit		**Disturbance from the Project**	**Disturbance from Revised Stage B Project**	**Cumulative Disturbance**
Fortescue Marshes surrounds	320,400 ha	1.2%	1.1%	2.3%

Chichester Ranges footslopes 164,100 ha	2.3%	2.2%	4.5%

Total disturbance to land systems containing Mulga communities for both the Stage B and Projects therefore account for 4.5% within the Chichester footslopes unit, and 2.3% within the Fortescue Marshes unit based on Rangeland mapping. This represents a small percentage of the total area where these communities may be found. It is recognised that some of these areas are in 'degraded' to 'good' condition, whilst other areas are 'degraded' mainly as a result of grazing, drought and fire.

The above work has been expanded on by Dr van Etten who has developed a classification system for the Mulga vegetation in the Fortescue Valley. Seven Mulga vegetation types were identified by van Etten (2005) as follows:

- Community 1 - open mulga and mixed shrub woodland with hummock grass understorey of stony plains and hills of Chichester Range footslopes;
- Community 2 - Mulga-eucalypt woodland of broad drainage lines and creeks of Fortescue Valley;
- Community 3 - Mulga woodlands with mixed tussock/annual grass understorey of groves and alluvial flats;
- Community 4 - open Mulga woodland or shrubland with open annual grass understorey of intergroves and broad drainage plains (ironstone gravel prevalent on surface and in topsoil);
- Community 5 - dense Mulga woodland over open tussock grassland of *Chrysopogon fallax* and mixed annual grasses and herbs;
- Community 6 - Mulga woodland/shrubland with *Acacia* spp*., Atalaya hemiglauca* over **Cenchrus ciliaris* tussock grassland of creeklines;
- Community 7 - Mulga (*Acacia aneura* var. *aneura*) – Snakewood (*A. xiphophylla*) woodland over shrubs including other Acacia (*A. victoriae*, *A. tetragonophylla*), *Senna* spp, and mixed Chenopod low shrubs (*Maireana* and *Sclerolaena*).

This classification system has been used to compare the different Mulga vegetation types in the FMG Project disturbance area, with the likely extent of these same Mulga vegetation types in the entire Fortescue Valley. Table 21 compares the disturbance of FMG original Stage B Project and the Cloud Break Project, with the likely extent of the seven Mulga communities identified by Dr van Etten.

Table 21. Estimated extent of van Etten's (2005) Mulga Communities in Fortescue Valley Reference Area, and Cloud Break, Revised Stage B Project Disturbance Area.

Community	Estimated Total Area in Fortescue Valley (km^2)	Proportion in Revised Stage B Disturbance Area (%)	Proportion in Cloud Break Disturbance Area (%)
1	2,768	1.47	0

2	776	0.44	0.54
3	2,004	0.84	1.08
4	1,308	1.66	0
5	275	0	0
6	191	4.25	0
7	324	0	2.76

The Table above shows that the Mulga communities likely to be disturbed by FMG's projects are extensive outside the disturbance area.

A vegetation condition assessment of the Cloud Break Project Area (Mattiske Consulting, 2005b; Appendix E) indicated that some of these areas are in 'good' condition whilst other areas are 'degraded' mainly as a result of grazing, drought and fire (Section 6.2.1).

FMG will consider a combined offset package for the direct impacts of the Stage A, Stage B and Projects on Mulga groves in consultation with CALM and academic experts (Section 6.2.1).

6.14.2.2 Flora

Whilst no Declared Rare Flora were recorded within the Cloud Break or Stage B Project Areas, a number of Priority Flora were identified. FMG will avoid populations of Priority Flora where practicable, although it is acknowledged that it may not be possible to avoid all individuals of a Priority Flora. FMG will ensure that prior to clearing, areas will be searched for significant flora and an assessment undertaken in consultation with CALM to ensure that any proposed clearing will not adversely affect the conservation status of any species. Specific management measures may include use of significant flora in revegetation and/or research into the ecology or taxonomy of certain species.

In general the management measures outlined in Section 6.2.1 identify how FMG intends to minimise the impacts from land clearing on biodiversity. Both the Cloud Break and the Stage B Project have Rehabilitation and Revegetation Management Plans which will be implemented to ensure that cleared areas are progressively rehabilitated as closely as practicable to vegetation communities present prior to mining.

6.14.2.3 Threatened Fauna

The following significant fauna species were recorded or it is are considered they may occur within the vicinity of FMG's Project Areas (Table 22).

Table 22. Significant Fauna Species Recorded within the Vicinity of FMG's Project Area

Species	Project	Stage B Project
CS1 [1]		
Pilbara Olive Python *Liasis olivaceus barroni* (Vulnerable)	?	?
Night Parrot *Pezoporus occidentalis* (Critically Endangered)	✓	?
Peregrine Falcon *Falco peregrinus* (Schedule 4)	✓	✓
Fork-tailed Swift *Apus pacificus* (Migratory)	?	✓
Rainbow Bee-eater *Merops ornatus* (Migratory)	✓	✓
Mulgara *Dasycercus cristicaudata* (Vulnerable)	?	✓
Bilby *Macrotis lagotis* (Vulnerable)	✓ (burrows)	?
Orange Leaf-nosed Bat *Rhinonicteris aurantius* (Vulnerable)	?	
CS2 [1]		
Blind snake *Ramphotyphlops ganei* (Priority 1)	?	?
Skink *Ctenotus nigrilineatus* (Priority 1)	?	?
Skink *Ctenotus uber johnstonei* (Priority 2)	?	✓
Skink *Lerista macropisthopus remota* (Priority 2)		?
Grey Falcon *Falco hypoleucos* (Priority 4)	✓	?
Australian Bustard *Ardeotis australis* (Priority 4)	✓	✓
Bush Stone-curlew *Burhinus grallarius* (Priority 4)	?	?
Star Finch *Neochmia ruficauda subclarescens* (Priority 4)	✓	?
Long-tailed Dunnart *Sminthopsis longicaudata* (Priority 4)	?	✓
Lakeland Downs Mouse *Leggadina lakedownensis* (Priority 4)	?	✓
Spectacled Hare-Wallaby *Lagorchestes conspicillatus* (Priority 3)	?	?
Ghost Bat *Macroderma gigas* (Priority 4)	?	?
Western Pebble Mound Mouse *Pseudomys chapmani* (Priority 4)	✓ (mounds)	✓ (mounds)

Notes:
1. CS1 = Conservation Significance 1. Species listed under State or Commonwealth Acts.
   CS2 = Conservation Significance 2. Species not listed under State or Commonwealth Acts, but listed in publications on Threatened Fauna or as Priority species by CALM.
2. ? = may occur within the area
3. ✓ = recorded within the area

Both the Cloud Break and Stage B Projects will be designed to avoid where practicable, or to minimise disturbance to, significant fauna habitats. Specific management measures will be implemented to ensure that the Projects do not adversely impact the conservation status of the Threatened species. Provided the measures outlined in Sections 6.2 and 6.3 are implemented, including minimising habitat disturbance and progressively rehabilitating disturbed areas, the cumulative impacts of FMG's Projects on significant fauna are expected to be minor or non-existent.

For the Project, FMG will develop specific management plans for significant species such as the Night Parrot and the Bilby (Appendix L). In particular, a preliminary management plan for Night Parrot has been developed in consultation with CALM, which focuses on avoiding known habitats of these species in Project design, minimising indirect impacts on these animals and researching the species' biology and habitat (see Section 6.3).

6.14.2.4 Future Conservation Areas

The EPA's objective with regards to future conservation areas is:

- *to avoid adversely affecting the future conservation value of the pastoral stations proposed to be included in the Conservation Estate, or managed for conservation purposes.*

The Fortescue Marshes has been identified as a 'Nationally Important Wetland' (Section 4.4.3) and is listed as an 'indicative place' on the Register of National Estate due to its importance as a habitat for migratory birds. CALM is proposing that portions of the Mulga Downs and Hillside pastoral stations on which FMG's Project is located, be excluded from the renewal of pastoral leases in 2015 so that they can be added to the Conservation Estate (or managed by conservation agreement with the Pastoralists). The areas proposed for conservation are within the vicinity of the Fortescue Marshes, some of which overlap the Project (Figure 22). Of the 2015 pastoral lease exclusion area (213,400 ha), 1.6% is overlapped by the proposed Cloud Break Project and 0.04% is overlapped by the revised Stage B Project.

However, it should be noted that the 2015 Exclusion Zones have not yet been formally proposed as a Conservation Reserve. In 2015, when the pastoral leases expire, the exclusion areas will become Vacant Crown Land, and CALM will need to initiate the normal process required to convert the area into a Conservation Reserve. For this to occur, the Minister for Planning and Infrastructure is required to make a Reservation Order under Part 4 of the *Land Administration Act 1997*. Before the Minister issues such an order, consultation occurs with the DoIR (in terms of its interests with respect to granted tenements, State Agreement Acts and prospectively for minerals, basic raw materials and petroleum). CALM is also required to meet Native Title requirements before the Reservation Order can be issued by the Minister.

This process can result in significant changes to the boundaries of proposed Conservation Reserve areas, to take into account other values, such as mineralisation. In some cases, after such consultation, parts of the area (or sometimes the entire area) may not be included in the Conservation Estate, due to the State Government's assessment of values in the area for other land uses. It is FMG's belief that by conducting its activities in an environmentally responsible manner, so as to not adversely impact the overall conservation values of the Fortescue Valley, any future Conservation Reserve proposal in the area can co-exist with FMG Projects to bring about positive outcomes for the environment and community.

The key issues relating to the protection of future conservation values of the area include:

- potential impacts on the Mulga Woodlands which are in good condition within the Project Area such as:
  - vegetation clearing;
  - disruption to surface hydrology;
  - erosion;
  - weeds;
  - fire; and
  - dust; and
- potential impacts to the Fortescue Marshes ecosystem such as:
  - hydrogeological impacts;
  - surface water impacts;
  - weeds and pests;
  - noise impacts on fauna using the Marshes; and
  - light overspill.

These issues and proposed management measures are discussed in more detail in Section 6.5.4 (Surface Water), Section 6.6.4 (Groundwater), Section 6.9.3 (noise) and Section 6.2.2 (Mulga groves).

FMG has committed to avoiding impacts on the Fortescue Marshes and its immediate surrounds wherever practicable, to ensure the conservation value of these areas is not reduced as a result of FMG’s operations in the Fortescue Valley.

6.14.3 Groundwater Abstraction

6.14.3.1 Water Resources

Whilst the Project is considered to be separate from FMG’s Stage B development, the total proposed production from all of FMG’s mining Projects will not exceed 45 Mtpa of ore which was originally proposed in the Stage B PER. As such the water requirement for all of FMG's mines will not exceed the 11 GL per year originally proposed for the Stage B Project. However 11 GL per year will not be required until after year 6 of operations, as this is when it is planned to commence beneficiation at Christmas Creek. The potential impacts on the environment and other users of supplying this volume of water from the proposed Stage B borefield and mine dewatering were assessed as part of the Stage B PER and found to be manageable (Section 6.2 of ENVIRON, 2005a).

Whilst the majority of the water will still be required for beneficiation as part of the Stage B Project, some of this water will now be used by the Project (for dust suppression and general use) and sourced at least in the first few years from dewatering of the Cloud Break pits (Section 5.3.3.3). Modelling of groundwater abstraction for the Stage B Project and for the Cloud Break Project indicate that the predicted zones of groundwater drawdown will not overlap. However, any station bores in the vicinity of the groundwater drawdown zones may be affected by reduced yields. FMG has committed to minimising this impact, and providing alternative water sources to pastoralists should this be required (Section 6.6.1).

At Cloud Break there is the potential that mining may intersect saline groundwater. Therefore as dewatering progresses, the water being abstracted is likely to become more saline and abstraction may cause the deeper saline water to 'upcone' in the vicinity of the pits. It is possible that the saline water will be unsuitable for use by the Project and will require disposal. FMG has developed management measures for disposal of this water based on a 'worst-case' scenario, and is continuing to investigate alternative discharge methods (Section 6.6.2). FMG has committed to not discharging dewatering to natural surface water features or disposing of this water in a way which will contaminate fresh groundwater sources. If contamination of station bores occurs, FMG will drill replacement bores or provide an alternative water sources to pastoralists.

Groundwater abstraction for Stage B, or the Project is not expected to have an impact on the hydrological regimes of the Fortescue Marshes either individually or cumulatively. Available data indicate that the Fortescue Marshes are predominantly a surface water feature, rather than dependent on groundwater discharge (Section 4.5.1.1). Predicted groundwater drawdown contours for FMG's Projects do not extend as far as the Marshes boundary, and hydrogeological changes in the upper catchment as a result of groundwater abstraction are not expected to result in changes to groundwater levels below the Marshes.

6.14.3.2 Phreatophytic Vegetation

Phreatophytic (i.e. groundwater-dependent) vegetation is expected to occur within FMG's Project Areas. Within the Stage B Project Area, creekline vegetation including species such as River Red Gums (*Eucalyptus camaldulensis*), Cadjeput (*Melaleuca argentea*) and Coolibah (*E. victrix*) were identified as potential phreatophytes (Biota, 2004c). In the vicinity of the Project, Mattiske Consulting also identified selected tree species and larger shrubs in creek and drainage line communities and on the flats and broad plains. The fringes of the samphire flats containing *Halosarcia* spp., *Maireana* spp. and *Atriplex* spp. are also considered to be partially phreatophytic (Section 6.2.7).

Groundwater drawdowns will be greatest in those areas proposed to be disturbed for mining. In the Stage B area, *Eucalyptus victrix* woodlands are present where groundwater drawdown contours were predicted to range between 1 m and 5 m. It was predicted that vegetation within the 1 m to 2 m drawdown zone would be unaffected by this level of drawdown, as this is generally within seasonal variations (unless this were compounded by drought or other stresses placed on vegetation). However, in areas where drawdown was greater than 2 m, some individual trees may show signs of stress and lose condition.

Within the Cloud Break Project Area, groundwater drawdown is also generally between 0.5 m and 5 m outside the areas proposed to be disturbed for mining. A number of vegetation communities potentially containing phreatophytic species may also occur within this drawdown zone and are likely to be unaffected by drawdowns of up to 2 m (unless subject to other stresses), but may be affected by drawdowns of greater than 2 m. Groundwater levels may be lowered by up to 0.5 to 1 m within the fringes of the samphire flats surrounding the Marshes (Figure 16c) and up to 5 m in an area at the north west extremity of the Operation...

While the potential for some adverse impact from a temporary groundwater drawdown cannot be ruled out, it would appear to be within the range of fluctuations that are likely to occur within natural cycles of flooding and aridity. Samphires are likely to survive naturally occurring falls in groundwater through changes in root architecture and through utilisation of residual soil moisture. In the event that reductions in groundwater levels are prolonged, samphires are equipped with various physiological mechanisms to survive. The degree to which they are able to do this will be dependent upon environmental factors such as soil and water salinity (Barrett 2005).

To monitor the potential impacts on phreatophytic vegetation from groundwater abstraction within the Stage B and Cloud Break Projects, FMG has developed a Vegetation Monitoring and Management Programme as part of the Borefield and Dewatering Management Plan. Management measures are likely to include groundwater monitoring, annual calibration of numerical groundwater models to better predict the effects of groundwater abstraction, and vegetation condition assessments. If this monitoring and assessments indicate that groundwater abstraction is likely to result in unacceptable impacts, dewatering operations will be modified. FMG will consider options for short-term irrigation of affected vegetation until groundwater levels recover (Section 6.6.1).

6.14.3.3 Stygofauna

It is likely that stygofauna are present within the predicted groundwater drawdown zones at Cloud Break and the Stage B Project (Section 4.6.3). However, stygofauna sampling completed in March 2005 for both Projects has indicated that none of the stygofauna species recorded within the dewatering drawdown area was considered of significance or unique to the area. The June 2005 survey recorded two undescribed species of *Syncaridia* within the drawdown area at Mt Nicholas. However due to recent changes to the Stage B Project, Mt Nicholas will no longer be mined. The management measures outlined in Section 6.4 of this document will be applied to both Projects and are considered sufficient to avoid unacceptable cumulative impacts on stygofauna within the area. Most importantly, the Projects are not expected to adversely affect the conservation significance of any particular stygofauna that may be present within FMG's Project Areas.

6.14.4 Fortescue Marshes Catchment

The proposed Stage B and Cloud Break mining areas are located within the upper Fortescue River catchment as shown in Figure 5. Runoff from this catchment drains to the Fortescue Marshes which form an extensive intermittent wetland. The main potential cumulative impacts from the proposed mine developments on this catchment would be a potential reduction of surface water runoff volume and water quality in the downstream environment.

The potential surface water impacts from the Project are presented in Appendix B and summarised in Section 6.5. When considering all of FMG's Project Areas within the catchment, the total area of disturbance over the life of the two Projects (21 years) will be approximately 162 km^2. However, these areas will be progressively rehabilitated and not all subjected to disturbance at one time. The maximum area of working pits at Cloud Break at one time is expected to be 475 ha, and the maximum area of working pits for the Stage B Project at any one time is expected to be 450 ha. If a conservative estimate is made that one quarter of the proposed mining area for both Projects will be active at any one time, then this represents 0.1% of the upper Fortescue River catchment. However, the actual impact is expected to be less than this, as FMG will minimise the total area under active mining throughout the life of the Projects.

It is acknowledged that FMG's proposed Projects within the upper Fortescue River catchment may alter the hydrological regimes at a local level and management measures have been developed to minimise these impacts (Section 6.5). However, the Projects are not expected to result in any significant reduction in surface water flows from the catchment into the Fortescue Marshes. The estimate of a 0.1% reduction in surface water flows during mining is considered insignificant when compared with natural seasonal variation in surface water run-off.

Any surface water runoff from pit areas, overburden placement areas, and plant areas will be treated via sedimentation basins prior to release to the downstream environment. Any area where potential polluting substances (e.g. hydrocarbons) are stored or handled will be bunded and internal drainage collected, treated and used on-site. Provided the proposed management measures outlined in Section 6.5 are implemented, the potential impact of FMG's Projects on the quality of surface water runoff draining to the Fortescue Marshes is therefore considered low.

Risk Assessment of Potential Impacts on the Fortescue Marshes

FMG conducted a Risk Assessment to further investigate the potential impact on the Fortescue Marshes ecosystem as a result of FMG's proposed Projects originally undertaken for Stage B, but considered applicable to the Project (Appendix P). The Risk Assessment investigated the potential impact on the Fortescue Marshes ecosystem and primarily focused on the potential disruption to surface water flows, any impacts on water quality or habitats due to the introduction of foreign materials or by-products of the mining process into the area, and the impacts from water abstraction for water supply and mine dewatering.

The overall residual risk to the Fortescue Marshes ecosystem as a result of the proposed Project was found to be minimal when control measures were considered. The initial, uncontrolled (inherent) risk levels were found to be low in most instances due to the distance of the Projects from the Fortescue Marshes.

When the Project and FMG's other Projects within the upper Fortescue River catchment are considered, the potential cumulative surface water drainage impacts on the catchment are not expected to be significant as outlined above. Provided the proposed management measures are implemented, FMG's Projects are not expected to have significant impacts on sheet-flow dependent ecosystems, result in excessive erosion or sedimentation, or significantly impact on the quantity or quality of water quality flowing into the Fortescue Marshes.

The interaction of groundwater and surface water flowing into the Fortescue Marshes was also considered in the Risk Assessment. Groundwater drawdown from dewatering and water supply operations for FMG's Projects will not extend as far as the Marshes. In any case, as the Marshes are recognised as a surface water feature, abstraction of groundwater in the vicinity of this area would not be expected to result in drying out of the Marshes.

FMG will continue to work with CALM throughout the life of the Project to ensure that the Project does not adversely affect the conservation values of the Fortescue Marshes.

6.14.5 Greenhouse Gas Emissions

Greenhouse Gas emissions for the Project have been estimated and are presented in Section 6.7. Table 16 also shows the estimated Greenhouse Gas emissions of other projects per tonne of iron ore produced, including FMG's Stage A and Stage B Projects. Table 23 below takes into account the cumulative Greenhouse Gas emission estimates from mining and also for transport of the ore to port.

Table 23. Cumulative Impacts of Greenhouse Gas Emissions for FMG's Projects

Project		**Units**	**Reference**
FMG Project (mine + transport to port) [2]	14.6 *(11.2)* [1]	$kgCO_{2e}$/t of ore shipped	(see Table 16 – Cloud Break + Stage A)
FMG Stage B Project (mine + transport to port) [2]	16.5 *(13.0)* [1]	$kgCO_{2e}$/t of ore shipped	(see Table 16 – Stage B + Stage A)
Robe River West Angelas Project	10-13	$kgCO_{2e}$/t of ore shipped	Robe River, 1998
BHP Mining Area C Project	12	$kgCO_{2e}$/t of ore shipped	BHPBIO, 1997
Hamersley Iron Nammuldi Silvergrass Iron Ore Project	9-12	$kgCO_{2e}$/t of ore shipped	Hamersley Iron, 2000

Notes:
1. Estimated CO_2 emission if natural gas-fired power station used.
2. Calculations do not include continued CO_2 emissions after mine life, from biomass decay and soil carbon loss (see Section 6.7).

As can be seen from Table 23, the estimated emissions of carbon dioxide per tonne of ore shipped are similar to other iron ore projects in the Pilbara region, if it is assumed that power supply will be from natural gas (most likely scenario). Differences between FMG's Projects and other iron ore projects in the Pilbara that may affect Greenhouse Gas calculations are:

- the proposed method of mining for FMG's Projects which often requires greater area of disturbance (although more readily enables backfilling and rehabilitation of pits) and which over-estimates emissions as revegetation off-sets are not included in calculations;
- the relatively long haulage distances associated with this proposal; and
- the higher proportion of beneficiable material to be processed by FMG compared with these other operations.

6.14.6 Noise

Due to the remoteness of FMG's Project Areas and the distance between the Project and the Stage B Projects, cumulative noise impacts on residences in the area are expected to be insignificant. However, the potential noise impacts from the Stage B railway were re-modelled as the alignment of the proposed railway has changed since the previous assessment undertaken for the Stage B PER. Assessment of the revised Stage B rail corridor alignment was undertaken by Lloyd Acoustics and is presented in Appendix N. The results of the assessment are summarised in Table 24.

Table 24. Predicted Night-time $L_{Aeq\ (8\ hour)}$ and L_{Amax} Noise Levels from Trains

Receiver Location	Night Time $L_{Aeq\ (8\ hour)}$ Noise Level dB	L_{Amax} Noise Level dB
Mine Camp	38	47
Fortescue Marshes	39	44
Marillana Station	32	37
Bamboo Springs	26	29
Mulga Downs Outcamp	25	32
Warrie Outcamp (not residential)	43	50

The predicted maximum and average night-time noise levels from the revised Stage B railway alignment to noise-sensitive receivers adjacent to the alignment are significantly below the criteria stated in the Western Australian Planning Commission's Draft Statement of Planning Policy: Road and Rail Transport Noise. The most affected receiver would be Marillana Station with predicted noise level results of $L_{Aeq\ (8\ hour)}$ 32 dB and L_{Amax} 37 dB, which would not be considered a significant impact.

It should be noted that higher noise levels ($L_{Aeq\ (8\ hour)}$ 43 dB) are predicted at Warrie Outcamp, however, this is a remote camp and is not considered to be a residence.

Cumulative noise impacts on fauna that utilise the Fortescue Marshes from the Stage B and Projects are not expected to be significant, due to the distance between the two Projects and distance from the Marshes. Research on birds suggests that there is likely to be some short-term disturbance from blasting at both operations, but birds are quick to adapt to a changing environment and would be expected to resume normal activities in a short period of time (Appendix N).

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7. STAKEHOLDER CONSULTATION

7.1 STAKEHOLDER CONSULTATION STRATEGY

Community consultation regarding the Cloud Break deposit commenced in January 2005. However, FMG has had ongoing communications with the key stakeholders for the Stage A and Stage B Projects since August 2003. The key stakeholders for the Project are expected to be similar due to the proximity to the Stage B Project and similarities in Projects.

Consultation has included public presentations, government presentations, one on one discussion with pastoral lease holders, environmental groups, community groups, local members of parliament, government departments, and members of local Aboriginal communities.

All stakeholders holding a registered interest in land where the Project Area intersects their land, have been contacted in writing. Follow up meetings have been arranged when requested by stakeholders to further discuss the Project and the potential impacts.

A Stakeholder Consultation Strategy has been implemented for the Project to ensure that the concerns and interests of stakeholders are taken into consideration in design and development of the Project.

Throughout the consultation process, stakeholders will have the opportunity to become involved and be kept informed on the Project. A community consultation and stakeholder engagement programme will be prepared and implemented by FMG. The consultation programme is expected to consist of an ongoing 'open-door' approach. The Proponent encourages members of the community to contact them and be advised of the Project and possible effects it may have on them.

Consultation and information dissemination will be undertaken in a variety of forms suitable to the party being consulted. This includes specific verbal and/or written correspondence where the Project will have a direct effect on the stakeholder. The consultation strategy for the Project will also include group presentations, community meetings, individual meetings, newsletters, mail outs, newsletters, display materials, newspaper articles, radio presentations, site visits, and website information.

FMG already has in place a consultation strategy for working with the Claimant Working Groups established by the Native Title claimant groups during the Stage B Project. FMG will continue to work with these groups and discuss its intention to seek approval to construct and operate its proposed Cloud Break Mine.

