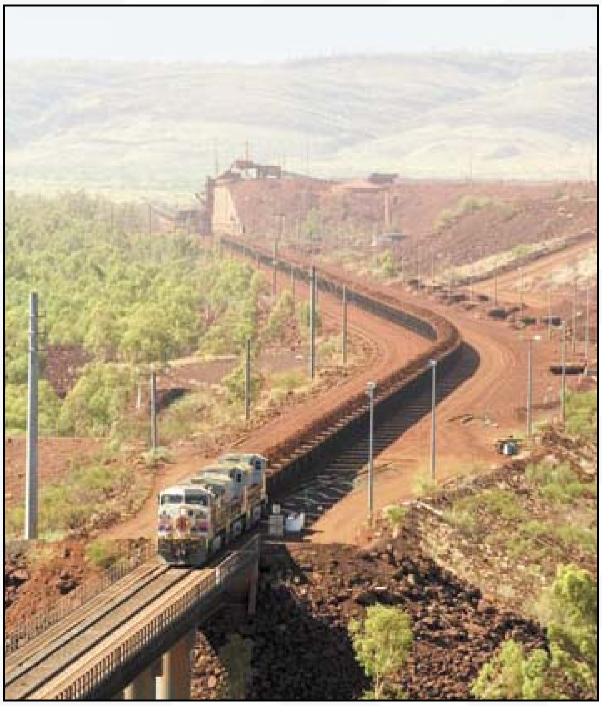
Mesa A / Warramboo Iron Ore Project

Public Environmental Review



Prepared for
Robe River Mining Company Pty Ltd
by Strategen

July 2006

Mesa A / Warramboo Iron Ore Project

Public Environmental Review

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July 2006

Disclaimer and Limitation

Client: Robe River Mining Company Pty Ltd

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Preliminary Draft Report	V1	JN/EP/WM/AF	AF	email	29/11/05
Draft Report	V2	JN/EP/WM/AF	AF/WM	electronic	08/02/06
Draft Report	V3	JN/EP/WM/AF	AF/WM	electronic	14/03/06
Final Draft Report	V4	JN/EP/AF	AF	electronic	21/06/06
Final Report	Final	EP/AF	AF	electronic	24/07/06

Front cover: Loaded ore train crossing Robe River – Mesa J mine operation in background

AN INVITATION TO COMMENT ON MESA A/WARRAMBOO IRON ORE PROJECT

PUBLIC ENVIRONMENTAL REVIEW

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 e-mailed to the EPA Service Unit project officer would be most welcome.

The Robe River Mining Company Pty Ltd (Robe) proposes the development of the Mesa A/Warramboo Iron Ore Project in the Robe Valley area of the Pilbara region of Western Australia. The proposal comprises the development of new mining pits (and associated infrastructure) at Mesa A and Warramboo to supplement and eventually replace the existing Mesa J mine site, and construction of an ore transport corridor from Warramboo to Mesa A and from Mesa A to existing infrastructure at Mesa J. Ore will be transported to Cape Lambert port (approximately 245 km north-east of the proposed mine) using existing rail facilities.

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 8 weeks from **31 July 2006**, closing on **25 September 2006**.

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

Where to get copies of this document

Printed copies of this document may be obtained from:

Name: Melinda Brand

Address: Rio Tinto Iron Ore, Central Park. 152 – 158 St Georges Tce Perth WA 6000

Phone: (08) 9327 2224

e-mail: melinda.brand@riotinto.com

Hard copies of the PER may be purchased at a cost of $10.00 per copy, or a CD-ROM version will be provided (no charge). Copies may also be obtained from www.pilbarairon.com/SiteContent/news/reports.

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 approaches. 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 or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the work for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to ten people) please indicate the names of all 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 with 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 submissions to be analysed:

- attempt to list points so that the issues raised are clear. A summary of the 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 wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name
- your address
- the date
- whether you want your submission to be confidential.

The closing date for submission is 25 September 2006.

The EPA prefers submissions to be sent in electronically. You can either e-mail the submission to the project officer at the following address:

eia@dec.wa.gov.au

OR

use the submission form on the EPA's website:

www.epa.gov.au/submissions.asp and click on the EIA Assessment Submission option

OR

if you do not have access to e-mail then please post your submission to:

The Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6842

Attention: **Kirsty Quinlan**

EXECUTIVE SUMMARY

INTRODUCTION

The Robe River Mining Company Pty Ltd (Robe), as Manager for Robe River Iron Associates, is the proponent for this proposal. The project will be managed by Pilbara Iron Company (Services) Pty Ltd (Pilbara Iron) on behalf of Robe. Pilbara Iron is a member of the Rio Tinto Group, and was established in 2004 to manage the group's Western Australian iron ore operations on behalf of their asset owners.