The Local, State and Commonwealth Decision Making Authorities and other involved Non-government Agencies will be consulted and kept informed on an ongoing basis. This will enable them to provide input into the environmental assessment and recommend management measures for the Project. The consultation strategy has been included in the Project scheduling and will continue throughout the life of the Project with all interested parties.

A list of consultation activities held is shown in Table 25, refer to Appendix Q for a list of issues raised by stakeholders and outcomes. For all consultation prior to 31 December 2004, please refer to the Stage A and B PER's (ENVIRON, 2004; 2005a).

Table 25. Summary of Consultation Undertaken to Date

Consultation	Date
Weekly Progress Meeting (PNTS) - Yamatji	21 January 2005
Letter - Wildflower Society	8 February 2005
Weekly Progress Meeting (PNTS) - Yamatji	8 Tuesday 2005
Meeting with representative from Mumbultjari Aboriginal Corporation	10 February 2005
Meeting with Indee Station	14 February 2005
Weekly Progress Meeting (PNTS) - Yamatji	15 February 2005
Meeting with Roy Hill Station	15 February 2005
Weekly Progress Meeting (PNTS) - Yamatji	1 March 2005
Presentation to Pilbara Native Title Services (PNTS)	2 March 2005
Weekly Progress Meeting (PNTS) - Yamatji	15 March 2005
Weekly Progress Meeting (PNTS) - Yamatji	23 March 2005
Native Title Project Meeting (PNTS)	31 March 2005
Palkyu Native Title Negotiation Meeting (Port Hedland)	4 April 2005
Kariyarra Native Title Negotiation Meeting (Port Hedland)	5 April 2005
Meeting with Landcorp	6 April 2005
Community Presentation – Newman	6 April 2005
Martu Idja Banyima Native Title Negotiation Meeting (Port Hedland)	6 April 2005
Nyiyaparli Native Title Negotiation meeting (Port Hedland)	6 April 2005
Native Title Project Meeting (PNTS)	12 April 2005
Meeting with DoE Karratha	14 April 2005
Meeting with Department of Indigenous Affairs (DIA)	21 April 2005
Combined Native Title Negotiation Meeting with the Palyku, Kariyarra, Martu Idja Banyjima and Nyiyaparli Native Title Claimant Groups (Port Hedland)	27 – 29 April 2005
Attendance at Landcorp workshop	28 April 2005

Consultation	Date
CALM briefings Significant Fauna Species	May 2005 (ongoing)
Weekly Progress Meeting (PNTS) - Yamatji	4 May 2005
Weekly Progress Meeting (PNTS) - Yamatji	10 May 2005
Weekly Progress Meeting (PNTS) - Yamatji	17 May 2005
EPA Briefing	19 May 2005
Weekly Progress Meeting (PNTS) - Yamatji	25 May 2005
EPA Briefing	16 June 2005
DoE Hydrogeological Briefing	29 June 2005

7.2 ISSUES RAISED

Issues raised during consultation and the section of this document in which these issues are addressed are outlined in Table 26.

Table 26. Key Issues Raised During Consultation

Issue	Section of this document addressing these issues
Restriction of access and impact on pastoral activities	Section 5.4.6
Impacts from mine dewatering	Section 6.6
Protection of significant flora species	Section 6.2.8
Weed management	Section 6.2.4
Area of clearing	Section 6.2.1
Impact on surface water sheet-flows	Section 6.5
Protection of significant fauna species	Section 6.3
Acid mine drainage	Section 6.10.2
Impact on Mulga groves as a result of interruption to surface water sheet-flows	Section 6.2.2
Impacts on Fortescue Marshes	Sections 6.5.4, 6.6.4
Employment opportunities	Section 6.12
Aboriginal heritage	Section 6.13
Rehabilitation	Section 6.11

Key issues raised are briefly discussed below, and more fully in the sections listed above.

7.2.1 Surface Water Impacts

The Cloud Break mining area is located on the southern flanks of the Chichester Ranges in an area which drains towards the Fortescue Marshes to the south. Design, construction and operation of the open pits, ore and overburden stockpiles, access and haul roads, and other infrastructure will need to take into account natural surface hydrology conditions.

All of the mines will require drainage diversion structures. FMG and its consultants have designed the Project to minimise impacts on natural drainage flow patterns and downstream areas. Surface water management in the mining areas is discussed in further detail in Section 6.5.

7.2.2 Groundwater Impacts

Potential impacts on groundwater and proposed management measures are outlined in Section 6.6 of this document.

Mine dewatering will be required at Cloud Break to lower groundwater levels below the base of each of the proposed pits (in the alluvium and Marra Mamba formations) for mining to proceed. Groundwater drawdown contours will extend out from the pits proposed to be dewatered.

It is proposed to use dewatering water for dust suppression and potable supplies (in conjunction with an RO plant) at Cloud Break, and also for the Stage B beneficiation plant (after year 6). However, available data indicate that dewatering water is expected to become more saline over time.. Management measures for disposal of groundwater have considered the worst-case scenario and FMG will continue to investigate alternative discharge options.

The risks to phreatophytic (groundwater dependent) vegetation from groundwater drawdown were assessed and considered to be manageable. Potential risks to the Fortescue Marshes from groundwater abstraction were considered low as data indicate that the Marshes are predominantly a surface water feature and are not fed by groundwater discharge.

7.2.3 Fortescue Marshes

The Fortescue Marshes, to the south of the proposed Project, is listed as a ‘Nationally Important Wetland’. It is recognised by CALM as supporting a rich diversity of migratory birds when in flood. The Fortescue Marshes is also listed as an ‘Indicative Place’ on the Register of the National Estate (natural heritage) due to its importance for conservation of waterbirds. Much of the northern Fortescue Marshes is being sought by CALM for inclusion in the conservation estate, during the review of pastoral leases that will occur when all leases expire in 2015.

FMG has committed to avoiding, minimising, mitigating and offsetting direct or indirect impacts on the Fortescue Marshes. As such, FMG has located the Project as far north of the Marshes as practicable, within resource location, transport, engineering and heritage constraints. The proposed mining areas will be 3 km from the edge of the Marshes at the closest point.

As discussed under 'Surface Drainage', FMG intends to design, construct and operate the Project to minimise hydrological impacts on the upper catchment, and ensure that there are no resultant impacts on the Marshes (Section 6.5.4). Similarly proposed pit dewatering will take into consideration the regional groundwater system and potential hydraulic linkage to the Fortescue Marshes, and avoid impacts on the Marshes (Section 6.6.4). FMG has conducted a Risk Assessment regarding the Fortescue Marshes ecosystem to ensure all risks are identified and managed (Appendix P).

7.2.4 Vegetation Clearing

FMG's resources are relatively shallow and cover extensive areas. As such, strip mining is considered the most suitable method of mining. This allows one or more strips (or shallow parallel pits) to be mined, whilst progressively placing overburden and beneficiation rejects as backfill in mined-out sections of the pits. This reduces the extent of the working open pit, reduces surface area for storage of overburden and rejects, and allows the pit to be progressively filled and rehabilitated.

The majority of this area will be rehabilitated during the life of the Project. Land clearing and open pit areas will be kept to a minimum for safe working practices, and sensitive vegetation communities and significant flora species will be avoided where practicable. Whilst a large area will be cleared over 12 or more years, the area cleared at any one time will be minimised.

As successful revegetation is key to the minimisation of impacts from land clearing, FMG has developed a draft Rehabilitation and Revegetation Management Plan which outlines how FMG propose to re-establish as close as practicable the vegetation communities that were present prior to mining. Implementation will include revegetation trials and ongoing research into revegetation methodology and regular review and update of the Management Plan (Section 6.11 and Appendix J).

7.2.5 Mulga Groves

Mulga communities including areas of grove/intergrove Mulga occur within the Project Area and are considered near the northern-most extent of Mulga in WA. However, it should be recognised that approximately 121,145 ha of land systems containing Mulga communities exist north of FMG's Project Area (Section 4.6.1.1). Mulga communities are thought to be partially dependent on surface water sheet-flow and therefore have the potential to be adversely affected by changes to surface hydrology patterns as a result of construction of the Project if this aspect is not appropriately managed.

Direct clearing impacts from the Project will account for approximately 4.5% of the total Mulga in the Chichester Range footslopes based on Rangeland mapping (see Section 6.14.2.1). This is not expected to affect the conservation value of mulga in the area.

A potential indirect impact on Mulga is the obstruction of surface water flow patterns through the development of the proposed mine. FMG will design appropriate drainage structures to maintain sufficient sheet-flow to support downstream Mulga (and other) communities. Refer to Section 6.5 for proposed surface water management measures.

Other potential indirect impacts include fire and weeds, however, FMG will implement management plans to address these issues (Sections 6.2.5, 6.2.4). FMG has developed a draft Rehabilitation and Revegetation Management Plan for the mining areas that will focus on re-establishment of native vegetation communities after mining, to resemble as close as practicable the original communities (Section 6.11). Successful revegetation of mining and other disturbed areas will rely on sound baseline survey data and ongoing research into revegetation techniques. With appropriate techniques, it is possible to effectively revegetate Mulga (Dr E. Mattiske, *pers. comm.*).

7.2.6 Threatened Fauna

Four species of Schedule fauna (Bilby, Rainbow Bee-eater, Peregine Falcon and Night Parrot) and four Priority listed species (Grey Falcon, Australian Bustard, Western Pebble Mound Mouse and Star Finch) were recorded from the FMG Project Area during fauna surveys for the Project. A further four Schedule species and eight Priority species were not recorded during the current survey, but are considered likely to occur in the area based on other survey data and records from the region.

The Project was referred to the Federal Department of Environment and Heritage (DEH) under the *EPBC Act 1999* on the basis that two Threatened Fauna species (Night Parrot and Bilby) listed under the *EPBC Act 1999* were recorded in the vicinity of the Project, and a number of other species listed under the Act could potentially occur within the Project Area.

FMG will minimise habitat disturbance and avoid where practicable, known populations of Threatened Fauna species that may occur within the Project Area. FMG has also committed to the development of a management plan for Threatened Fauna found near the Project Area, such as for the Night Parrot and Bilby (Appendix L).

7.2.7 Stygofauna

Consultants carried out stygofauna sampling in March and June 2005. Six bores were sampled throughout the Project Area, however no stygofauna considered of conservation significance was located within the influence of the dewatering drawdown. Potentially two new species of *Paramelitidae* were identified in a regional bore (FMG26) away from the influence of dewatering drawdowns. FMG has developed a Subterranean Fauna Management Plan (Appendix K), which includes a biannual sampling plan to be implemented for the first two years prior to Project commissioning (until December 2006). Depending on the outcomes of the sampling plan, further ongoing sampling will be conducted throughout the life of the Project (see Section 6.4).

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8. ENVIRONMENTAL MANAGEMENT COMMITMENTS

FMG intends to design, construct and operate the proposed Project in a manner which encompasses the principles of Sustainability (Section 6.14.1).

The following environmental management commitments have been developed for the more significant environmental issues for FMG's Project. This will represent key components within FMG's Environmental Management System (EMS).

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Table 27. Environmental Commitments for the Cloud Break Iron Ore Project

Topic	Objectives	Actions	Timing	Advice from
Environmental Management Plan (EMP)	To minimise the environmental impacts associated with the Project. To provide a mechanism for monitoring environmental parameters, impacts, compliance with legal requirements, feedback, reporting and continual improvement.	1. Prepare an EMP as part of the Environmental Management System (EMS), containing specific environmental management strategies for the construction of the Project *(refer to Appendix I for draft)*.	Prior to the start of construction.	DoE/DoIR
		2. Implement the Construction EMP.	During construction.	
		3. Prepare an EMP as part of the EMS, containing specific environmental management strategies for the operation of the Project.	Prior to commissioning.	DoE/DoIR
		4. Implement the Operational EMP.	During construction and operations.	
		5. Ensure that all personnel and contractors comply with the requirements of the EMPs and be made aware of their obligations through an Environmental Awareness Training programme.	During construction and operations.	
Project Closure Plan	To ensure, as far as practicable, that decommissioning and rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape, and meets other environmental objectives including biodiversity.	6. Develop a comprehensive Mine Closure Plan which includes Closure Criteria to be agreed with the regulators *(refer to Appendix M for draft)*.	Within two years of commencement of mining.	DoIR/DoE
		7. Review the Project Closure Plan regularly during the operational life of the Project.	At least every two years during the operational life of the Project.	
		8. Submit a final Project Closure Plan to the regulators for approval, no later than two years prior to the planned closure of operations.	Two years prior to the planned closure of operations.	DoIR/DoE
Terrestrial flora and vegetation	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	9. Complete flora and vegetation surveys of all areas proposed to be disturbed, prior to commencement of construction.	Prior to construction.	CALM

Topic	Objectives	Actions	Timing	Advice from
	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*.	10. Design infrastructure to avoid Declared Rare and Priority Flora and species of Conservation Significance where practicable, and minimise disturbance to flora and vegetation communities in general.	During the design phase.	CALM
		11. Prepare and implement a Rehabilitation and Revegetation Management Plan, to address the impact of vegetation clearing *(refer to Appendix J)*.	Prior to construction.	CALM/DoE
		12. Complete revegetation and rehabilitation activities in accordance with agreed closure criteria to be developed as part of the Closure Plan.	During progressive rehabilitation activities throughout the life of the Project and on closure.	DoIR/DoE
Weed Hygiene and Management Plan	Maintain the abundance, species diversity, geographic distribution, and productivity of vegetation communities.	13. Prepare a Weed Hygiene and Management Plan that contains procedures to minimise the introduction and spread of weeds, including: • identifying target weeds; • hygiene inspection and washdown procedures for all mobile plant and equipment. • control measures that may be necessary for some species; • monitoring and any follow-up control including reporting to relevant authorities.	Prior to construction.	CALM/AgWA
		14. Implement the Weed Hygiene and Management Plan.	During construction, operations, and decommissioning.	
		15. Ensure sites (including temporary construction camps) have contained wash down facilities.	During construction and operations.	
Fire Management Plan	Reduce the risk of unplanned fires and provide contingency measures to minimise any impacts in the event that a fire starts.	16. Prepare a Fire Management Plan to include: • installation of necessary fire breaks; • safe work procedures for all welding and grinding work; • personal fire hazard procedures;	Prior to construction.	CALM/FESA

Topic	Objectives	Actions	Timing	Advice from
		• vehicle fire hazard procedures; • emergency fire response procedures; and • bushfire contingency plans. 17. Implement the Fire Management Plan.	During construction and operations.	
Terrestrial fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*.	18. Design infrastructure to avoid Specially Protected (Threatened) Fauna habitats where practicable and minimise disturbance to fauna habitats in general. 19. Prepare management plans for Threatened Fauna species recorded within or near the Project Area (*refer to Appendix L for Night Parrot Management Plan)*. 20. Implement the Threatened Species Management Plans.	During the design phase. Prior to construction. Prior to construction.	CALM CALM
Mine dewatering	Maintain or improve the quality and quantity of groundwater to ensure that existing and potential uses, including ecosystem maintenance, are protected.	21. Continue to investigate alternative options for disposal of potentially saline water from mine dewatering. 22. Prepare a Borefield and Dewatering Management Plan. 23. Implement the Borefield and Dewatering Management Plan, including the Groundwater and Vegetation Monitoring Programmes.	Prior to commencement of borefield and dewatering activities. Prior to commencement of borefield and dewatering activities. During construction, operations and post-closure.	DoE (WRC) DoE (WRC)
Subterranean Fauna Management Plan	Maintain the abundance, diversity and geographical distribution of subterranean fauna.	24. Prepare a Subterranean Fauna Management Plan for the Project *(refer to Appendix K)*. 25. Implement the approved Subterranean Fauna Management Plan.	Prior to construction. During construction and operations.	CALM

Topic	Objectives	Actions	Timing	Advice from
Water courses and wetlands	Maintain the integrity, functions and environmental values of watercourses and sheet flow.	26. Design and construct the Project to minimise disturbance to natural surface water flows. 27. Design and construct bunds, culverts and other drainage structures to maintain surface water flows if there are dependent ecosystems downstream (e.g. such as implementation of approved surface water redistribution systems).	During the design phase. During design and construction.	CALM/DoE CALM/DoE
Dust Management Plan: construction	Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems, and ensure that dust emissions, both individually and cumulatively, meet appropriate criteria and do not cause environmental or human health problems.	28. Prepare a Construction Dust Management Plan that addresses: • minimising clearing (as practicable) • minimising the generation of dust and impacts and emissions on and off site; • dust control measures; and • outlines a complaints and response process. 29. Implement the Construction Dust Management Plan.	Prior to construction. During construction.	DoE/DoIR
Dust Management Plan: operations	Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems, and ensure that dust emissions, both individually and cumulatively, meet appropriate criteria and do not cause environmental or human health problems.	30. Prepare an Operations Dust Management Plan that addresses: • minimising the generation of dust and impacts and emissions on and off site; • dust control measures; • ore stockpiles moisture content; • dust monitoring; and • outlines a complaints and response process. 31. Implement the Operation Dust Management Plan.	Prior to commissioning. During operations.	DoIR/DoE

Topic	Objectives	Actions	Timing	Advice from
Greenhouse Gases Management	To minimise Greenhouse Gas emissions for the Project and reduce emissions per unit product to as low as reasonably practicable, and mitigate Greenhouse Gas emissions in accordance with the *Framework Convention on Climate Change 1992*, and with established Commonwealth and State policies.	32. Develop a Greenhouse Gas Management Plan that addresses efficient use of resources and equipment and other measures to reduce Greenhouse Gas emissions.	Prior to construction.	DoE
		33. Implement the Greenhouse Gas Management Plan.	On commencement of construction.	
Water Quality – surface and groundwater	To maintain or improve the quality of surface and groundwater, to ensure that existing and potential uses, including ecosystem maintenance are protected.	34. Treat any waste water or surface water runoff that is potentially contaminated prior to discharging to the environment.	During construction and operations.	DoE
		35. Ensure potentially polluting substances are stored, bunded, and handled in accordance with appropriate standards.	During construction and operations.	DoE
Acid Mine Drainage	Minimise the risk to the environment resulting from potentially acid forming materials.	36. Complete sampling and analysis of materials potentially exposed during mining.	Prior to commencement of mining.	DoE/DoIR
		37. Develop an Acid Mine Drainage Management Plan if potentially acid-generating materials are likely to be disturbed.	Prior to, or during mining (as required).	DoE/DoIR
		38. Implement the Acid Mine Drainage Management Plan if potentially acid-generating materials are likely to be disturbed.	Prior to, or during mining (as required).	
		39. Undertake additional investigations (such as oxygen diffused modelling) if monitoring indicates that the cone of groundwater depression is likely to extend into black shales.	During dewatering operations (as required).	DoE/DoIR

Topic	Objectives	Actions	Timing	Advice from
Waste Management Plan	Ensure that disposal/management of wastes do not adversely affect environmental values or health, welfare and amenity of people and land uses, by meeting statutory requirements and acceptable standards.	40. Develop a Waste Management Plan. As part of the Waste Management Plan, FMG will implement a procurement policy which minimises waste generation.	Prior to construction.	DoE
		41. Implement the Waste Management Plan.	During construction, operations and mine closure.	
Noise Management Strategy	Ensure noise levels comply with statutory requirements and acceptable (and appropriate) standards.	42. Prepare a Construction Noise and Vibration Management Plan.	Prior to construction.	DoE/DoIR
		43. Implement the Construction Noise and Vibration Management Plan.	During construction.	
		44. Prepare an Operational Noise and Vibration Management Plan for the Mines that: • identifies noise reduction strategies; • minimises disturbance to the Fortescue Marshes and residence(s) from blasting noise generated at operations; • outlines monitoring program to measure noise emissions and assess optimal placing of noise barriers.	Prior to commissioning.	DoE/DoIR
		45. Implement the Operational Noise and Vibration Management Plan.	During operations.	
Aboriginal Heritage	Ensure the proposal complies with requirements of the *Aboriginal Heritage Act 1972* and that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations with the area.	46. Complete ethnographic and archaeological surveys of the Project Area.	Prior to the start of construction.	DIA/PNTS
		47. Develop a Cultural Heritage Management Plan for the Project in consultation with the Aboriginal Traditional Owners.	During the design phase.	DIA/PNTS
		48. Implement the Cultural Heritage Management Plan in consultation with the Aboriginal Traditional Owners.	During construction, operations and decommissioning.	DIA/PNTS

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10. GLOSSARY

Abbreviations

AMD	Acid Mine Drainage
ANZECC	Australia New Zealand Environment and Conservation Council
APB	Agricultural Protection Board
ARI	Average Recurrence Interval: how many times an event could be expected to occur over a period of time, for example a 1 in 100-year storm event.
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
BHPBIO	BHP Billiton Iron Ore
BIF	Banded Iron Formation
CALM	Department of Conservation and Land Management
CF_x	Perfluorocarbons
CH_4	Methane
CO_2	Carbon dioxide
d(B)	Decibels
d(B)A	Decibels (A-weighted)
DoE	Department of Environment
DoIR	Department of Industry and Resources
DRF	Declared Rare Flora
EPBC Act	*Environmental Protection and Biodiversity Conservation Ac 1999t*
EPA	Environmental Protection Authority
ESD	Ecologically sustainable development
HFCs	Hydrofluorocarbons
N_2O	Nitrous oxide
NEPC	National Environment Protection Council
NSESD	National Strategy for Ecologically Sustainable Development
PER	Public Environmental Review
PNTS	Pilbara Native Title Service
SF_6	Sulphur hexafluoride
TDS	Total Dissolved Solids
TPH	Tonnes per hour
WAM	Western Australian Museum
WRC	Water and Rivers Commission

Definitions

Alluvium: Young sediment, eroded rock particles that are carried downslope by streams.

Anthropogenic: Man-made

Archaeological: Containing traces of past human activity, including artefact scatters, quarries, art sites, stone arrangements, rock shelters etc.

Banded Iron: Ironstone deposited in a banded structure.

Basalt: A hard, dense, dark volcanic rock composed chiefly of plagioclase, pyroxene, and olivine, and often having a glassy appearance.

Biodiversity: The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems.

Bioregion: A region constituting a natural ecological community with characteristic flora, fauna, and environmental conditions and bounded by natural rather than artificial borders.

Chert: A variety of silica that contains microcrystalline quartz.

Dolomite: A magnesia-rich sedimentary rock resembling limestone.

Ethnographic: Pertaining to the study of human cultures in their natural settings.

Geothitic: A rock which is usually a brown black colour and containing mainly goethite. A Goethite is a later derived oxide often formed by weathering of hematite (FeO[OH]).

Gilgai: Soil type with uneven micro-relief, often as a result of expansion and contraction of soils. Nutrients may accumulate in the depression areas or salts/carbonates may accumulate on mounds.

Herpetofauna: Cold-blooded terrestrial vertebrates (reptiles and amphibians).

Holocene: Of, or belonging to, the geological time, rock series, or sedimentary deposits of the more recent of the two epochs of the Quaternary Period, beginning at the end of the last Ice Age about 11,000 years ago.

Invertebrate: Lacking a backbone or spinal column.

L_{A1}: An A-weighted noise level which is exceeded for one percent of the measurement period. An L_{A1} level is considered to represent the "intrusive" noise level.

L_{A10}: An A-weighted noise level which is exceeded for 10 percent of the measurement period. An L_{A10} level is considered to represent the 'intrusive' noise level.

L_{Amax}: The maximum A-weighted noise level measured during the measurement period.

Limonitic: A rock which is usually a brown yellow colour and containing mainly limonite.

Linear sound pressure level: A sound pressure level that has not been filtered. It is described in the linear scale and noted by the symbol dB(L).

Mesic: A moderately moist habitat

Obligate: Species restricted to a particular condition of life.

Passerines: Perching birds.

Phreatophytes: Plants which are dependent on the water table for survival.

Physiographic Unit: Distinct landscape grouping based on geomorphology, climate and biological features.

Pisolitic: Consisting of rounded grains, often pea-size, like pisolites which are a spherical concretionary body over 2mm in diameter and made of concentric internal layers that developed around a nucleus.

Potentiometric Head: The pressure head. In an unconfined aquifer the potentiometric head is the water table.

Primary porosity aquifer: An aquifer where the porosity occurs in inter-particle void space originating from the time of deposition.

Quaternary: Of, or belonging to, the geological time, system of rocks, or sedimentary deposits of the second period of the Cenozoic Era, from the end of the Tertiary Period through the present.

Regolith: A loose incoherent mantle of rock fragments on solid rock.

Shale: A fissile rock composed of layers of claylike, fine-grained sediments.

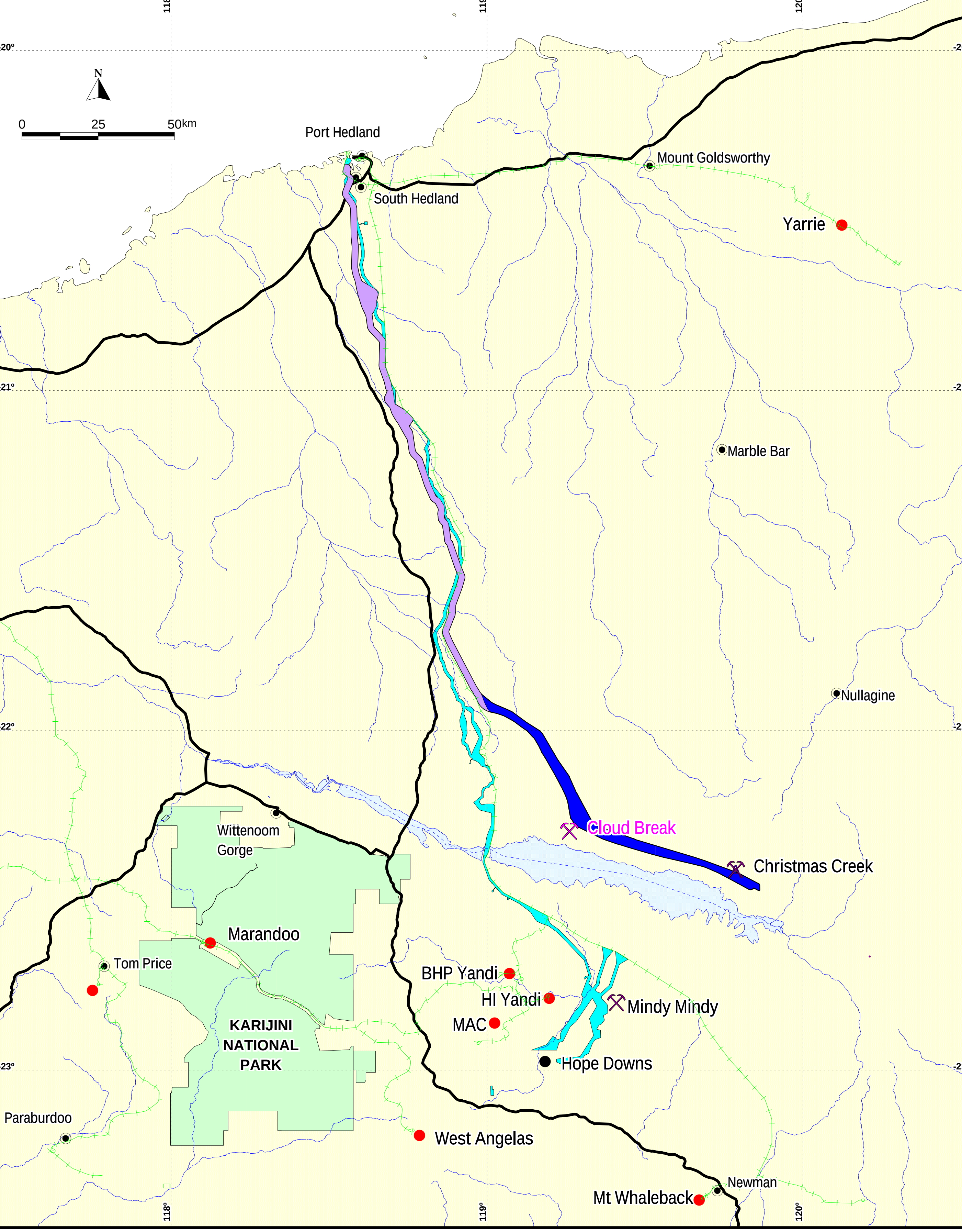
Stygofauna: Subterranean fauna living in aquatic environments

Vertebrate: Having a backbone or spinal column.

Vuggy: Porosity resulting from dissolution in small cavities (typically less than 1 cm).

Yandeeying: From ‘yandy’ which is a long shallow dish to separate minerals from alluvium by means of a rocking motion.

Figures



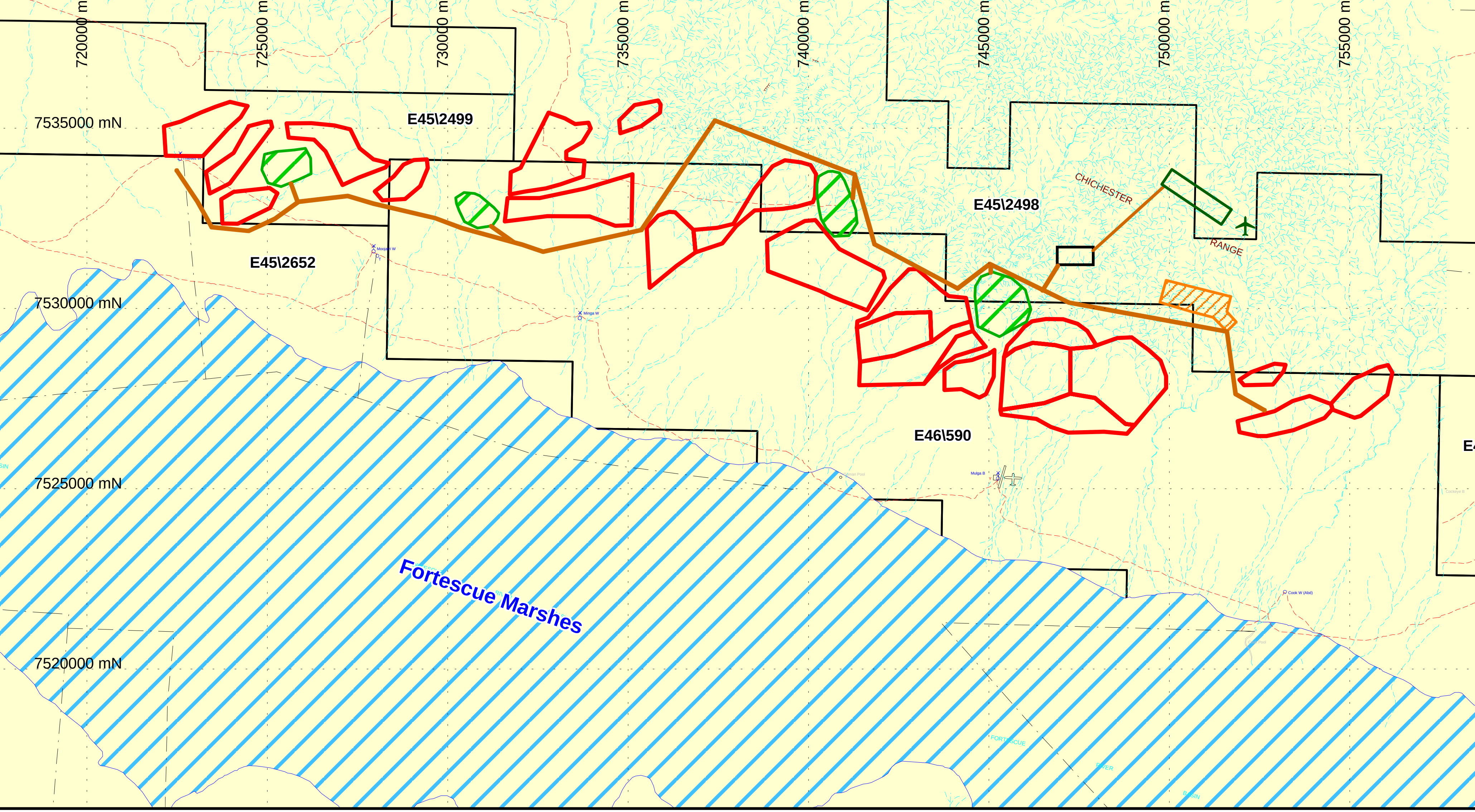
Legend

Town	Proposed FMG mine site
Highway	Proposed Cloud Break Mine Site
Drainage	Rail - Proposed FMG Stage A
Subject to inundation	Rail - Proposed FMG Stage B
Rail - existing	Rail - Hope Downs Rail Corridor
	Iron Ore deposit
	Iron Ore mine

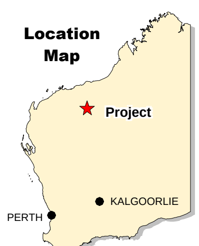
Fortescue Metals Group Limited

Figure 1. Pilbara Iron Ore & Infrastructure Project

Author: FMG	Date: 01/08/04
Drawn: A Gregory	Revised: 12/08/05
Fig No.: 1	Report No.: FMG 04037



Legend



- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Transport Corridor
- FMG Tenements Granted
- Water courses
- Tracks
- Fences
- Proposed Cloud Break Airstrip

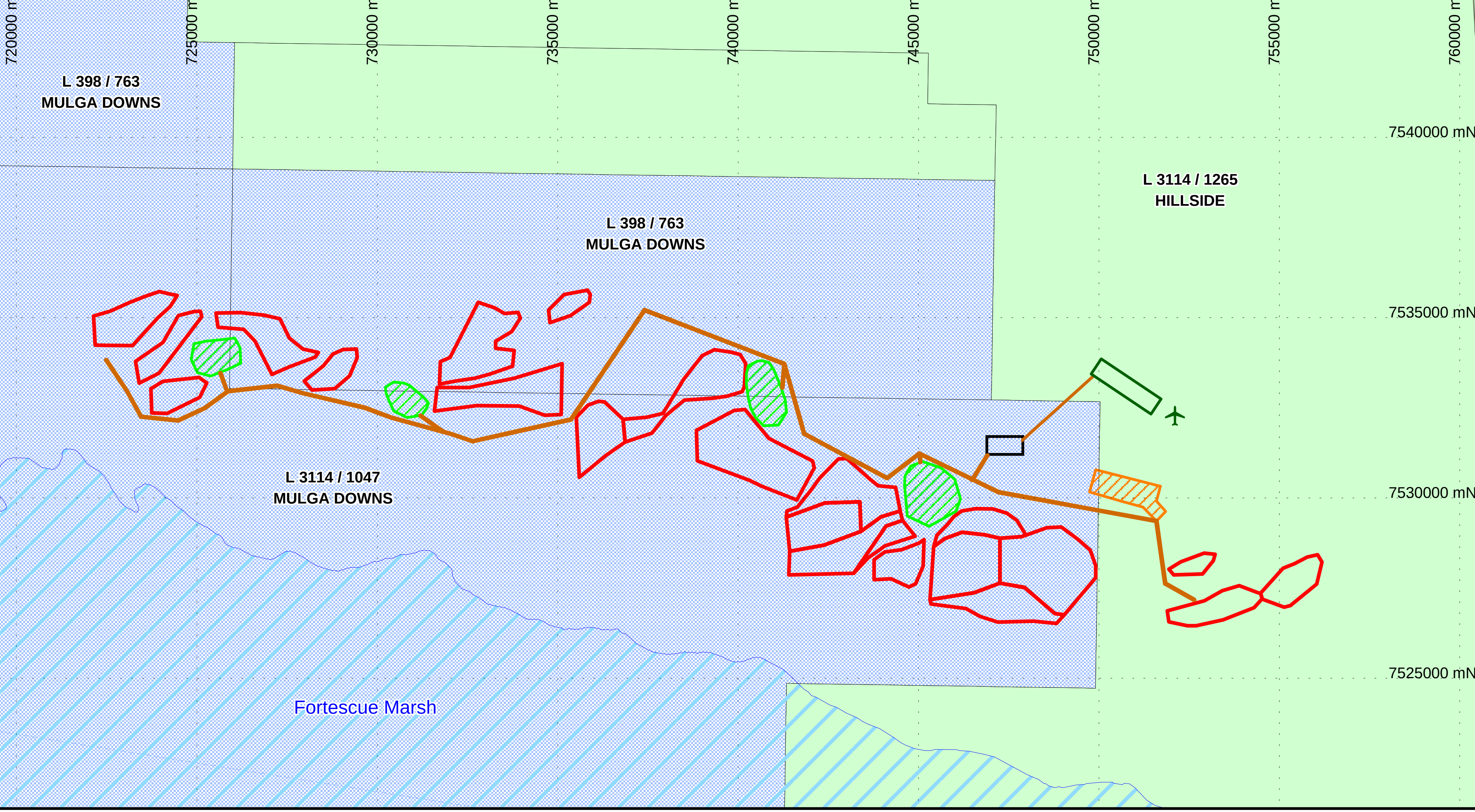
N

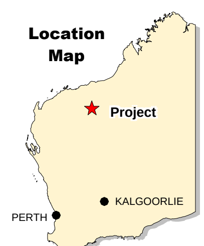
0 2.5 5
Kilometres

Fortescue Metals Group Limited

Figure 2. Cloud Break Project

Author: FMG	Date: 21/06/05
Drawn By: C Little	Revised: 29/08/05
Fig No.: 2	Report No.: FMG 05090





Legend

- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Proposed Cloud Break Airstrip
- Overburden Landforms
- Transport Corridor

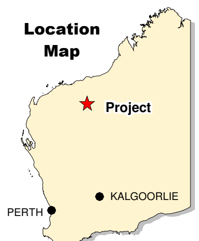
N

0 2.5 5
Kilometres

Fortescue Metals Group Limited

Figure 3. Pastoral Lease Map

Author: FMG	Date: 10/02/04
Drawn By: A Gregory	Revised: 05/08/05
Fig No.: 3	Report No.: FMG 04021_L3



Legend

- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Transport Corridor
- Proposed Cloud Break Airstrip

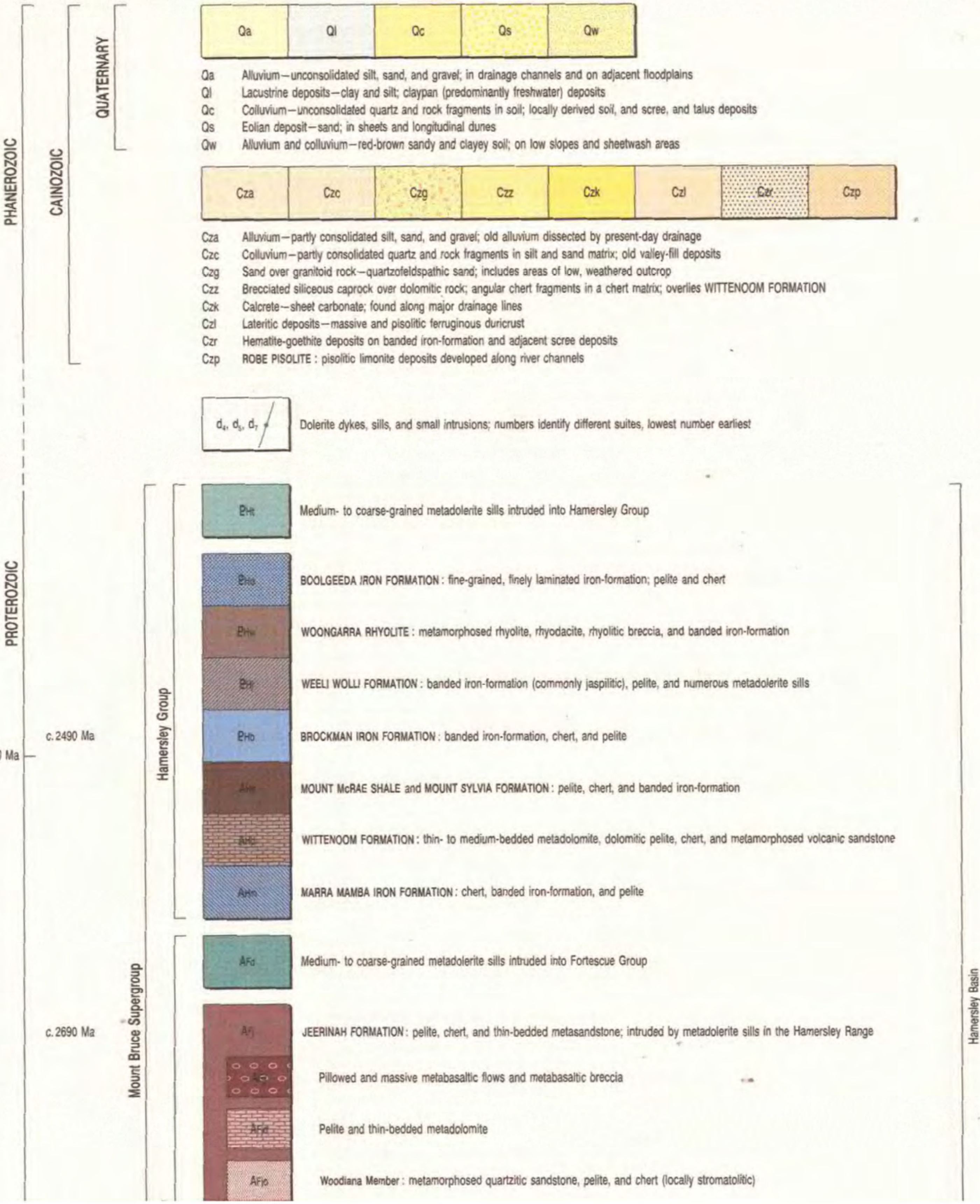
N

0 2.5 5
Kilometres

Fortescue Metals Group Limited

Figure 4. Regional Geology Cloud Break

Author: FMG	Date: 08/06/05
Drawn By: C Little	Revised: 03/08/05
Plan No.: 4	Report No.: FMG 05077

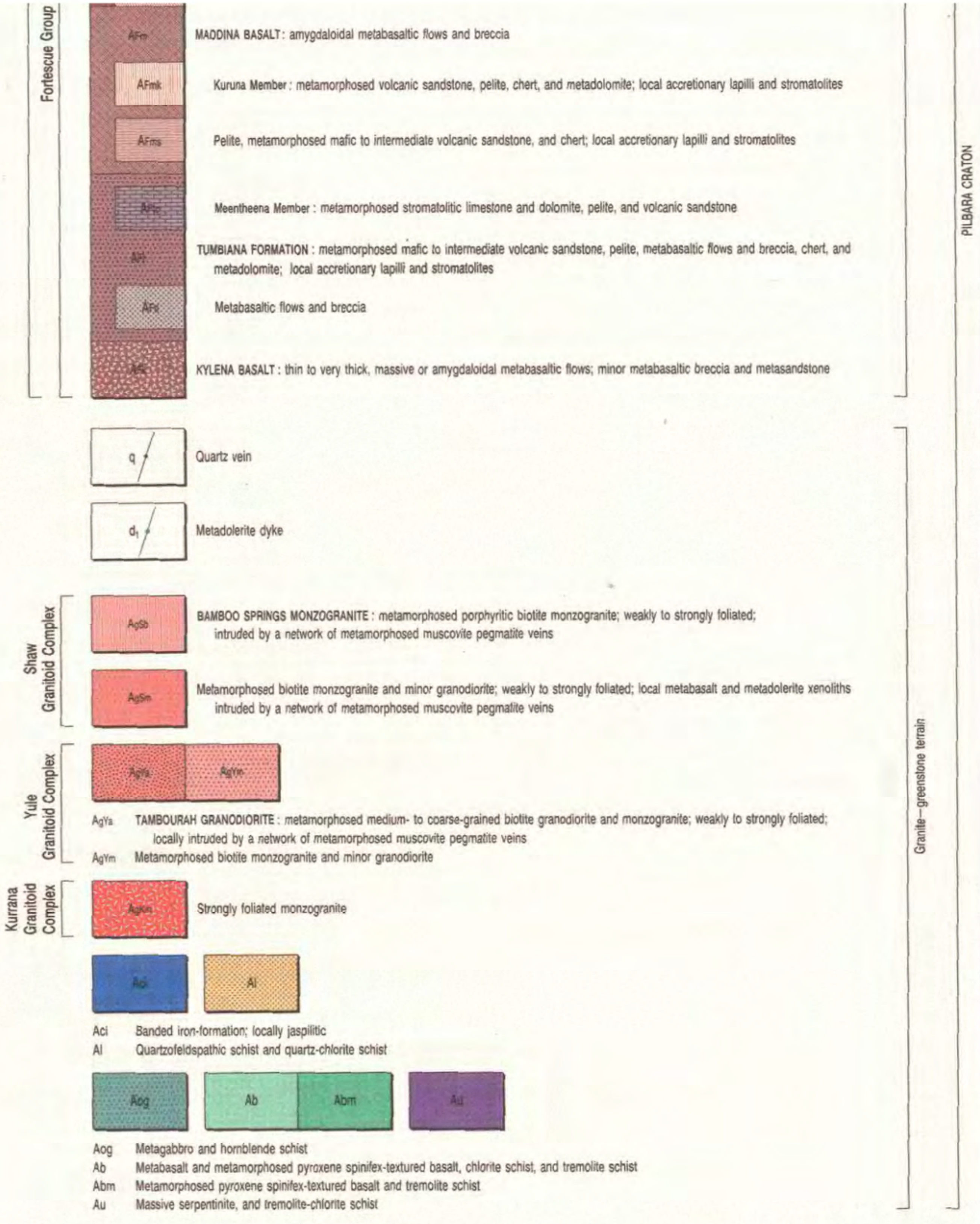


Fortescue Metals Group Limited

Figure 4a. Regional Geology Legend (1 of 2) Cloud Break

Author: FMG	Date: 08/06/05
Drawn By: C Little	Revised: 03/08/05
Fig No.: 4a	Report No.: FMG 05077_L2

Source: Geological Survey of W.A.

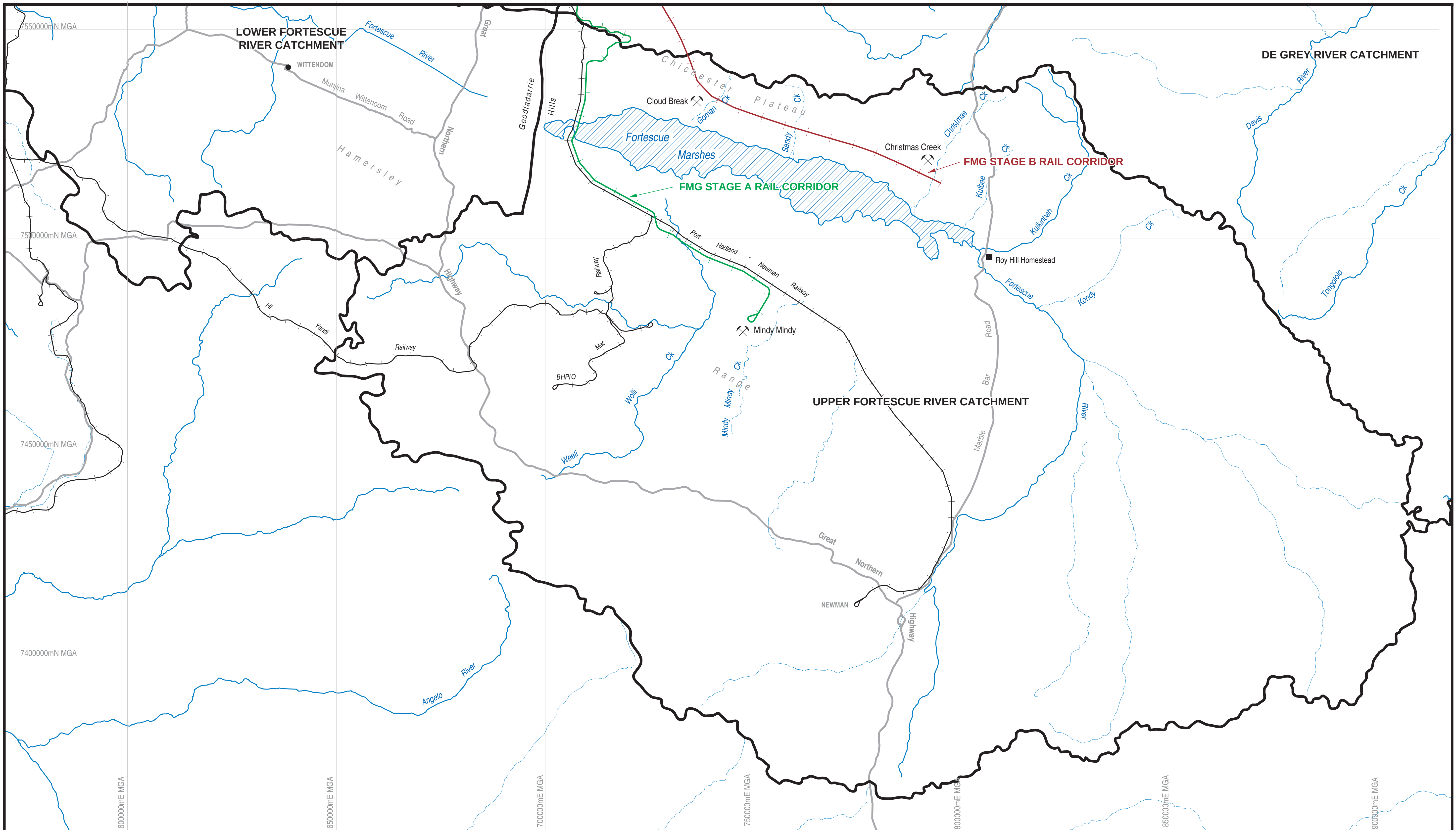


Source: Geological Survey of W.A.