Robe currently manages the Mesa J iron ore mining operation in the Robe River valley from which 32 Mtpa of ore is transported by the Central Pilbara Railway to the ship loading facilities at Cape Lambert, 200 km north of Mesa J on the Pilbara coast.

Current projections show that the Mesa J deposit will be mined to its maximum extent by 2010, with production predicted to begin to decline in 2008. Robe will continue to process approximately 7 Mtpa of sub-grade material through the existing scrubber plants until 2015. A replacement mine for Mesa J is required to produce pisolite ore by 2008 to meet market demand. The Mesa A/Warramboo deposit has been identified as the next deposit for the potential development in the Robe Valley.

Robe Valley pisolite iron ore is currently supplied to many steel producing companies in Japan, Korea, China and Europe. The unique technical properties of Robe Valley iron ore establish it as an important component of the iron ore blend in customers' blast furnace feedstock. Potential production from Mesa A/Warramboo is critical to ensure sustainability of Robe's business activities in the region.

LOCATION

The Mesa A/Warramboo deposit is located in the Robe Valley area of the Pilbara region of Western Australia. The deposit is approximately 38 km north-west of the existing Mesa J mine site, 43 km west of Pannawonica town and 245 km by rail from the Cape Lambert port facilities.

TENURE

The Mesa A deposit and approximately 70% of the Warramboo deposit are within the Mining Lease AML70/00248 Sec 100. The remaining area of the Warramboo deposit (approximately 12 million tonnes of ore) is held under Exploration Licence EL08/789 (Mining Lease applications M08/426-M08/428). Miscellaneous licence applications for the proposed southern transport corridor (L08/29 and L08/30) were lodged in February 2005. Applications for additional tenure for the northern transport corridor routes are in preparation. Tenure applications are required for the groundwater abstraction areas.

ASSESSMENT PROCESS AND EPA ADVICE

The Mesa A/Warramboo Iron Ore Mine project was referred to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) on 27 May 2005. On 27 June 2005 the EPA advised the level of assessment for the project as a Public Environmental Review (PER) with an eight week public review period.

An Environmental Scoping Document was prepared to seek EPA endorsement regarding the scope of the assessment of the project as well as providing an indicative timeline for the assessment process. The Environmental Scoping Document was submitted to the EPA on 15 August 2005 and included a summary of the potential environmental impacts, their significance and possible management responses, proposed scope of work to obtain information for the PER, key legislation, stakeholder consultation programme, project and assessment schedule, study team and peer review mechanisms. The EPA approved the Scoping Document on 21 December 2005.

The PER and Scoping Document were prepared in accordance with the *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002* (the Administrative Procedures) for environmental assessment prescribed under the EP Act.

DESCRIPTION OF THE MESA A/WARRAMBOO PROJECT

The principal activity of the Mesa A/Warramboo project will be mining, primary sizing and transportation of iron ore. The key components of the proposal can be summarised as follows:

- single open cut pit at Mesa A with associated Run of Mine (ROM) and sub-grade ore stockpiles, waste dumps, and drainage management structures; selected progressive backfilling of mine pit where practicable
- single shallow open cut pit at Warramboo with associated ROM ore stockpile and waste dumps, creek diversion, flood protection levees and other drainage management structures; selected progressive backfilling of mine pit where practicable
- unsealed haul road for transport of ore from Warramboo to Mesa A with construction of an overpass to carry the North West Coastal Highway
- new facility to transport primary sized ore from Mesa A to Cape Lambert, including new crossings of either the Robe River or Mungarathoona Creek; transport options are:
    - new sealed road located mainly to the north of the Robe River from Mesa A to Mesa J followed by rail to Cape Lambert on the existing rail line
    - new rail line located mainly to the north of the Robe River from Mesa A to north east of Mesa J linking to the existing rail line to Cape Lambert
    - new sealed road located to the south of the Robe River from Mesa A to Mesa J followed by rail to Cape Lambert on the existing rail line, or
    - new rail line located to the south of the Robe River from Mesa A to south east of Mesa J linking to the existing rail line to Cape Lambert.
- construction of ROM bin with primary sizer at Mesa A and secondary and tertiary crushing and screening at Cape Lambert using existing facilities
- new wellfield and associated pipeline to Mesa A/Warramboo to supply 1.5 GL/yr water to the operation; the preferred option for the wellfield is the Warramboo aquifer
- support infrastructure including; administration buildings, workshop, hydrocarbon storage facility, waste water treatment, sewage treatment, landfill, accommodation.