Fortescue Metals Group Limited

Figure 4b. Regional Geology Legend (2 of 2) Cloud Break

Author: FMG	Date: 08/06/05
Drawn By: C Little	Revised: 03/08/05
Fig No.: 4b	Report No.: FMG 05077_L3
Projection: N/A	Scale: Not to Scale



Location Map

Project

PERTH

KALGOORLIE

Legend

Major Road

Major River

Railway

Major Catchment Boundary

N

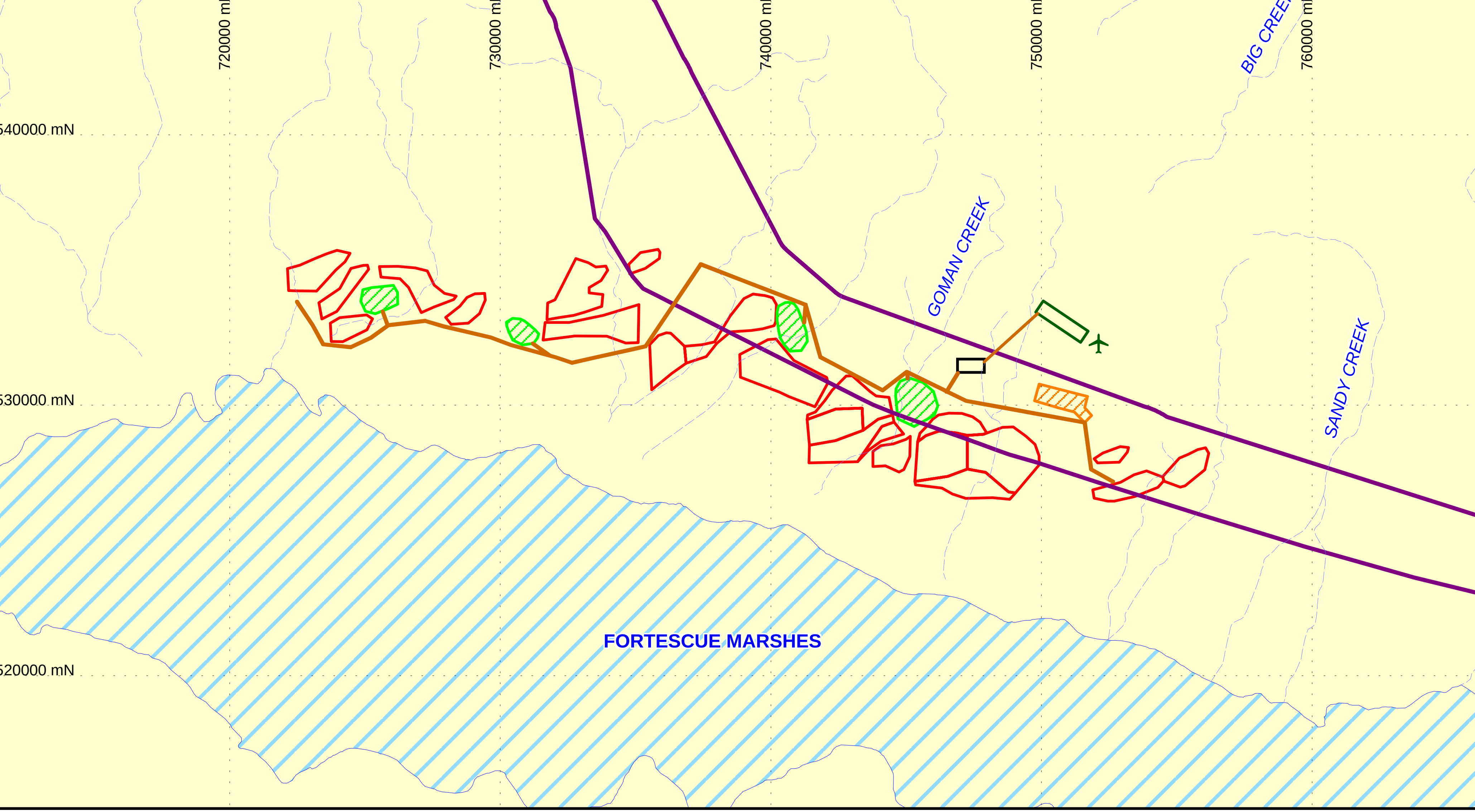
0 10 20Km

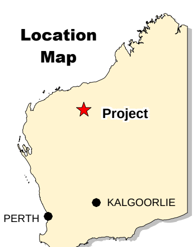
Fortescue Metals Group Limited

Figure 5 Upper Fortescue River Catchment

Author:	Aquaterra	Date:	Aug 05
Drawn By:	Vince Piper	Revised:	.
Fig No:	5	Report No.:	FMG 04084
Projection:	GDA94	Scale:	1 : 900 000

495B2_003FMG.dgn





Legend

- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Transport Corridor
- Proposed Rail Corridor
- Fortescue Marshes
- Creeks
- Proposed Cloud Break Airstrip

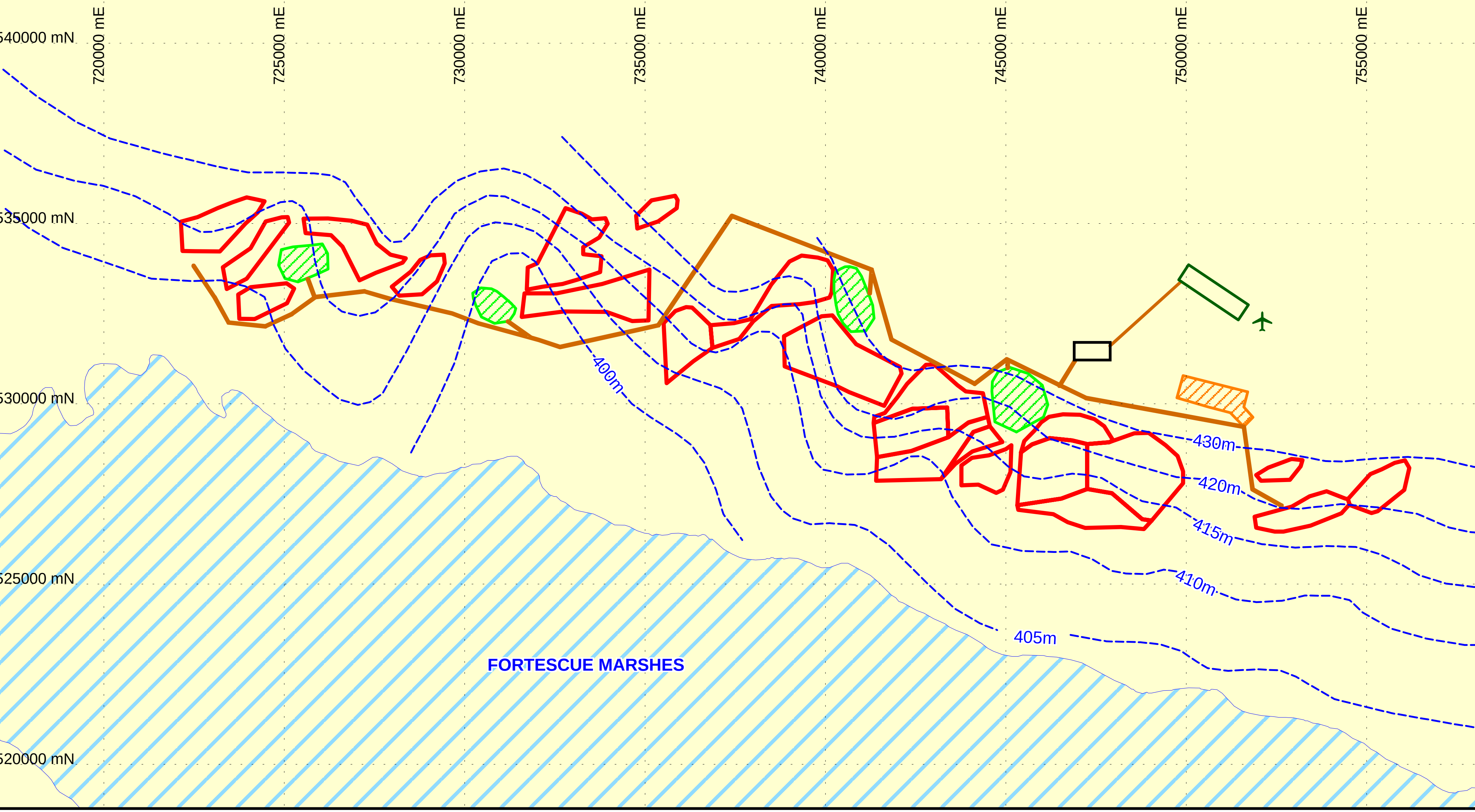
N

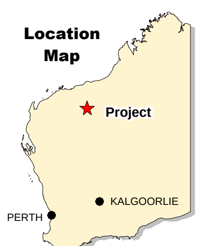
0 2.5 5
Kilometres

Fortescue Metals Group Limited

Figure 6. Surface Drainage of Cloud Break Area

Author: FMG	Date: 23/06/05
Drawn By: S Doherty	Revised: 03/08/05
Fig No.: 6	Report No.: FMG 05094





Legend

- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Groundwater Contours (mRL)
- Proposed Cloud Break Airstrip

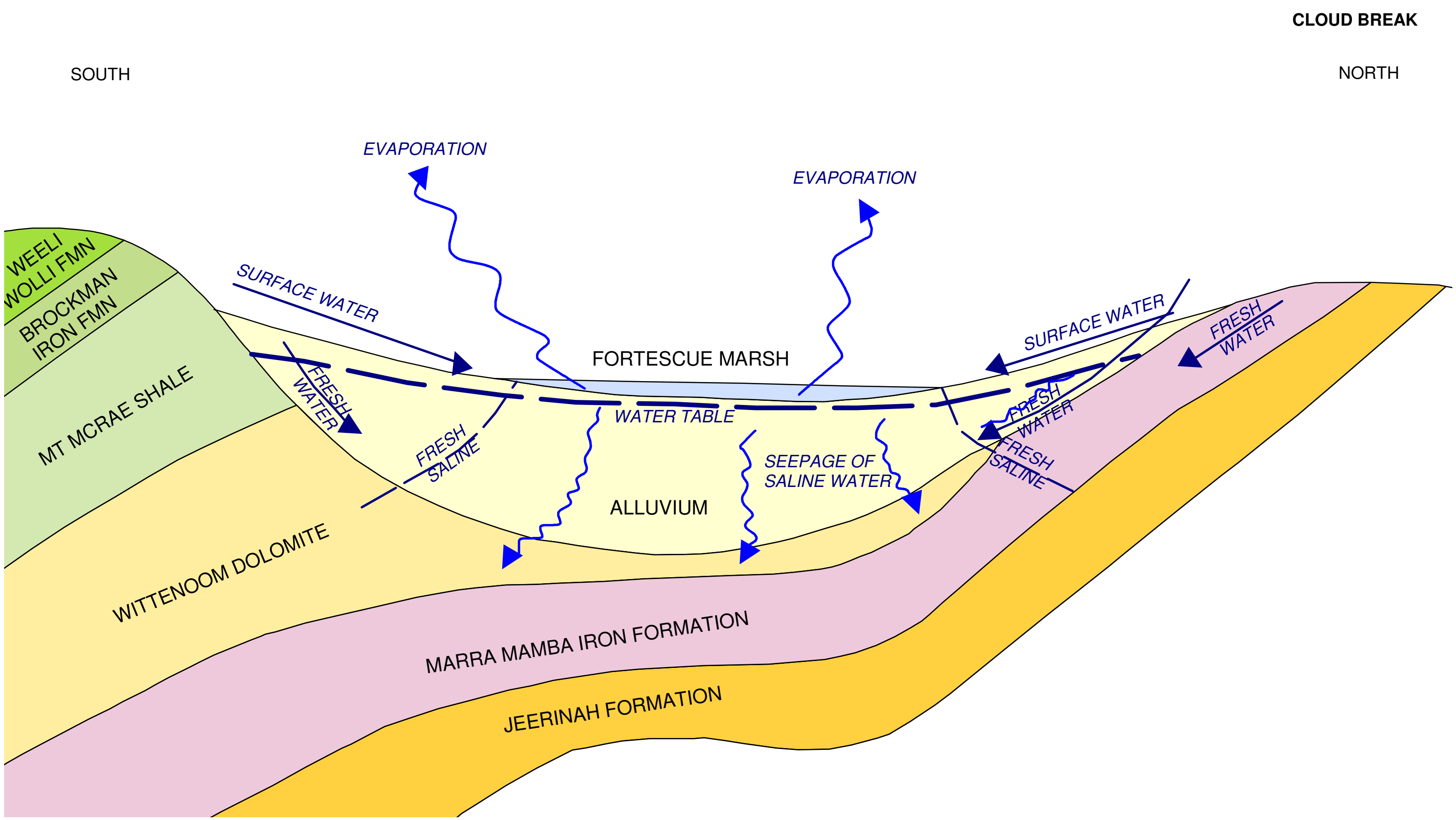
N

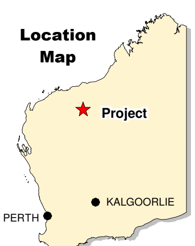
0 2.5 5
Kilometres

Fortescue Metals Group Limited

Figure 7. Regional Groundwater Contour Plan

Author: FMG	Date: 20/06/05
Drawn By: S Doherty	Revised: 31/08/05
Fig No.: 7	Report No.: FMG 05089

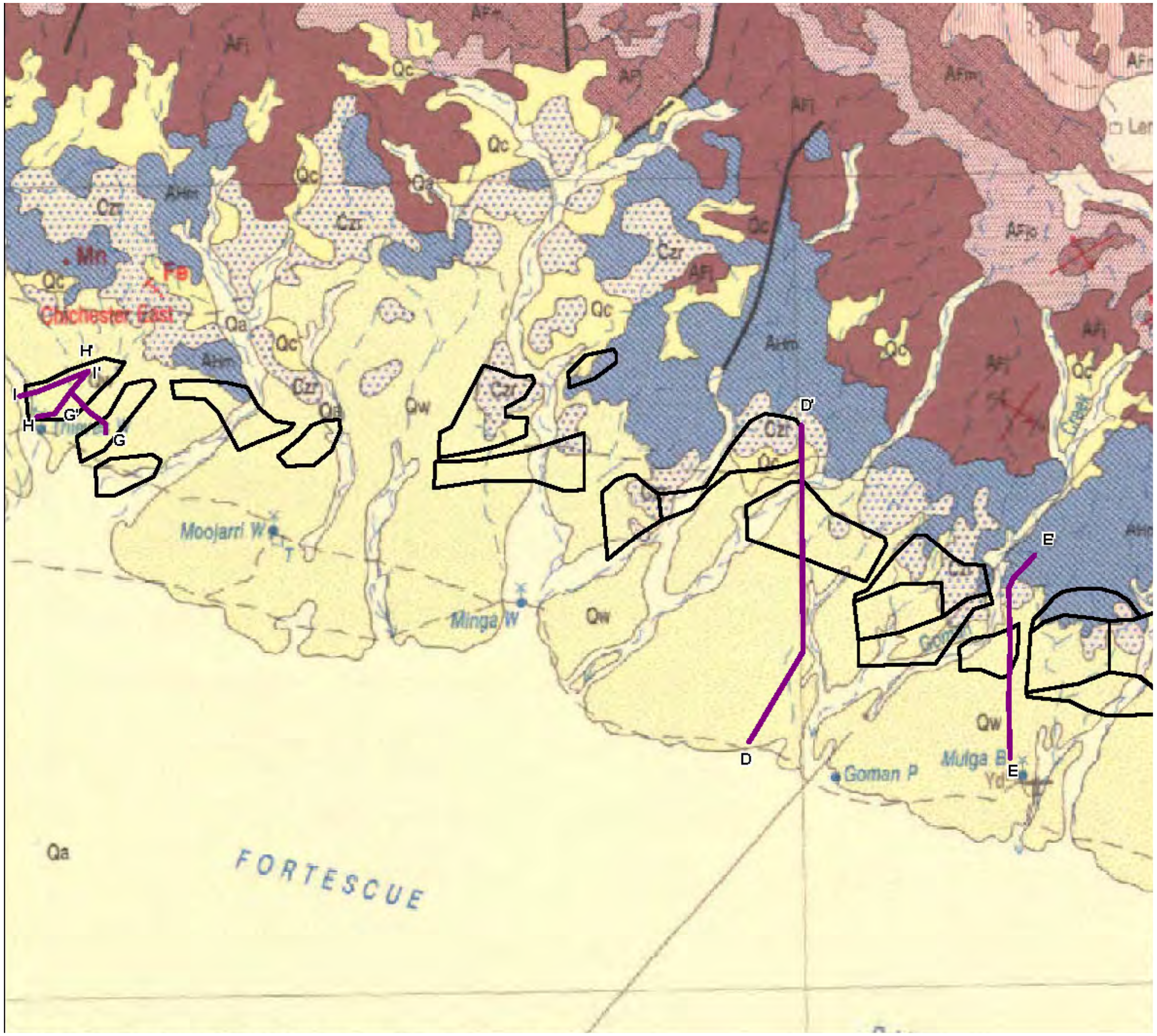


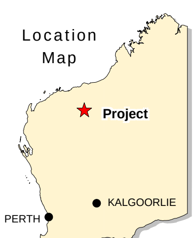


Fortescue Metals Group Limited

Figure 8. Schematic Section Across the Fortescue Marshes

Author: FMG	Date: 01/12/04
Drawn By: A Gregory	Revised: 03/08/05
Plan No.: 8	Report No.: FMG 04111





Cloud Break Mine Pit Outlines

G'

G

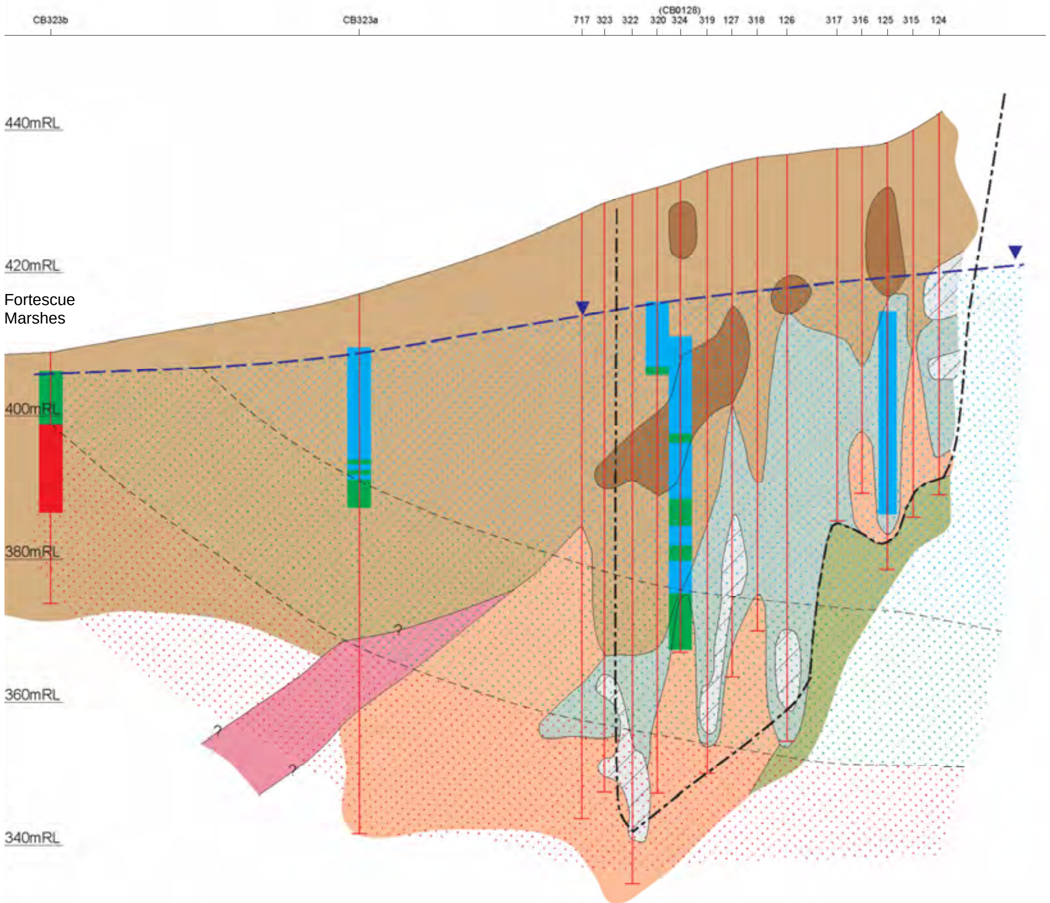
Location of Geological Cross-Section

Fortescue Metals Group Limited

Figure 9. Plan Showing Location of Hydrological Cross Sections

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 30/08/05
Fig No.: 9	Report No.: FMG 05098

HYDROGEOLOGICAL SECTION
(Section D - D')



LEGEND
Geology

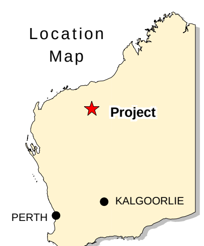
- TERTIARY DEPOSITS
- TERTIARY HARDCAP
- CALCRETE
- WITTENOOM DOLOMITE
- ORE ZONE
- NAMMULDI MEMBER SHALES
- BIF
- ROY HILL SHALE
- PIT OUTLINE

Hydrogeology

WATER QUALITY
(based on downhole geophysical logging)

- CONDUCTIVITY < 150 mS/m
- CONDUCTIVITY 150 - 2000 mS/m
- CONDUCTIVITY > 2000 mS/m
- INFERRED STATIC WATER LEVEL
- INFERRED WATER QUALITY INTERFACE

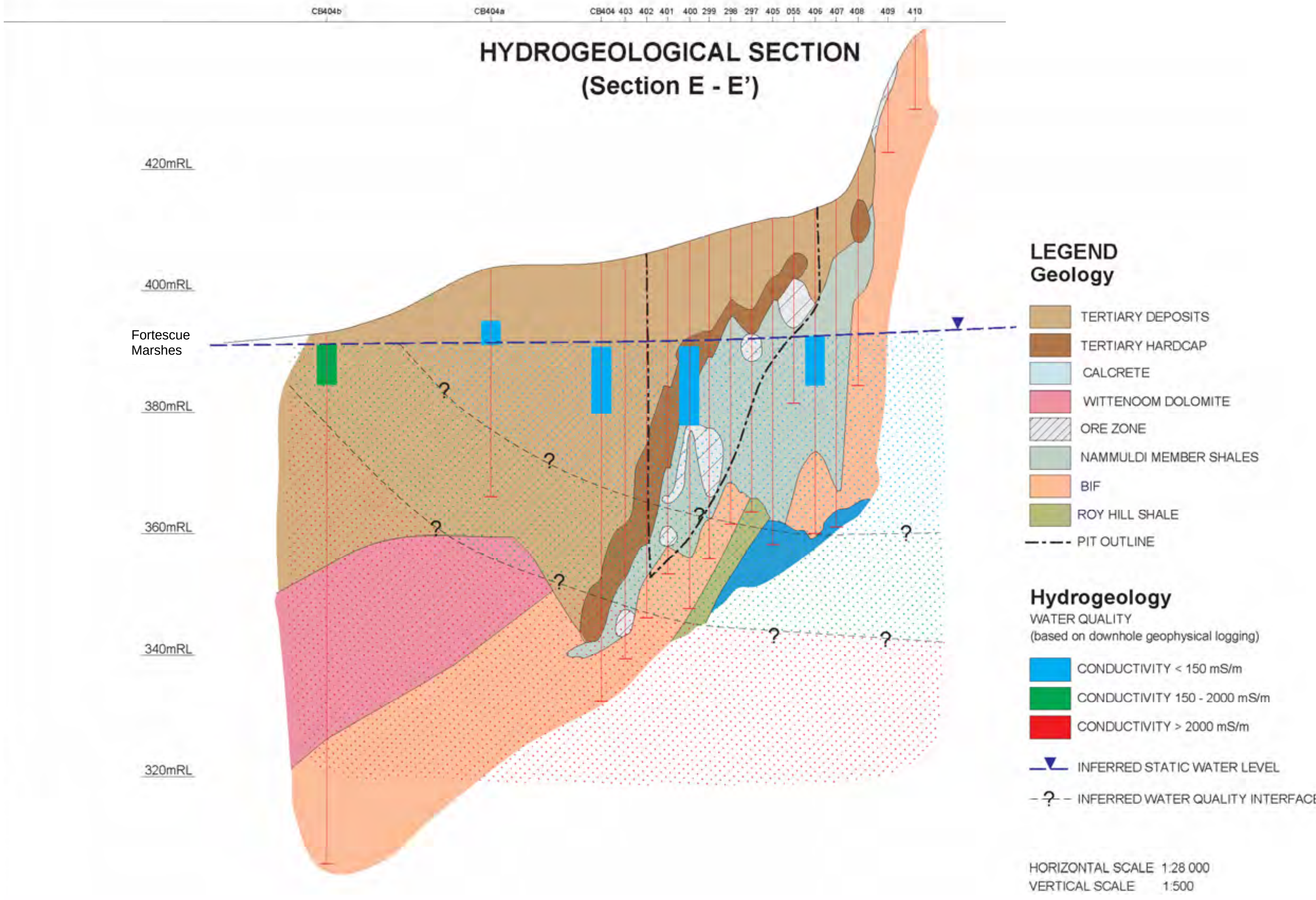
HORIZONTAL SCALE 1:28 000
VERTICAL SCALE 1:500

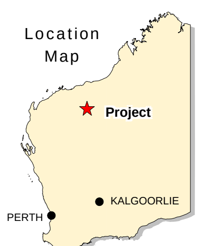


Fortescue Metals Group Limited

Figure 9a. Hydrogeological Section (Section D - D')
(Refer Fig. 9 for Cross Section Layout)

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 30/08/05
Fig No.: 9a	Report No.: FMG 05098

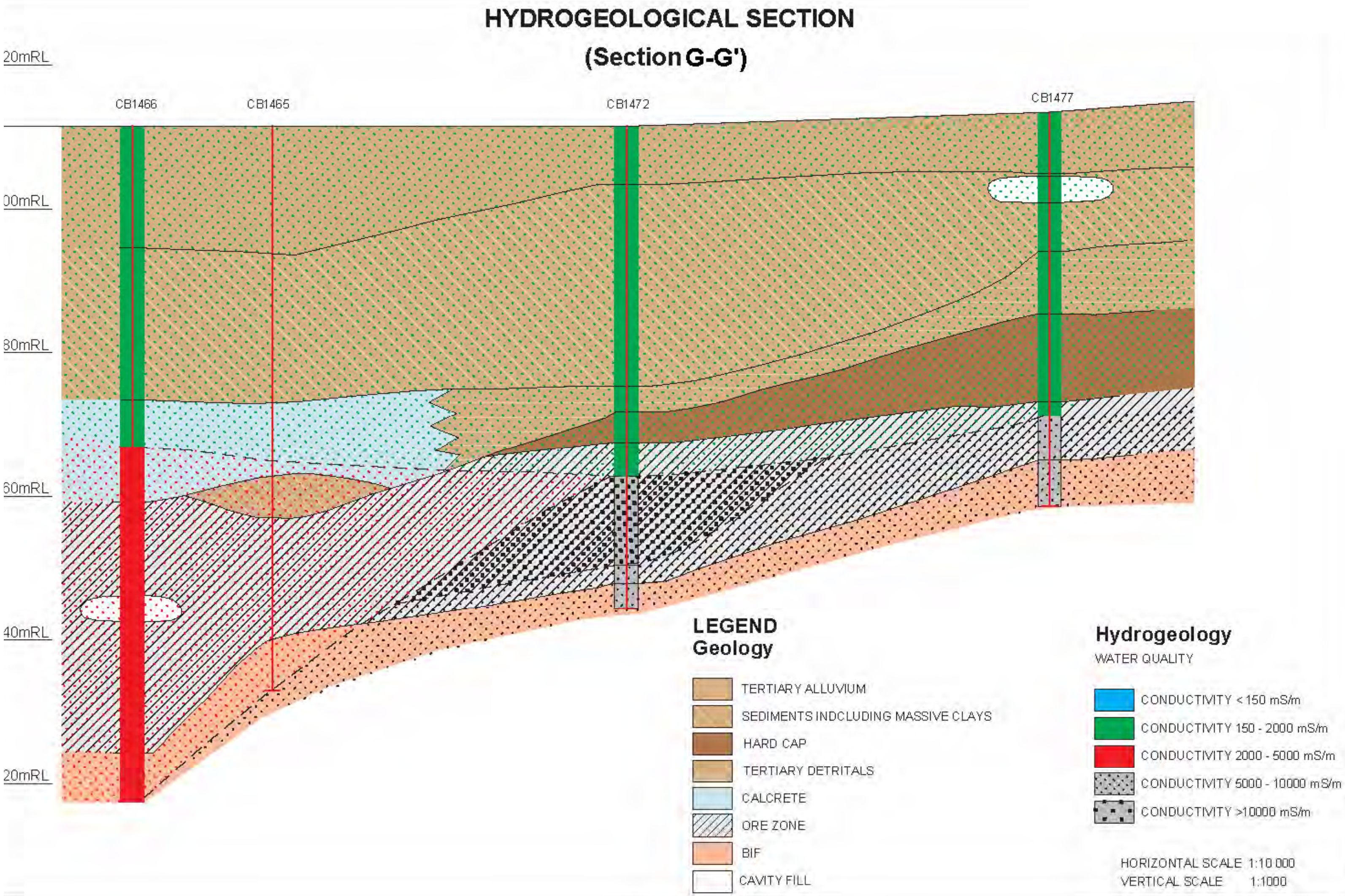


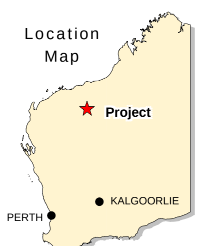


Fortescue Metals Group Limited

Figure 9b. Hydrogeological Section (Section E - E')
(Refer Fig. 9 for Cross Section Layout)

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 30/08/05
Fig No.: 9b	Report No.: FMG 05098



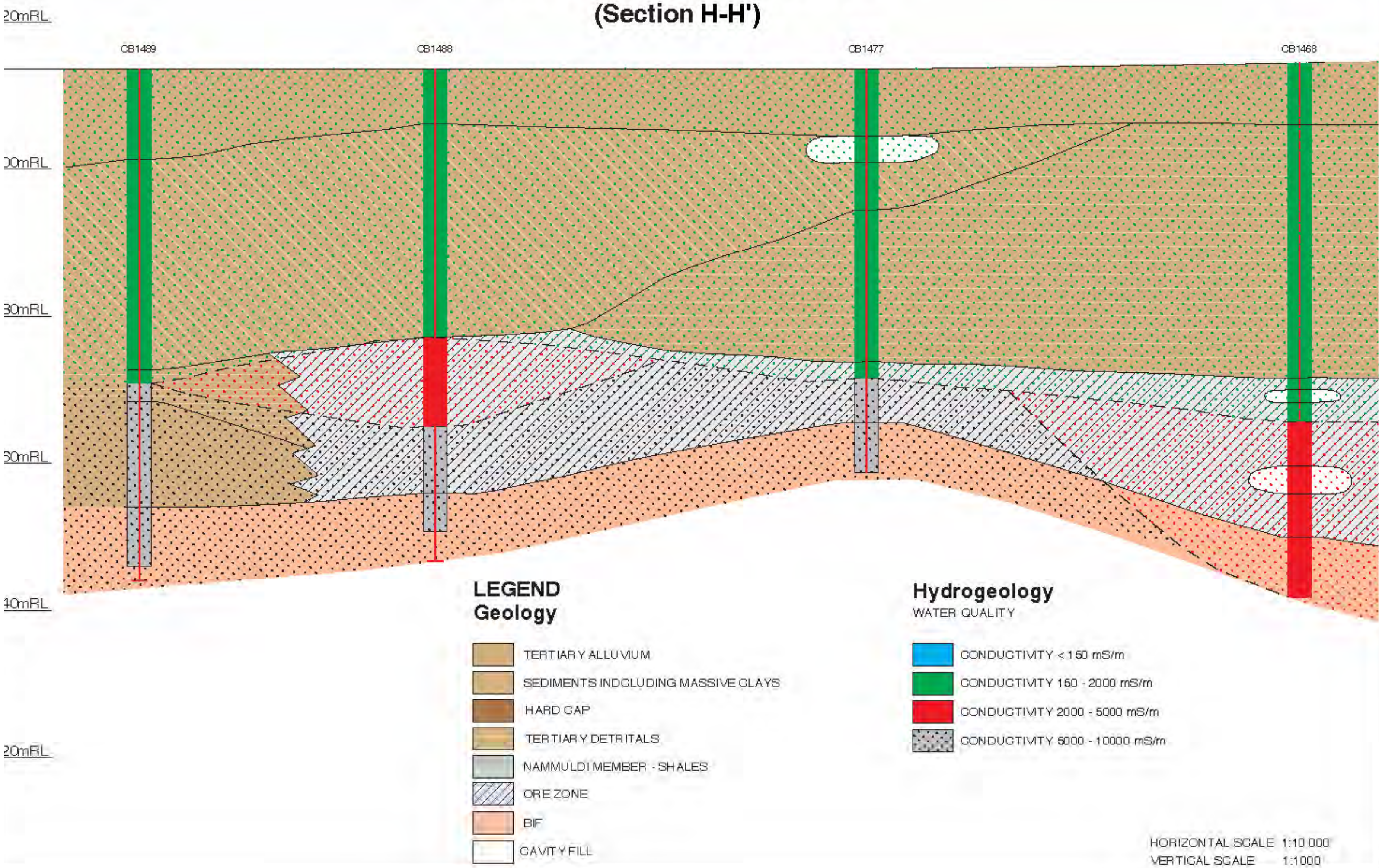


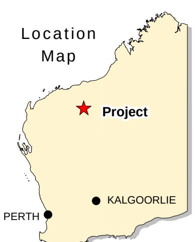
Fortescue Metals Group Limited

Figure 9c. Hydrogeological Section (Section G - G')
(Refer Fig. 9 for Cross Section Layout)

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 30/08/05
Fig No.: 9c	Report No.: FMG 05098

HYDROGEOLOGICAL SECTION
(Section H-H')



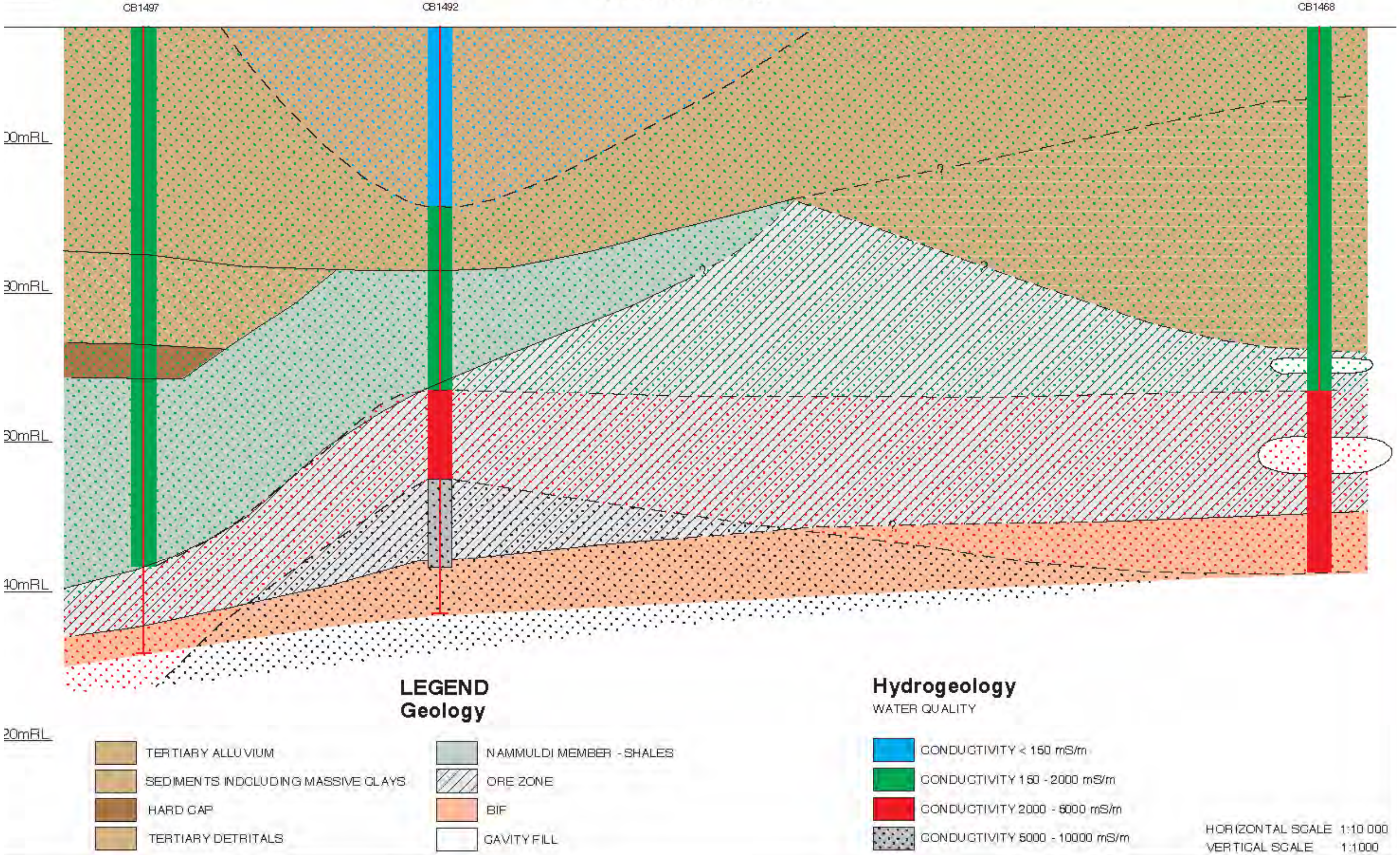


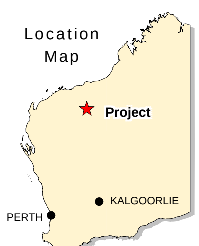
Fortescue Metals Group Limited

Figure 9d. Hydrogeological Section (Section H - H')
(Refer Fig. 9 for Cross Section Layout)

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 30/08/05
Fig No.: 9d	Report No.: FMG 05098

HYDROGEOLOGICAL SECTION
(Section I - I')

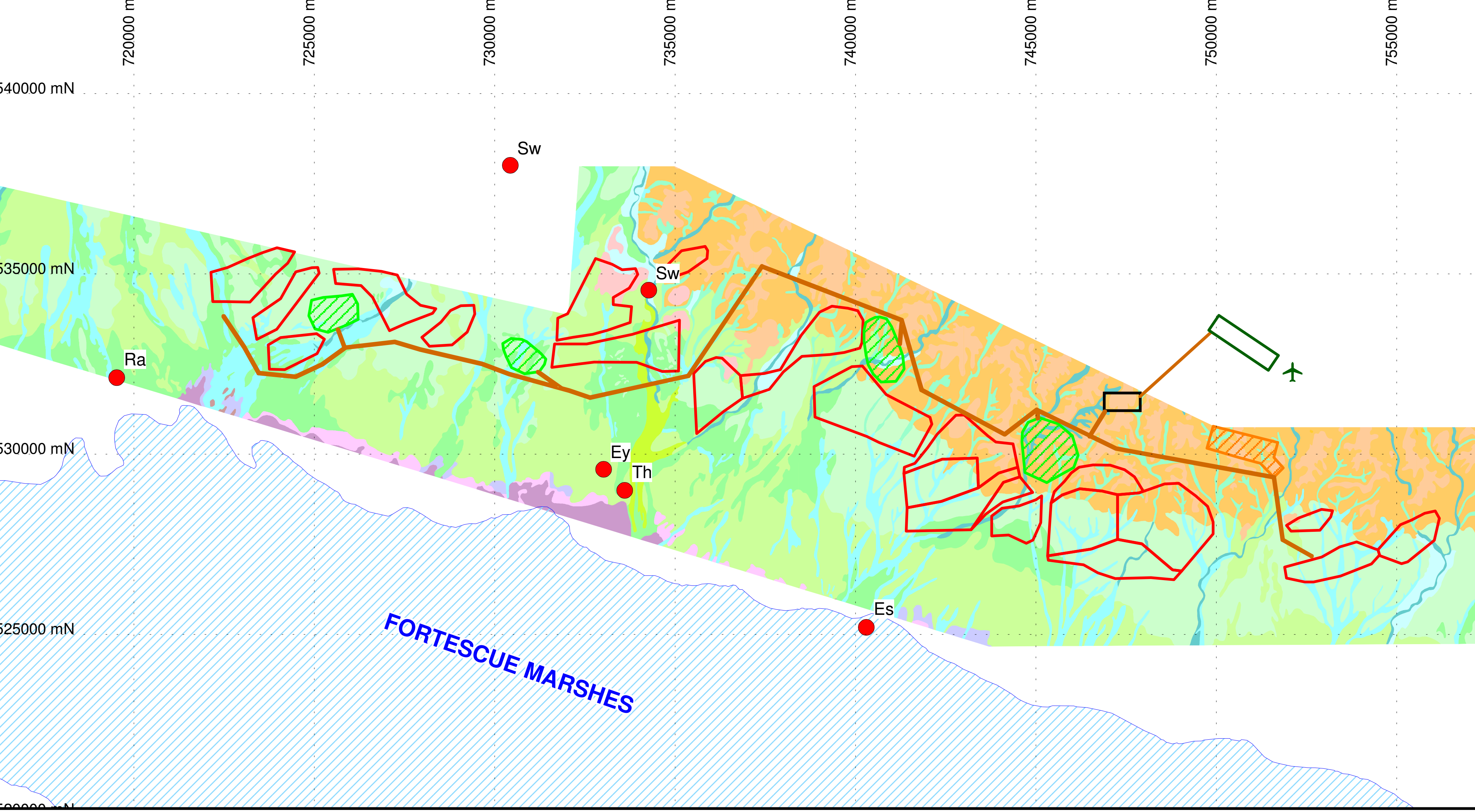


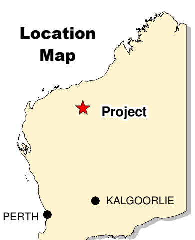


Fortescue Metals Group Limited

Figure 9e. Hydrogeological Section (Section I - I')
(Refer Fig. 9 for Cross Section Layout)

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 30/08/05
Fig No.: 9e	Report No.: FMG 05098





Legend

- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Proposed Cloud Break Airstrip
- Priority Flora

Ey *Eremophila youngii*
Es *Eremophila spongiocarpa (ms)*
Ra *Rostellularia adscendens* var. *latifolia*
Sw *Sida* sp. Wittenoom (W.R. Barker 1962)
Th *Themeda* sp. Hamersley Station (M.E. trudgen 11431)

N

0 2.5 5
Kilometres

Fortescue Metals Group Limited

Figure 10. Distribution of Priority Flora at Cloud Break

Author: FMG	Date: 20/06/05
Drawn By: S Doherty	Revised: 31/08/05
Fig No.: 10	Report No.: FMG 05088

LEGEND

Creekline and Drainage Lines

1 - Open Woodland of *Eucalyptus victrix*, *Eucalyptus camaldulensis* var. *obtusa* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica*, *Petalostylis labicheoides*, *Acacia tumida* over *Triodia longiceps*. *Chrysopogon fallax*, *Themeda triandra* and *Aristida* species.

2 - Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura*, *Acacia citrinoviridis*, *Acacia pruinocarpa* over *Acacia tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax*, *Stemodia viscosa*, *Blumea tenella*, *Themeda triandra* and species of *Triodia* and *Aristida*.

8 - Closed Scrub to Tall Shrubland of *Acacia pruinocarpa*, *Acacia tumida*, *Acacia ancistrocarpa*, *Acacia maitlandii*, *Acacia kempeana*, *Acacia tetragonophylla* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Triodia epactia*, *Themeda triandra* and *Aristida* species.

9 - Closed Scrub to Shrubland of *Acacia ancistrocarpa*, *Acacia maitlandii*, *Acacia kempeana*, *Acacia monticola* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Senna* species, *Triodia basedowii* and *Aristida* species.

Flats and Broad Plains

3 - Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa*, *Acacia tetragonophylla*, *Acacia tenuissima*, *Grevillea wickhamii* subsp. *aprica*, *Psydrax latifolia* over *Dodonaea petiolaris* and species of *Triodia* and *Aristida*.

4 - Low Open Woodland of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa*, *Acacia xiphophylla*, *Acacia victoriae* over *Acacia tetragonophylla*, *Psydrax latifolia* and *Psydrax suaveolens* over *Ptilotus obovatus* var. *obovatus* and mixed Chenopod species of *Maireana* and *Sclerolaena*.

5 - Low Woodland of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa* over *Acacia tetragonophylla*, *Psydrax latifolia* and *Psydrax suaveolens* over *Ptilotus obovatus* var. *obovatus* and mixed Chenopod and Poaceae species.

6 - Low Woodland of *Acacia aneura* var. *aneura*, *Acacia pruinocarpa* over *Acacia tetragonophylla*, *Psydrax latifolia* and *Psydrax suaveolens* over *Ptilotus obovatus* var. *obovatus* and *Triodia epactia* and Poaceae species.

10 - Low Open Woodland of *Acacia xiphophylla*, *Acacia victoriae*, *Acacia aneura* var. *aneura* over *Acacia tetragonophylla*, *Ptilotus obovatus* var. *obovatus*, *Senna* species and mixed Chenopod species of *Maireana* and *Sclerolaena*.

15 - Low Open Woodland of *Acacia victoriae*, *Acacia xiphophylla* over *Ptilotus obovatus* var. *obovatus*, *Senna* species and mixed Chenopod species of *Maireana* and *Sclerolaena*.

Ranges, Hills and Hillslopes

7 - Hummock Grassland of *Triodia basedowii* with emergent patches of *Eucalyptus gamophylla*, *Eucalyptus leucophloia*, *Corymbia deserticola* over *Acacia ancistrocarpa*, *Acacia sclerosperma*, *Acacia kempeana*, *Acacia arida*, *Grevillea berryana*, *Grevillea wickhamii* subsp. *aprica*, *Calytrix carinata* over *Goodenia stobbsiana* and mixed Poaceae species.

16 - Hummock Grassland of *Triodia basedowii* with pockets of *Triodia epactia* and *Triodia lanigera* with emergent patches of *Eucalyptus leucophloia*, *Corymbia deserticola* over *Acacia ancistrocarpa*, *Acacia hilliana*, *Acacia acradenia*, *Acacia pyrifolia*, *Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* species.

17 - Hummock Grassland of *Triodia basedowii* with pockets of *Triodia epactia* and *Triodia lanigera* with emergent patches of *Eucalyptus leucophloia*, *Corymbia deserticola* over *Acacia ancistrocarpa*, *Acacia pyrifolia*, *Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* and *Ptilotus* species.

18 - Hummock Grassland of *Triodia angusta* with emergent patches of *Eucalyptus leucophloia* over *Acacia ancistrocarpa*, *Acacia pyrifolia*, *Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* and *Ptilotus* species.

Fringes of Samphire Flats

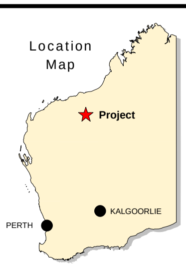
11 - Hummock Grassland of *Triodia angusta* with patches of *Acacia victoriae*, *Acacia aneura* var. *aneura*, *Acacia xiphophylla* over *Atriplex codonocarpa*, *Eremophila cuneifolia* and mixed Chenopods.

12 - Low Halophytic Shrubland of *Halosarcia auriculata* and *Halosarcia indica* subsp. *leiostachya* with associated Chenopod species of *Maireana* species and *Atriplex flabelliformis* with *Muehlenbeckia florulenta* with patches of *Acacia victoriae* and *Acacia sclerosperma* subsp. *sclerosperma*.

13 - Low Halophytic Shrubland of *Halosarcia auriculata*, *Halosarcia indica* subsp. *leiostachya*, *Halosarcia halocnemoides* subsp. *tenuis* with patches of *Frankenia* species.

14 - Hummock Grassland of *Triodia angusta* with patches of *Acacia victoriae* over *Atriplex codonocarpa* and mixed Chenopods and Poaceae species.