The key characteristics of the project are shown in Table S1.

Table S1 Key characteristics of the Mesa A/Warramboo proposal

Component	Project characteristic	Detail
General	Project life	About 10 years
	Ore deposit	Approximately 270 Mt high grade ore
	Ore production rate	Approximately 25 Mtpa
Clearing of native vegetation	Area of disturbance	2870 ha
Mine and mining	Ore type	Pisolite
	Ore location	Ore above watertable
	Stripping ratio	0.4:1 (waste:ore)
	Waste rock disposal	Out of pit waste rock dumps Selected progressive backfilling of mine pits where practicable
Processing	Primary sizer	Primary sizer located at Mesa A
Product transport	Product transport	By road from Warramboo to Mesa A minesite, then options from Mesa A to Cape Lambert are: • rail directly to Cape Lambert • road train to Mesa J then rail to Cape Lambert
Workforce	Workforce	Total operational personnel 250, with approximately 150 personnel at Mesa A during operation and an additional 100 personnel at Mesa J Approximate peak workforce during construction and shutdown of 650 personnel
	Accommodation	Camps near Mesa A and the transport corridor during construction Existing and upgraded accommodation in Pannawonica or fly-in fly-out to a residential village, near Mesa A or between Mesa A and Mesa J during operation

Abbreviations

Mt million tonnes
Mtpa million tonnes per annum
ha hectares

STAKEHOLDER CONSULTATION

Robe initiated a stakeholder consultation program for the Mesa A/ Warramboo project towards the end of 2004 prior to the submission of the environmental referral of the project to the EPASU in May 2005. The following key stakeholders were identified and consulted before and during the preparation of the PER.

Government agencies

- Environmental Protection Authority Service Unit (EPASU)
- Department of Environment (DoE)[1] – Northwest regional office (Karratha) and Perth office
- Department of Conservation and Land Management (CALM)[1] – Pilbara regional office (Karratha) and Perth office
- Department of Industry and Resources (DoIR)

[1] As of 1 July 2006 the Department of Environment and Conservation (Western Australia) (DEC) was formed by merging the Department of Environment and the Department of Conservation and Land Management.

- Department of Indigenous Affairs (DIA)
- Main Roads Western Australia
- Western Australian Museum
- Conservation Commission.

Non-government organisations

- Pilbara Native Title Service (PNTS) and Native Title Claimant Group
- Kuruma Marthundunera Working Group
- Conservation Council
- Wildflower Society
- Agility.

Local Government

- Shire of Ashburton.

Community

- Yarraloola Pastoral Station
- Point Samson community.

KEY ISSUES RAISED

The main issues raised by stakeholders related to sourcing water, flora and fauna (terrestrial and subterranean) impacts, retention of important features of the landscape and Aboriginal heritage.

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

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

- greenhouse gases
- public risk and safety
- vegetation and flora
- terrestrial fauna
- subterranean fauna
- landscape and geodiversity
- surface water and water quality
- groundwater (including water use)
- dust
- Aboriginal heritage

- rehabilitation and closure.

Three environmental factors were not addressed in great detail as they are considered to be minor factors given the remoteness of the location and existing management measures in place. These factors will be addressed in the Mesa A/Warramboo Construction Environmental Management Plan and the operational Environmental Management Plan.

These minor factors are:

- noise and vibration
- waste management (including mineral wastes)
- European heritage.

GREENHOUSE GASES

Construction of the Mesa A/Warramboo proposal will result in a net increase in peak annual greenhouse emissions from Robe operations in the Robe Valley. Emissions would increase approximately 74,600 t CO_2-e for a worst case scenario using road train transport of ore from Mesa A to Mesa J. Should the rail option be selected the greenhouse emissions from the proposal would be lower.

Implementation of Robe's greenhouse gas and energy conservation measures will enable the company to minimise emissions and provide a mechanism for continuous improvement in greenhouse gas emissions resulting from the proposal. It is considered that this will meet the EPA objective.

PUBLIC RISK AND SAFETY

The project has potential to generate off-site risk due to the proximity of mining activities to the North West Coastal Highway, particularly during blasting activities. Robe will develop a Public Risk and Safety Management Plan to minimise the risk (and inconvenience) to users of the North West Coastal Highway during periods when blasting will be required within 1000 m of the North West Coastal Highway. This plan will be developed in consultation with the relevant authorities and will include measures for closure of the highway during blasting.