Location Map



Fortescue Metals Group Limited

Figure 10a. Mattiske Vegetation Legend

Author: Mattiske	Date: 08/08/05
Drawn: Mattiske	Revised:
Fig No.: 10a	Report No.: FMG 05088

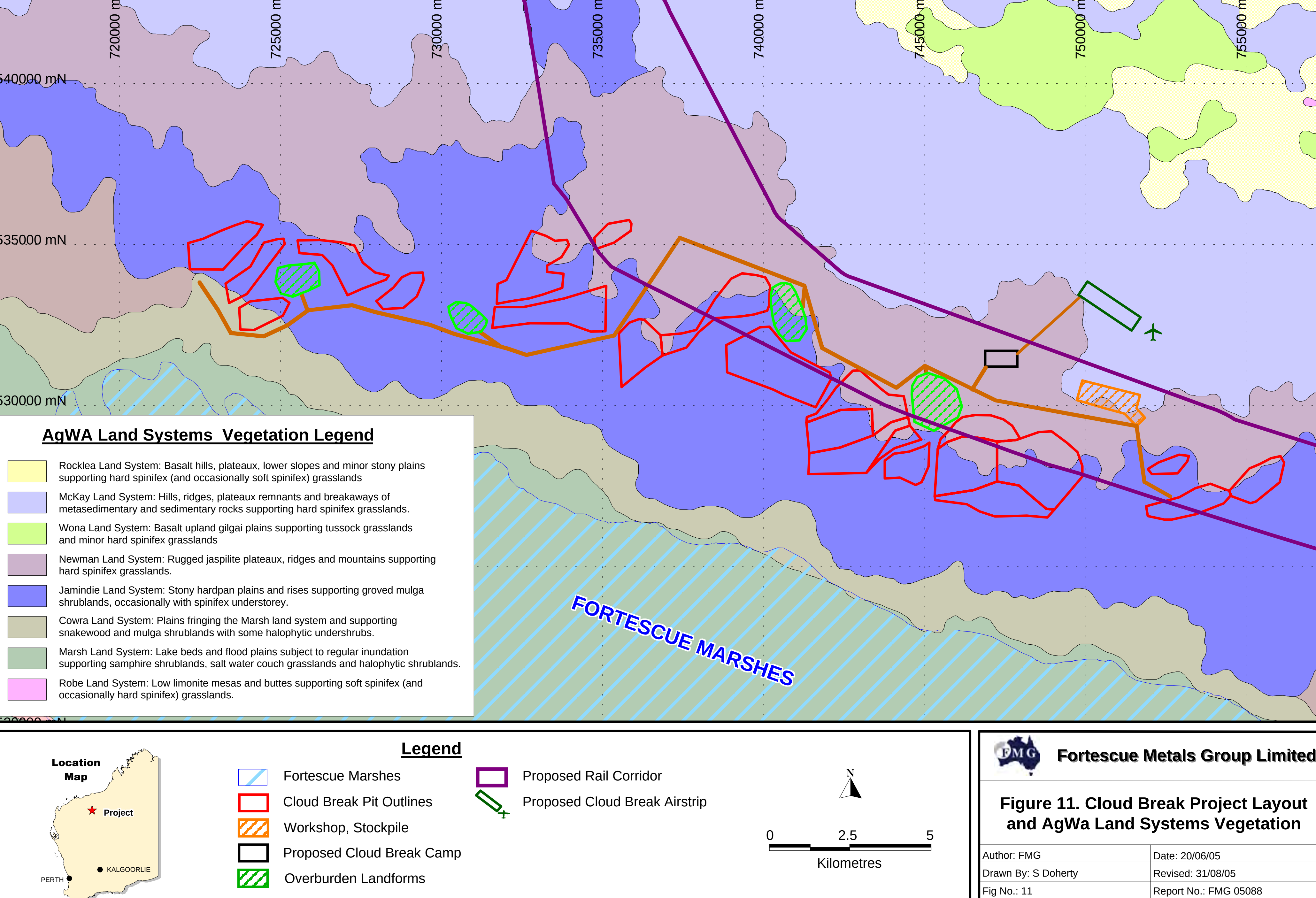
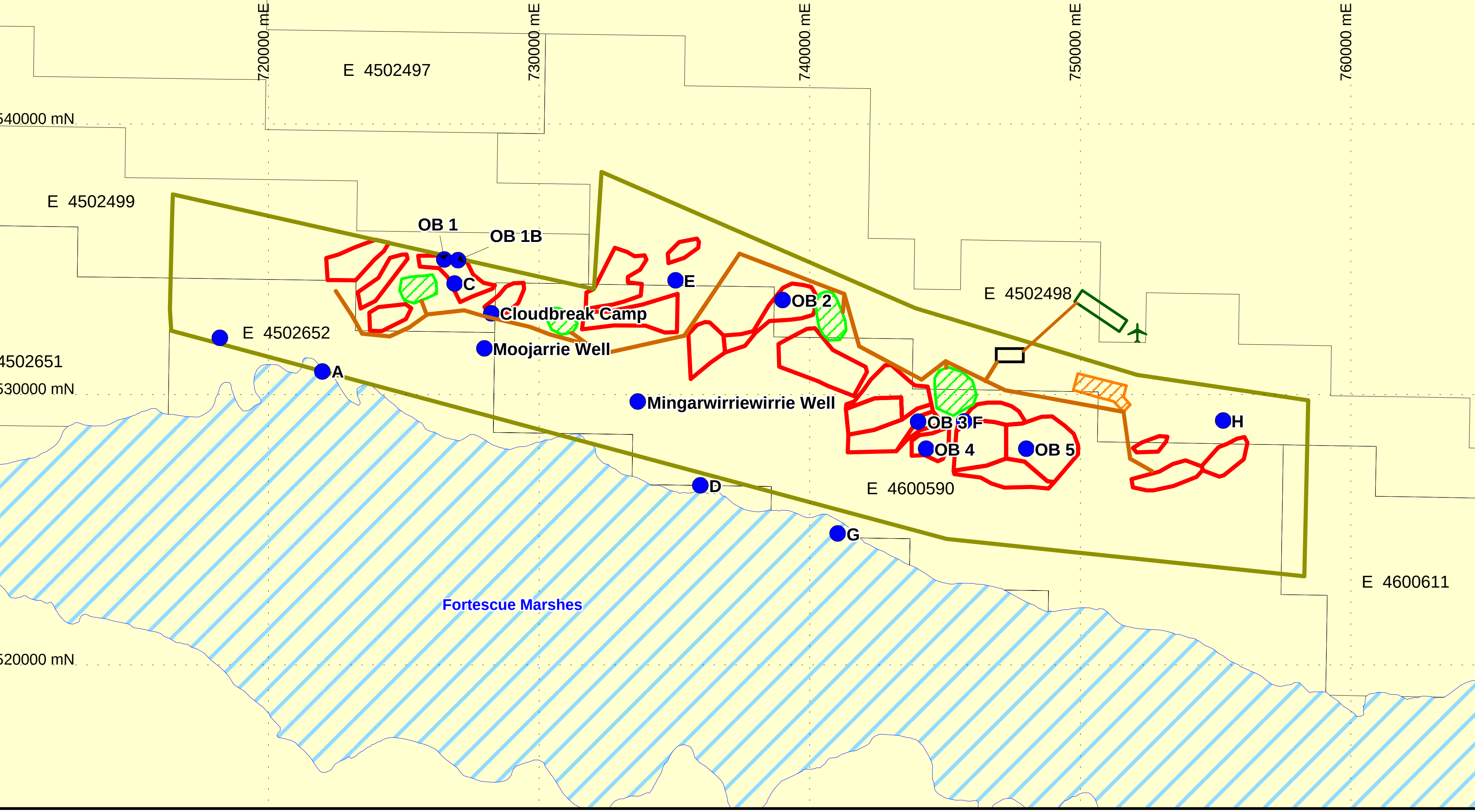


Figure 11. Cloud Break Project Layout and AgWa Land Systems Vegetation



Legend

Location Map: Project, PERTH, KALGOORLIE

- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Transport Corridor
- Fauna Sampling Site Locations
- Survey Boundary
- FMG Tenements Granted
- Proposed Cloud Break Airstrip

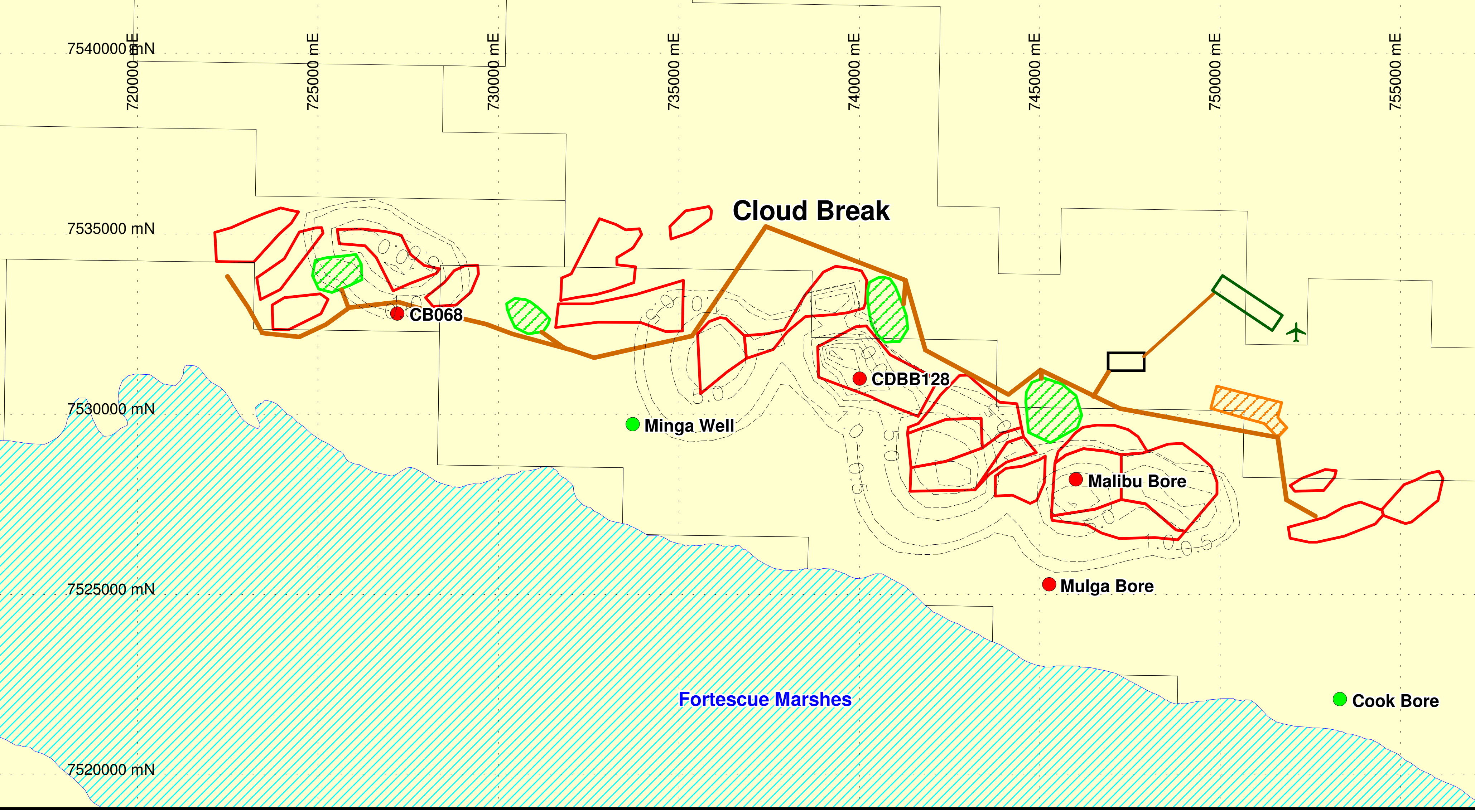
N

0 2.5 5
Kilometres

FMG **Fortescue Metals Group Limited**

Figure 12. Fauna Sampling Sites

Author: Bamford Consultants	Date: 23/06/05
Drawn By: C Little	Revised: 31/08/05
Fig No.: 12	Report No.: 05096_L1



Legend

- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Proposed Cloud Break Airstrip
- Tenement Boundary
- 2 Drawdown Contours

Stygofauna

- Stygofauna not present
- Stygofauna present

N

0 2 4
kilometres

Fortescue Metals Group Limited

Figure 13a. Stygofauna Sampling Bores Within Proposed Groundwater Drawdown Zones (5 years)

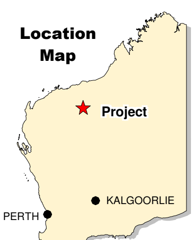
Author: N. Hogarth	Date: 13/06/05
Drawn By: C Little	Revised: 31/08/05
Fig No.: 13a	Report No.: FMG 05081_L1

Legend

Fortescue Marshes
Cloud Break Pit Outlines
Workshop, Stockpile
Proposed Cloud Break Camp
Overburden Landforms
Proposed Cloud Break Airstrip
Tenement Boundary
2 Drawdown Contours

Stygofauna
Stygofauna not present
Stygofauna present

Location Map



N
0 2 4
kilometres

Fortescue Metals Group Limited

Figure 13b. Stygofauna Sampling Bores Within Proposed Groundwater Drawdown Zones (12 years)

Author: N. Hogarth	Date: 13/06/05
Drawn By: C Little	Revised: 31/08/05
Fig No.: 13b	Report No.: FMG 05081_L3

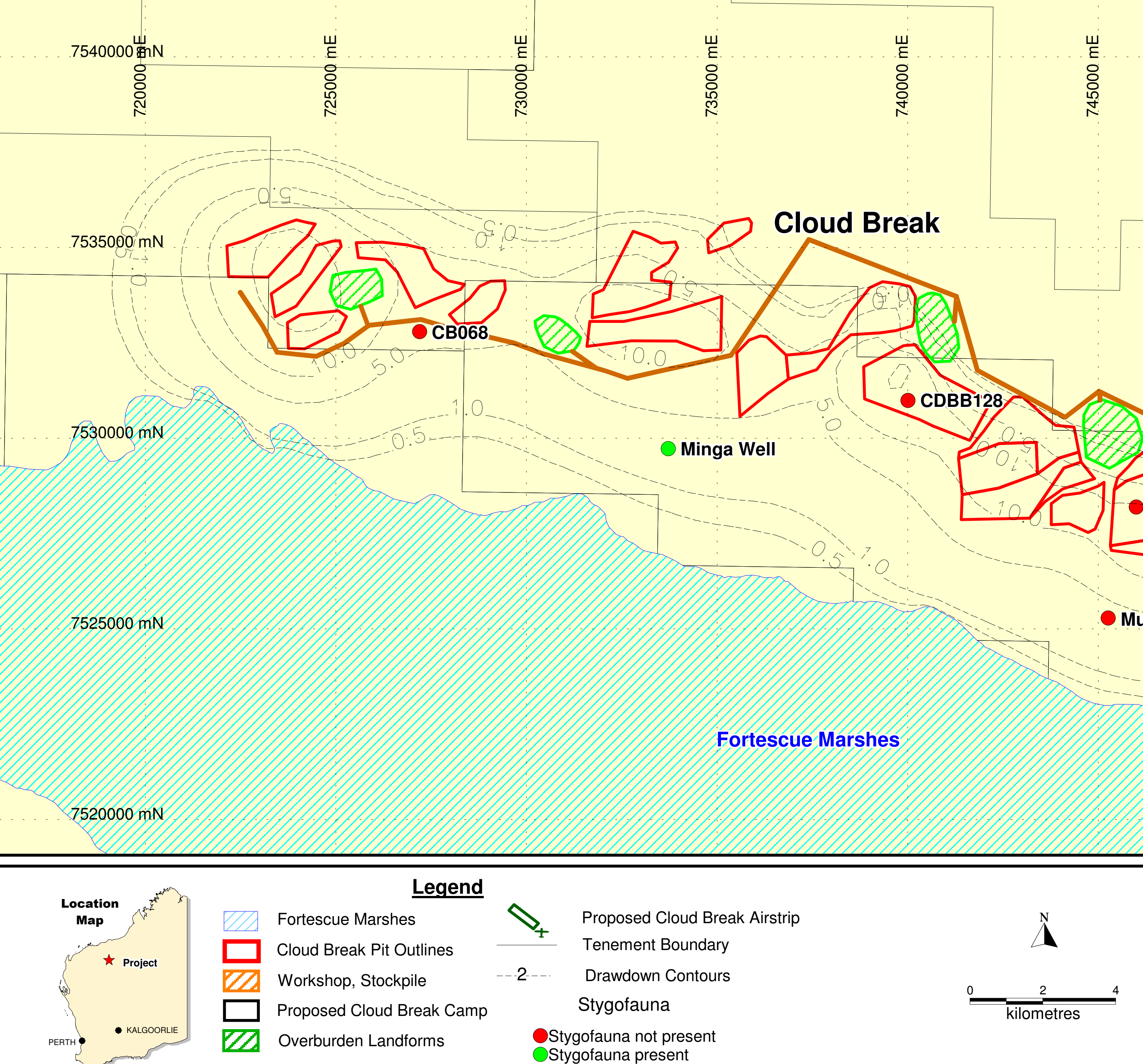


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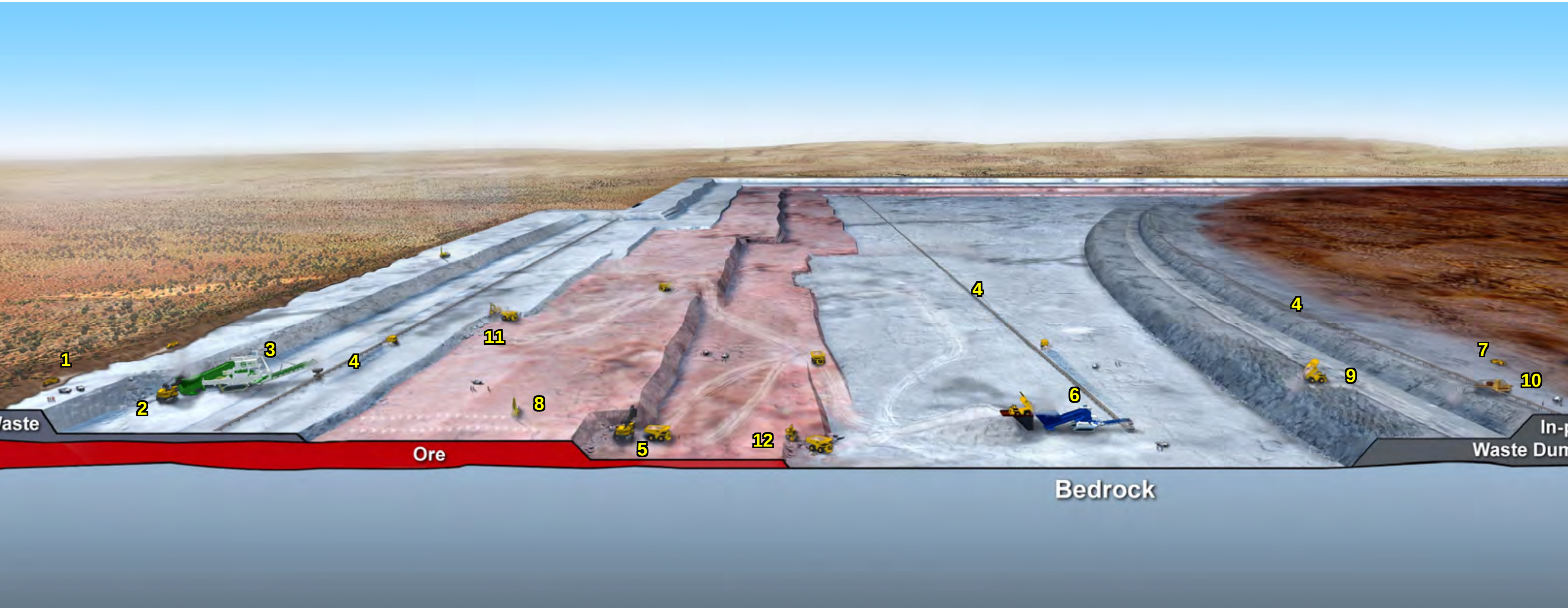
Figure 13c. Stygofauna Sampling Bores Within Proposed Groundwater Drawdown Zones (20 years)

Author: N. Hogarth	Date: 13/06/05
Drawn By: C Little	Revised: 28/08/05
Fig No.:13c	Report No.: 05081_L2



EGEND

Scraper stripping topsoil for placement on rehabilitation
Stripping shovel used to remove overburden
In-pit crusher to crush overburden prior to permanent placement
Conveyers to transport material.
Excavators placing ore in haul trucks for transport to crusher.
Ore crushed and transported to Benefication Plant or to stockpile for direct shipment.
scraper placing topsoil on rehabilitation areas.
Drill Rig
Dumping waste
. Waste Staker re-contouring land form
. Back Hoe used to remove remander of overburden
. Back Hoe used to remove remainder of ore

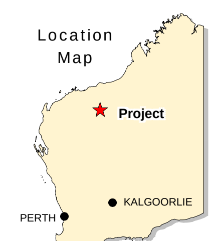


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Figure 14. Conceptual Mining Method

Author: FMG	Date: 09/06/05
Drawn By: Mapability	Revised: 04/08/05

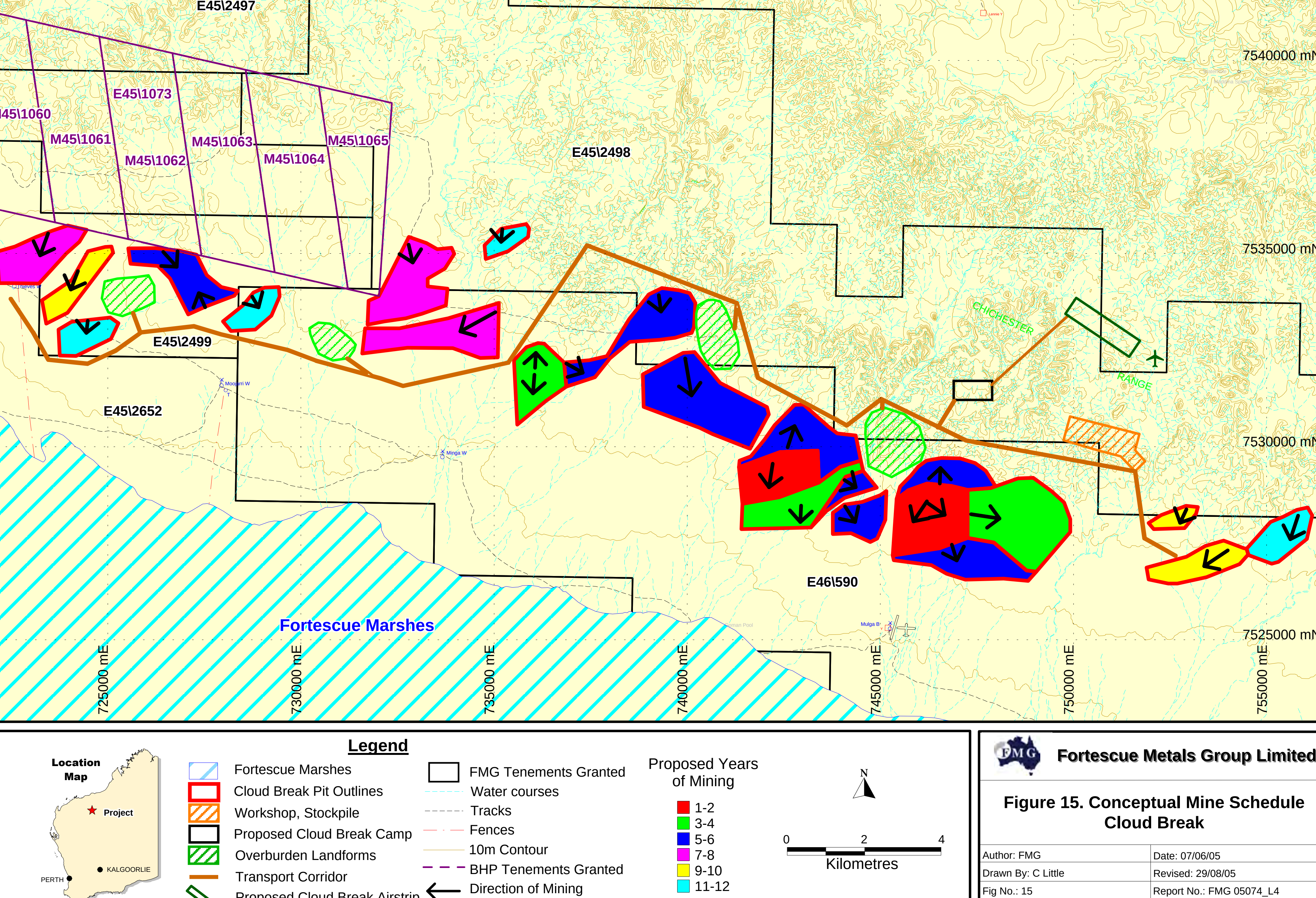


Figure 15. Conceptual Mine Schedule Cloud Break

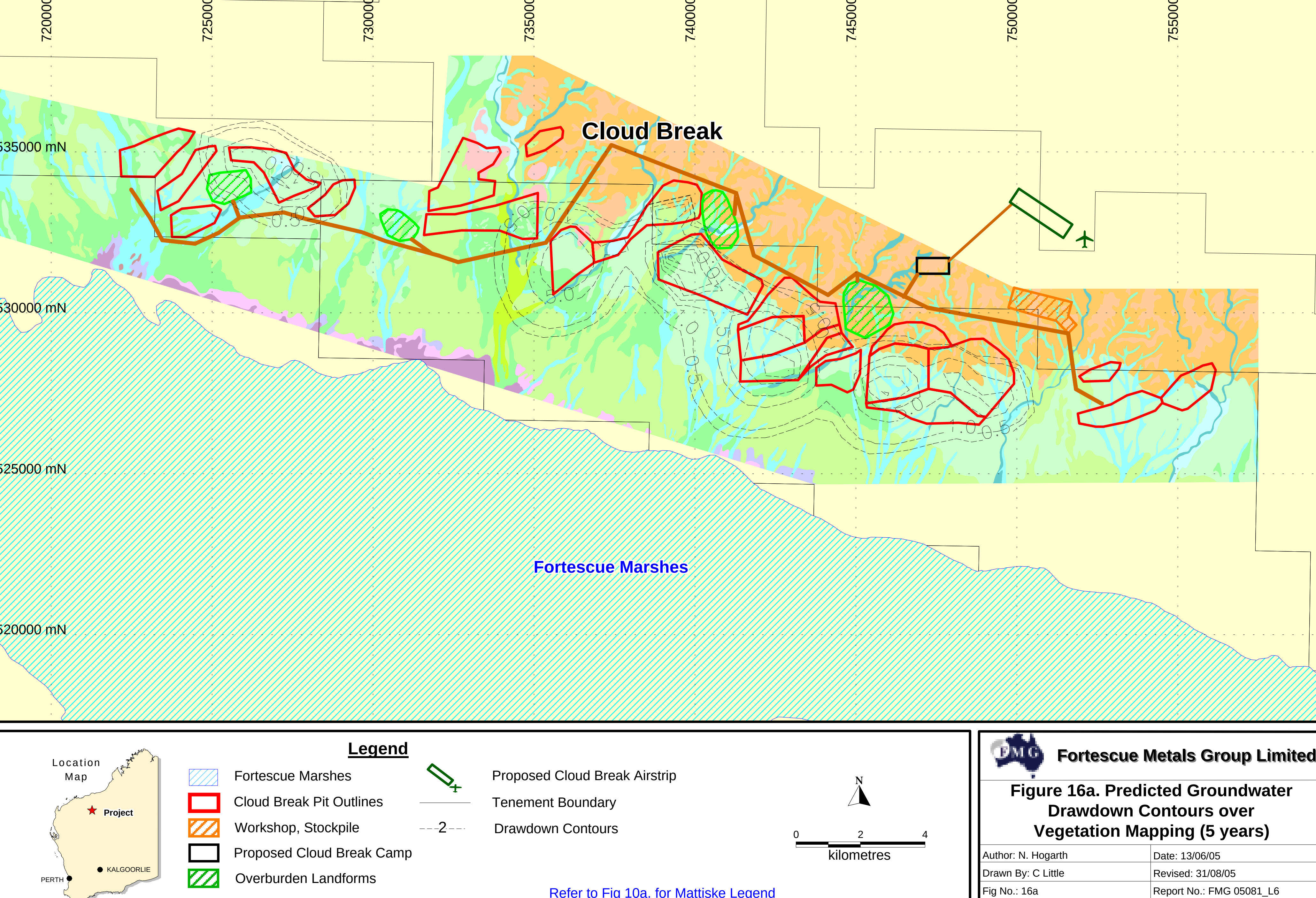
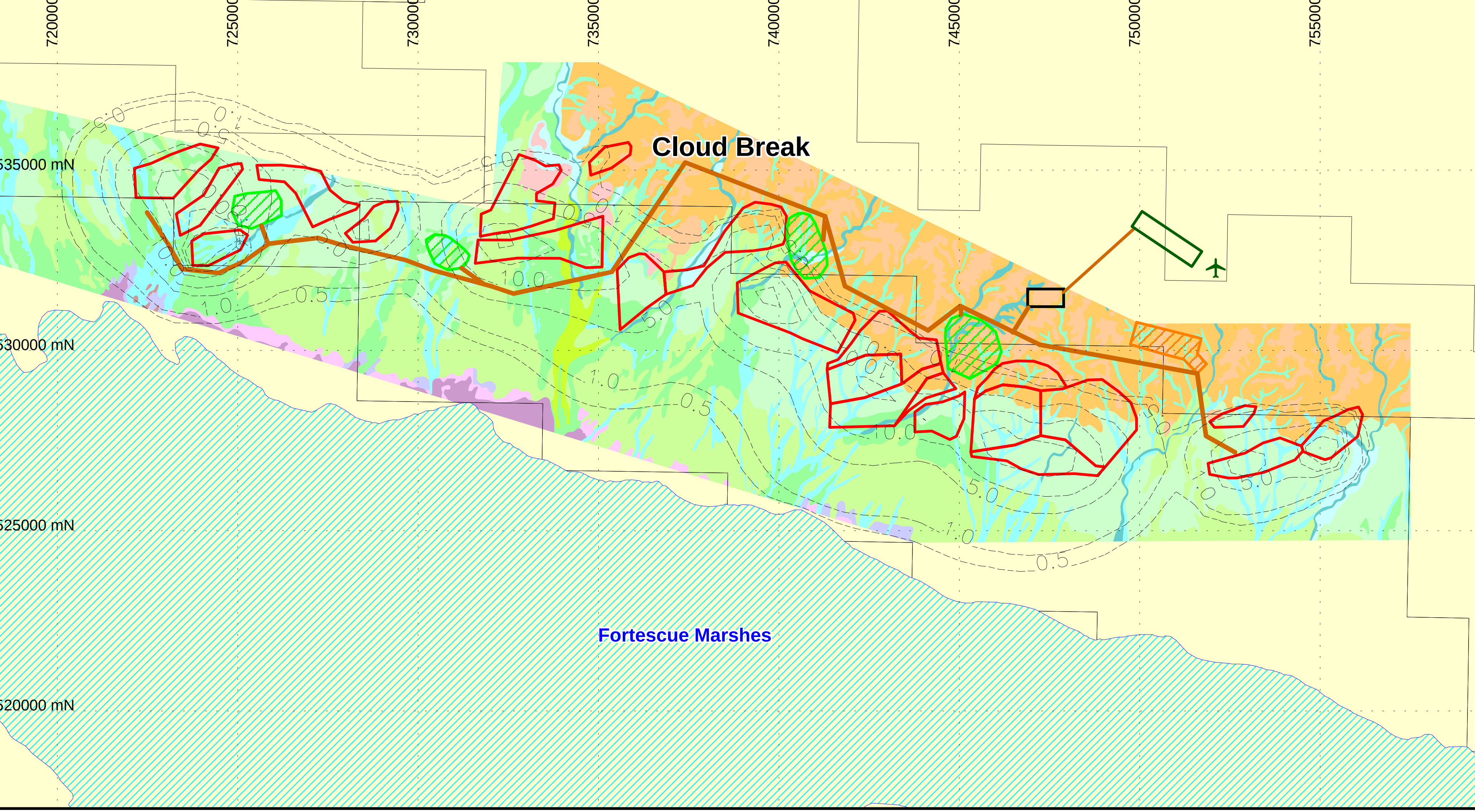
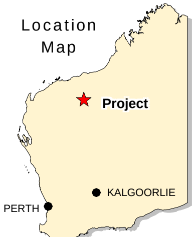


Figure 16a. Predicted Groundwater Drawdown Contours over Vegetation Mapping (5 years)

Author: N. Hogarth	Date: 13/06/05
Drawn By: C Little	Revised: 31/08/05
Fig No.: 16a	Report No.: FMG 05081_L6

Refer to Fig 10a. for Mattiske Legend





Legend

- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Proposed Cloud Break Airstrip
- Tenement Boundary
- Drawdown Contours

N

0 2 4
kilometres

Refer to Fig 10a. for Mattiske Legend

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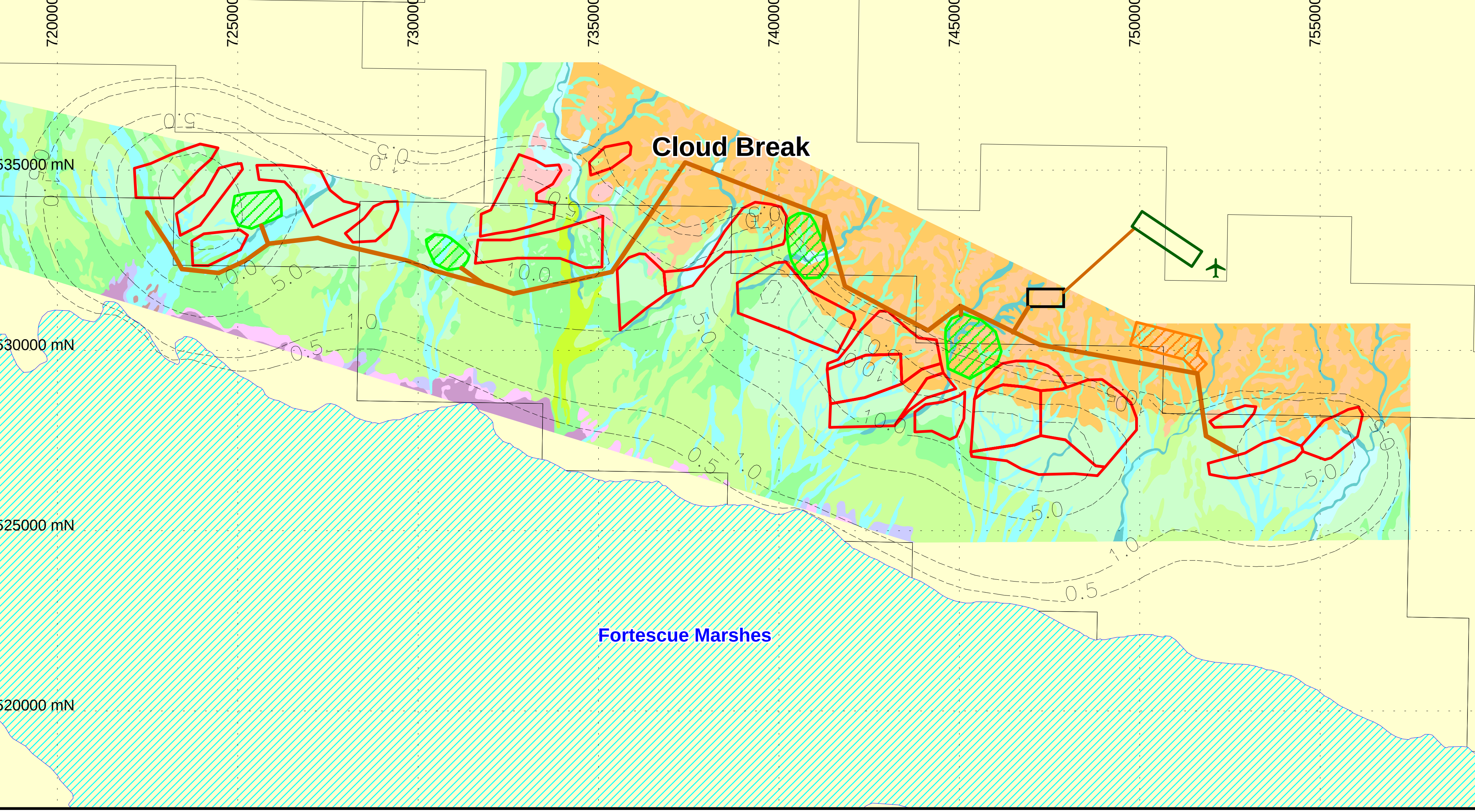
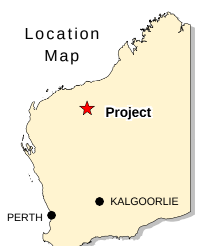
Figure 16b. Predicted Groundwater Drawdown Contours over Vegetation Mapping (12 years)

Author: N. Hogarth	Date: 13/06/05
Drawn By: C Little	Revised: 31/08/05
Fig No.: 16b	Report No.: FMG 05081_L8



Legend



- Fortescue Marshes
- Cloud Break Pit Outlines
- Workshop, Stockpile
- Proposed Cloud Break Camp
- Overburden Landforms
- Proposed Cloud Break Airstrip
- Tenement Boundary
- --2-- Drawdown Contours

N

0 2 4
kilometres

Refer to Fig 10a. for Mattiske Legend

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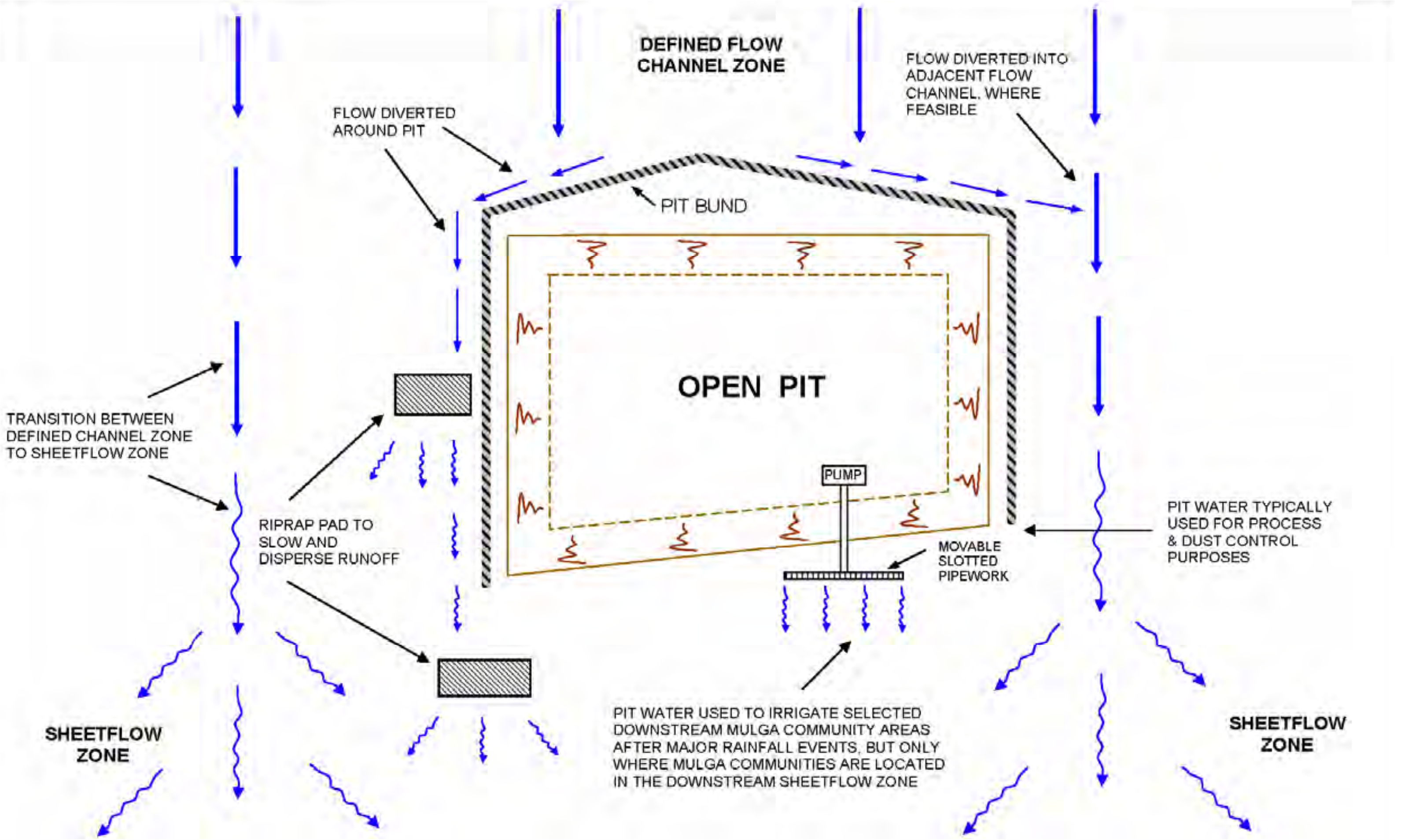
Figure 16c. Predicted Groundwater Drawdown Contours over Vegetation Mapping (20 years)

Author: N. Hogarth	Date: 13/06/05
Drawn By: C Little	Revised: 28/08/05
Fig No.: 16c	Report No.: FMG 05081_L7



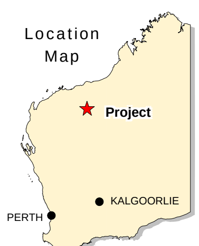


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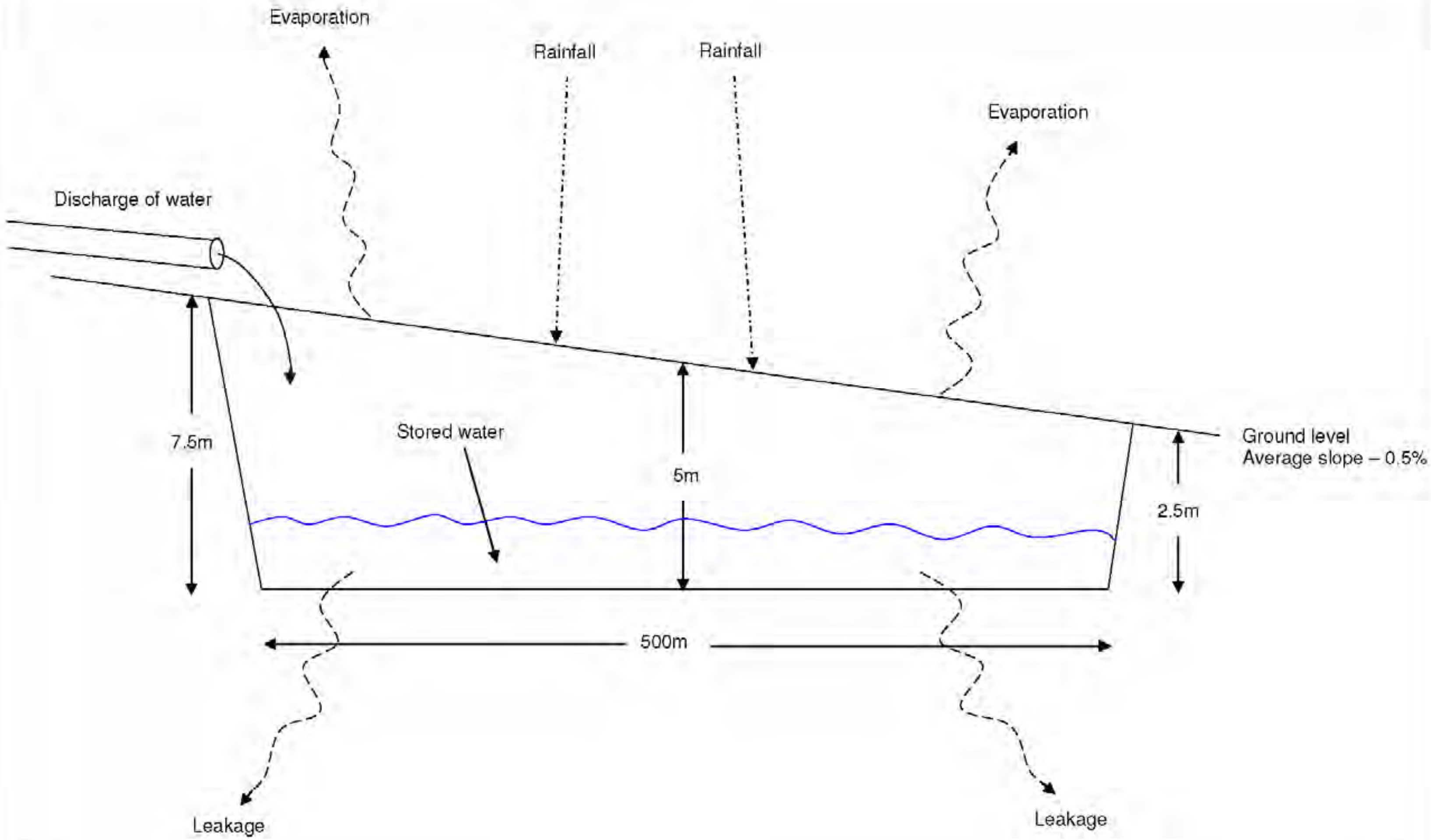
Figure 17. Conceptual Sheetflow Distribution for an Open Pit

Author: FMG	Date: 10/11/04
Drawn By: A Gregory	Revised: 04/08/05
Fig No.: 17	Report No.: FMG 04108



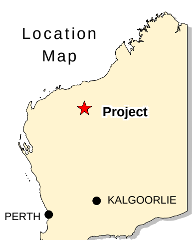


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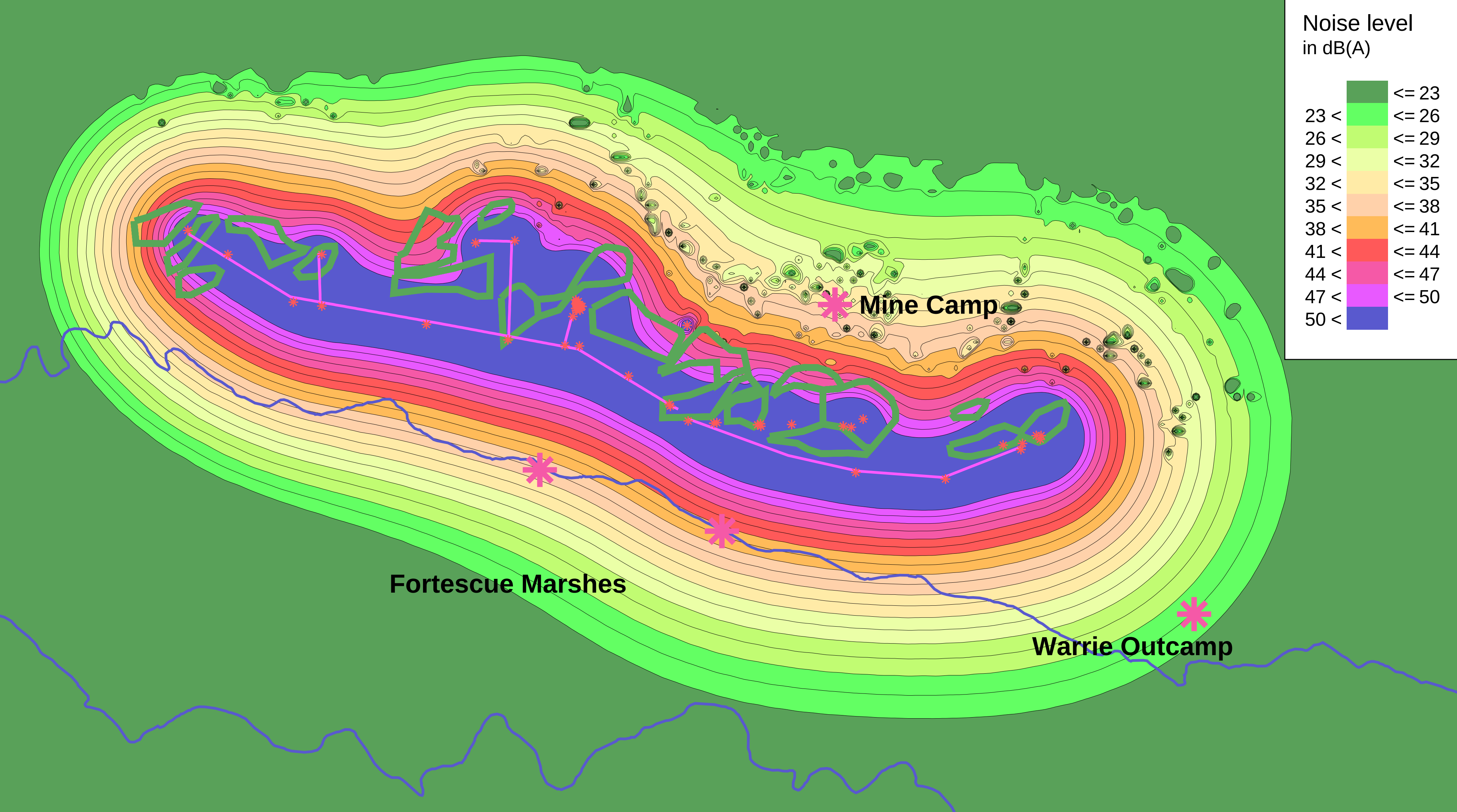
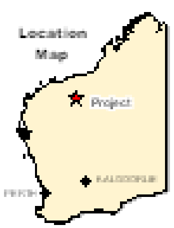
Figure 18. Conceptual Dewatering Management

Author: Aquaterra	Date:21/06/05
Drawn By: Aquaterra	Revised: 31/08/05
Fig No: 18	Report No.: FMG 05093_L2





Legend

- Elevation line
- Point receiver
- Point source
- Conveyor Line
- Marsh

N

0 1 2 4 km

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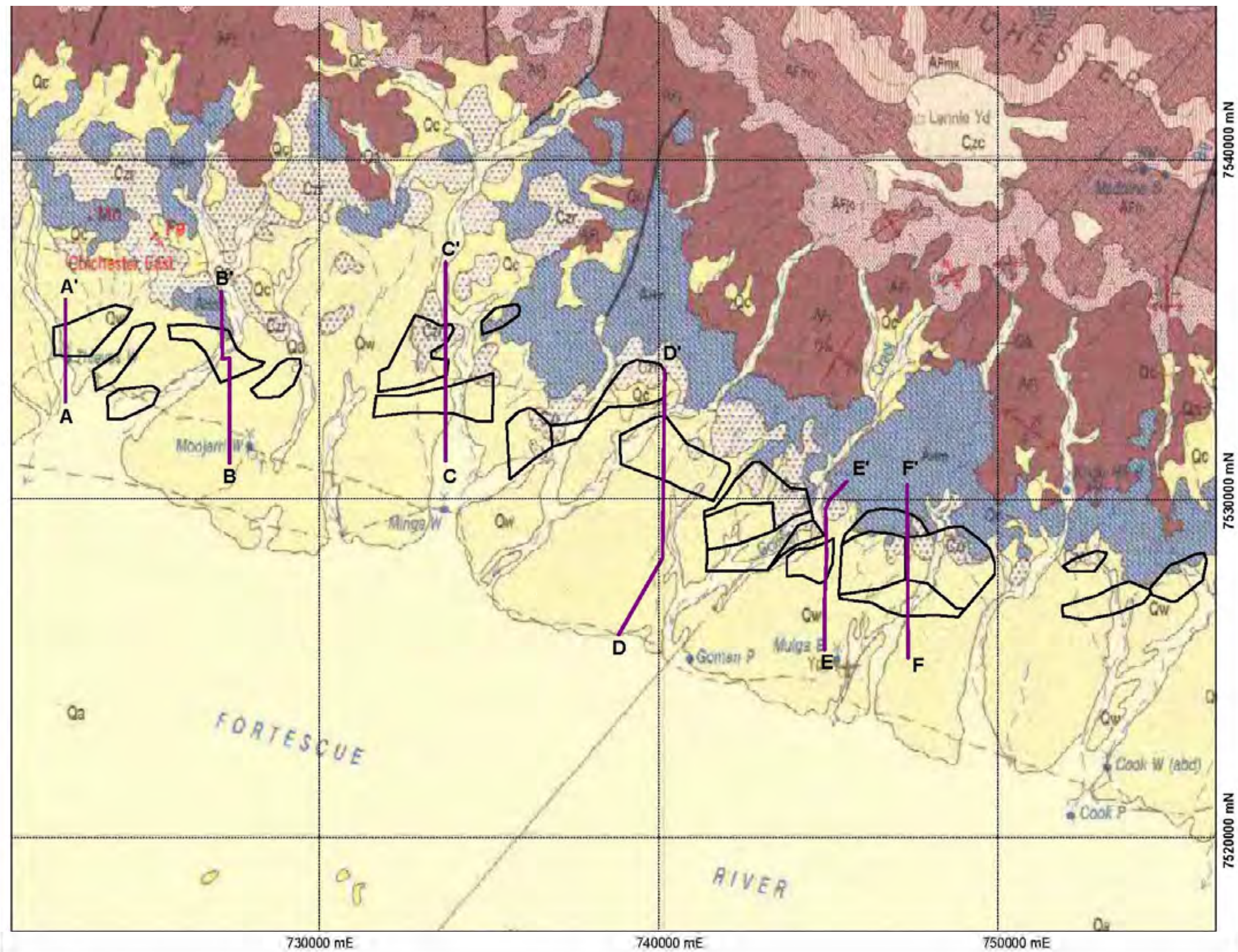
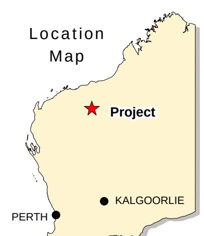
Figure 19. Noise Level Predictions for Cloud Break

Author: D Lloyd	Date: 14/06/05
Drawn By: D Lloyd	Revised: 04/08/05
Fig No.: 18	Report No.:





Cloud Break Mine Pit Outlines

A'

A

Location of Geological Cross-Section

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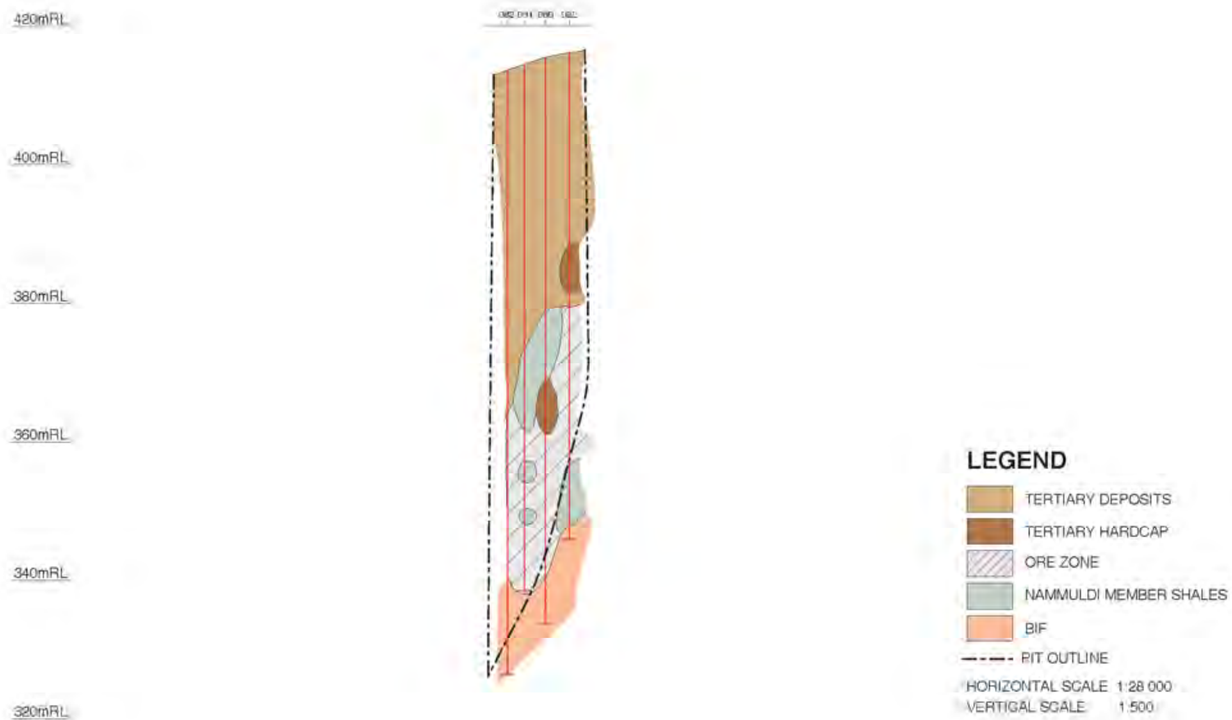
Figure 20. Plan Showing Location of Geological Cross Sections

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 04/08/05
Fig No.: 20	Report No.: FMG 05098

Section A - A'



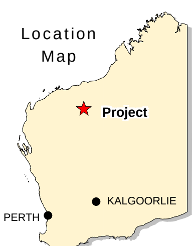


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Figure 20a. Geological Cross Section (Section A - A')

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 04/08/05
Fig No.: 20a	Report No.: FMG 05098

Section B - B'

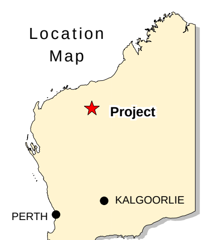

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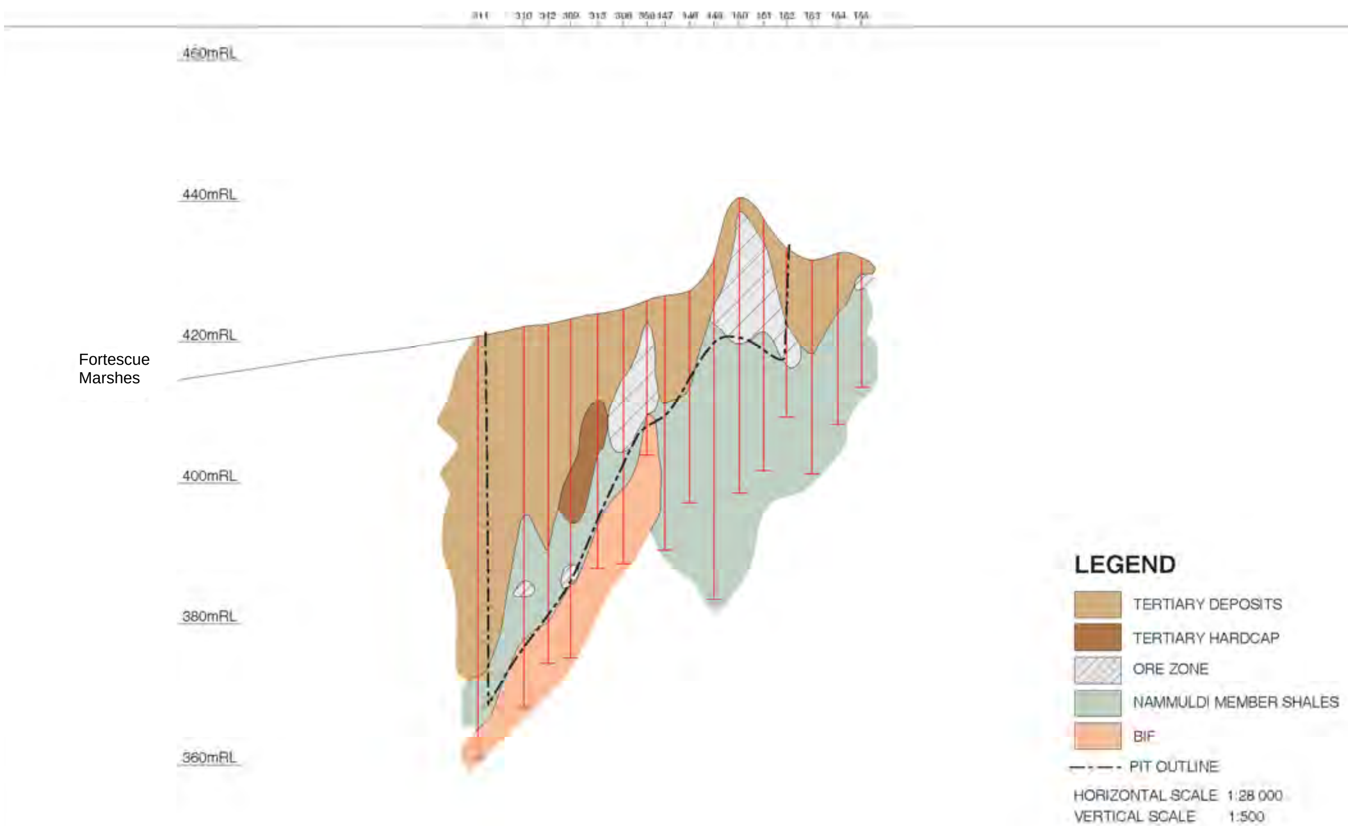
Figure 20b. Geological Cross Section (Section B - B')

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 04/08/05
Fig No.: 20b	Report No.: FMG 05098

Section C - C'



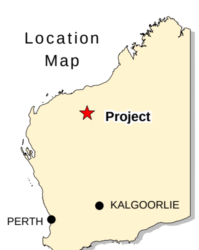


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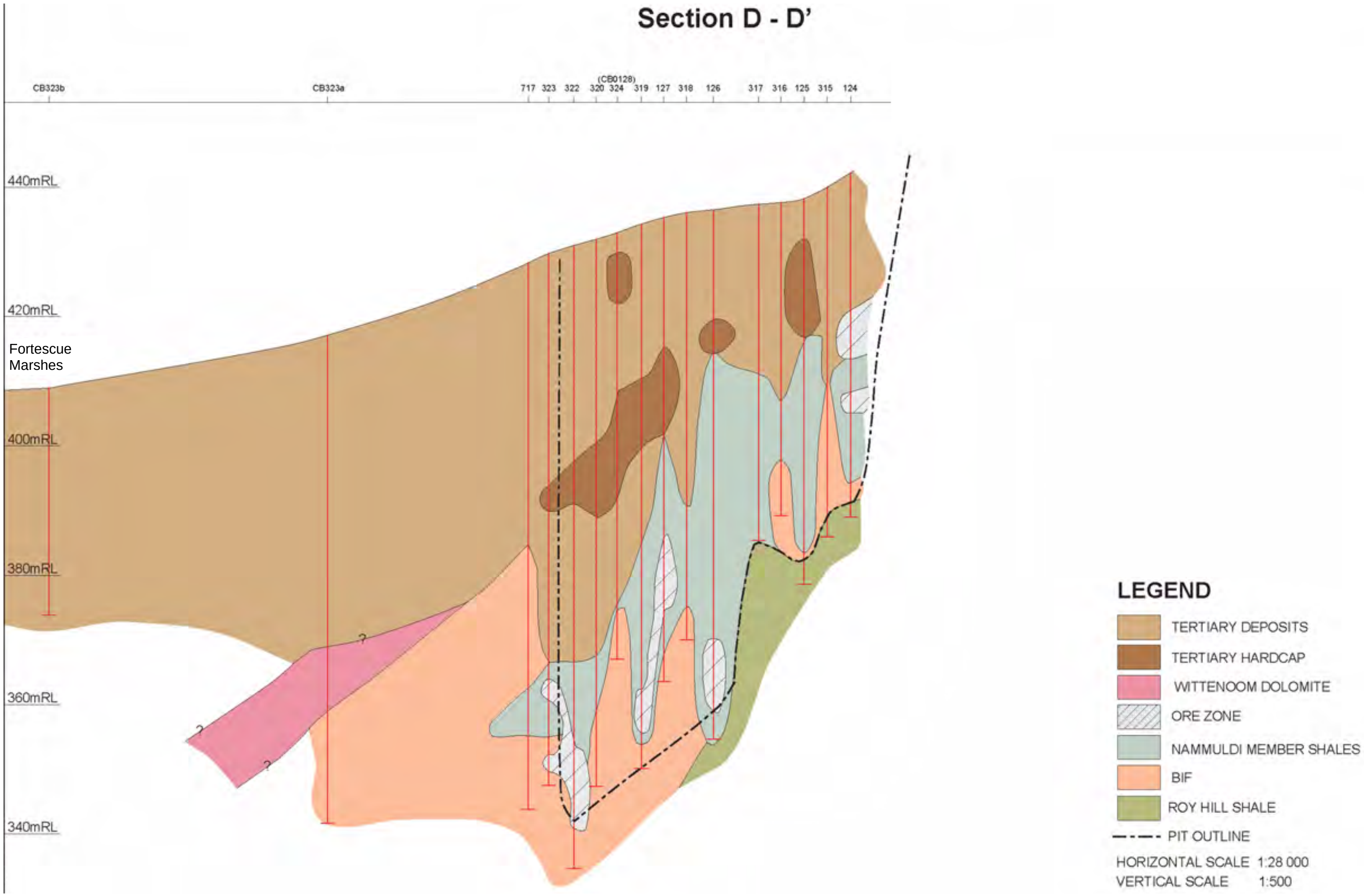
Figure 20c. Geological Cross Section (Section C - C')

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 04/08/05
Fig No.: 20c	Report No.: FMG 05098



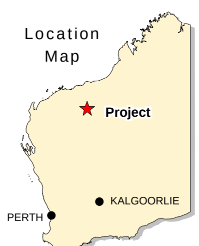


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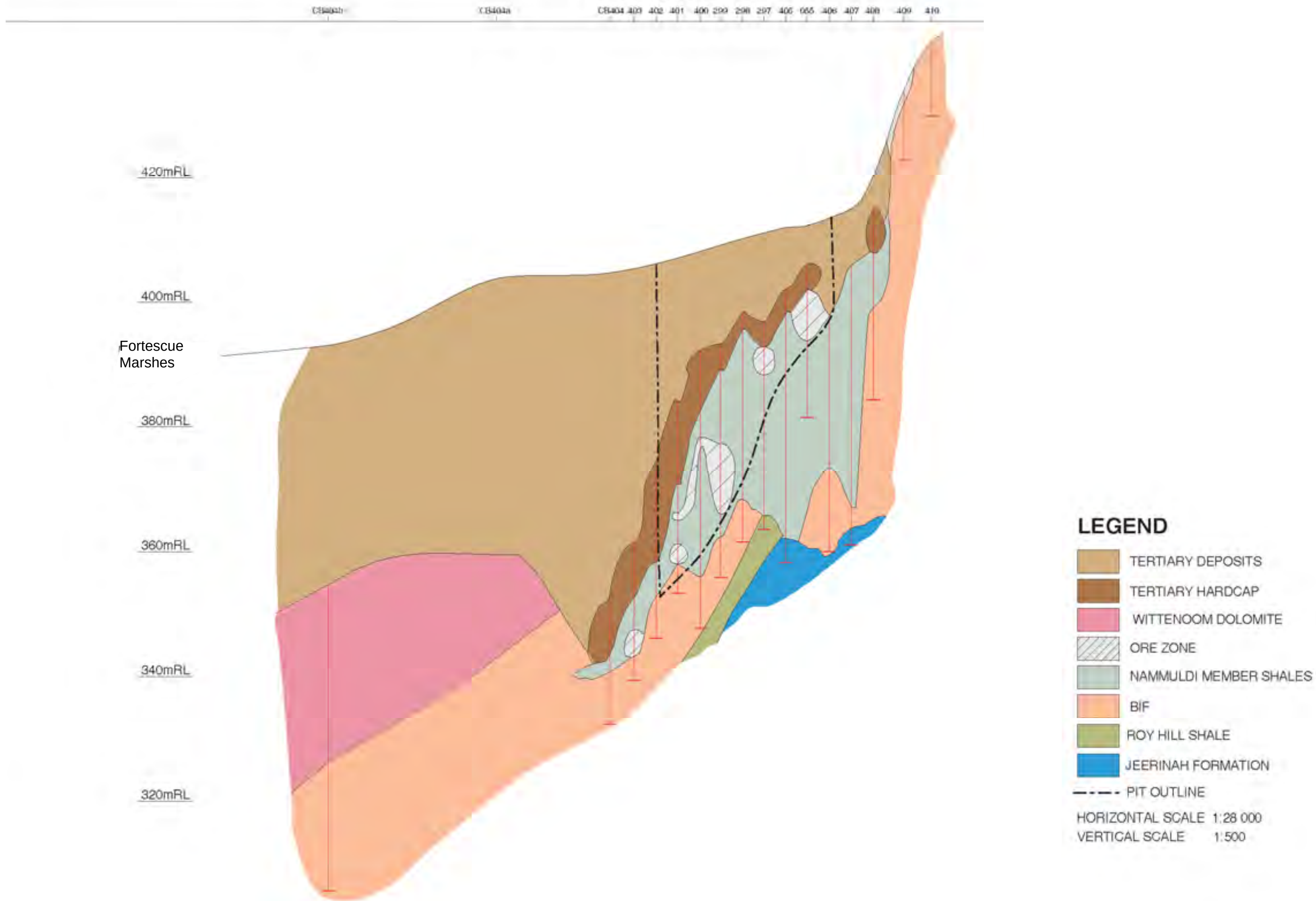
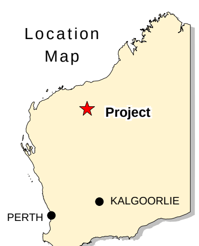
Figure 20d. Geological Cross Section (Section D - D')

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised: 04/08/05
Fig No.: 20d	Report No.: FMG 05098

Section E - E'





Fortescue Metals Group Limited

Figure 20e. Geological Cross Section (Section E - E')

Author: Aquaterra	Date: 27/06/05
Drawn By: Aquaterra	Revised:
Fig No.: 20e	Report No.: FMG 05098

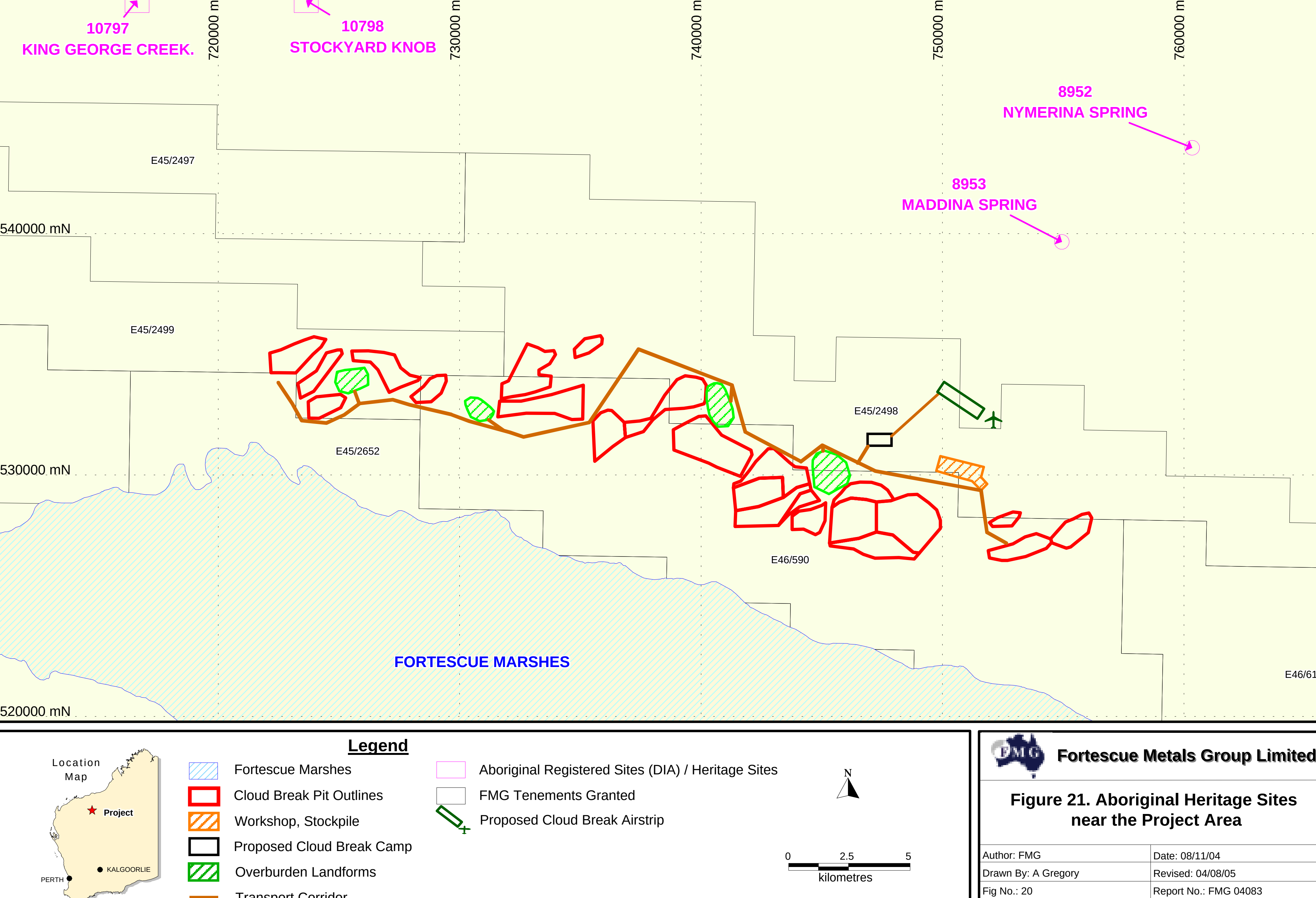
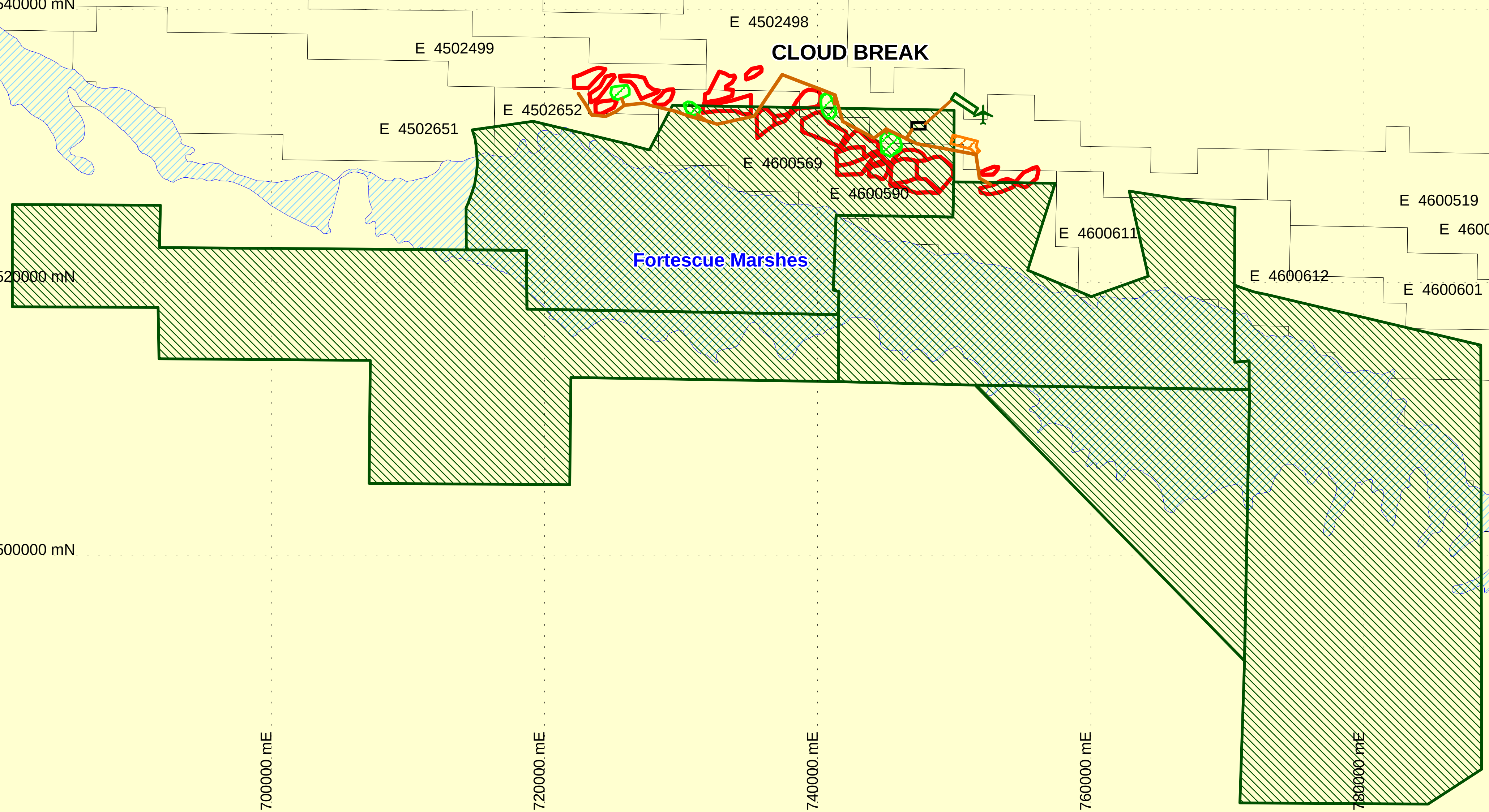
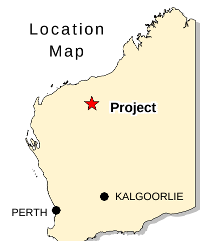


Figure 21. Aboriginal Heritage Sites near the Project Area



Legend

Fortescue Marshes
Cloud Break Pit Outlines
Workshop, Stockpile
Proposed Cloud Break Camp
Overburden Landforms
Transport Corridor
Proposed CALM Exclusion Zone
FMG Tenements Granted
Proposed Cloud Break Airstrip



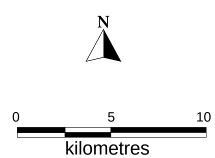


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Figure 22. Areas proposed for Future Conservation by CALM

Author: Bamford Consultants	Date: 23/06/05
Drawn By: C Little	Revised: 29/08/05
Fig No.: 21	Report No.: 05096_L2

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K

Appendix L

Appendix M

Appendix N

Appendix O

Appendix P

Appendix Q