The project has potential to generate risk to the public from the transportation of fuel and explosives. The public roads that would be utilised for the movement of fuel and explosives for the project are designed to carry such heavy vehicles and already do so in some sections. Robe will ensure that transportation of fuel and explosives is undertaken in accordance with relevant State legislation and Australian standards to minimise risk to public safety.

The project will result in an increase in general traffic volumes and freight movement on North West Coastal Highway and Pannawonica Road during construction and operation. However, the increase in traffic volumes will be within the current capacity of the public roads. Through implementation of risk mitigation measures potential risk to road users will be reduced as far as practicable to ensure that the EPA objective for this factor is met.

VEGETATION AND FLORA

The Mesa A/Warramboo mine development will result in the progressive removal and rehabilitation of approximately 2250 ha of native vegetation over the life of the project (excluding transport corridor).

The proposed northern transport corridor will result in the removal of approximately 365 ha of native vegetation, and approximately 122 ha will be disturbed for borrow pits. Clearing estimates for borrow pits are conservative and borrow pits will be rehabilitated. Approximately 50 ha more clearing would be required for the southern transport corridor (as this route is longer) and approximately 20 ha will be disturbed for the temporary construction camp and the construction bores. These will then be rehabilitated once they are no longer needed.

Mining operations and construction and use of the transport corridor have the potential to increase the spread of weeds. This risk will be reduced through the implementation of Robe's weed control and hygiene procedures.

Although the southern transport corridor has not been systematically surveyed, no substantially different vegetation types or flora assemblages are expected to occur. Surveys of the southern transport corridor would be undertaken should the southern corridor be selected. Most flora and vegetation types recorded from the project footprint are considered likely to be more widely represented in the western section of the Hamersley sub-region. Robe will implement control measures to reduce impacts on flora and vegetation values. No recorded Threatened Ecological Communities (TECs) or Declared Rare Flora (DRF) populations will be affected by mining. Therefore, the project is not expected to have any significant effect on regional flora and vegetation values.

Consistent with EPA objectives, the abundance, species diversity, geographic distribution and productivity of flora at species and ecosystem levels will be maintained thereby conserving regional biological diversity. The botanical studies undertaken by Robe have identified highly significant floristic areas so that impacts from the proposal can be mitigated and the implementation of vegetation protection measures will further ensure impacts are reduced.

TERRESTRIAL FAUNA

The Mesa A/Warramboo mine development will result in the progressive loss and subsequent restoration of fauna habitat over the life of the project and, as a result, the local abundance of terrestrial fauna populations may be affected. The construction of the transport corridor will result in the removal of a linear corridor of fauna habitat, which may also affect the local abundance of fauna populations. Operation of the transport corridor may result in direct mortality of individual fauna. Areas of borrow pits and areas of the transport corridor not required beyond the life of the mine, will be rehabilitated as early as practicable to re-establish fauna habitat values.

Several species that have been recorded from, or potentially occur in, the project area are listed as rare, threatened or vulnerable in State and/or Commonwealth legislation. However, minimal fauna habitats of high conservation significance will be affected by the proposal, and there will be no significant impacts on fauna which are of conservation significance at a regional, state, national or international level.

The fauna studies undertaken in the Mesa A/Warramboo project area have identified some areas with significant habitats. The project has been designed to avoid these areas as far as practicable. Robe's commitment to retain the majority of the escarpment of Mesa A, the main gully and the majority of the unique sand sheet habitats at Mesa A will reduce the impacts on sensitive fauna in the region. Consistent with EPA objectives, the abundance, species diversity, geographic distribution and productivity of fauna at species and ecosystem levels will be maintained thereby conserving regional biological diversity.

Funding for research into faunal ecology will increase the scientific body of knowledge regarding fauna ecology in the region and assist with future management of major projects in the region. Funding (to the amount of approximately $1M) will enable the establishment of a research facility to assist in the identification of short-range endemic species.

SUBTERRANEAN FAUNA

The proposed development will result in the loss of troglofauna habitat at Mesa A (but not stygofauna habitat). The available data indicate that Warramboo does not appear to provide a significant troglofauna or stygofauna habitat.

The construction of the transport corridor will potentially lead to disturbance to small areas of troglofauna habitat at Mesa F (if the southern transport corridor is chosen), and at Mesa B. Disturbance of these areas may result in some direct mortality of troglofauna, however the conservation status of these species involved will not be affected.

The retention of the Mesa A escarpment and gully exclusion area, combined with the sub-grade pisolite which exists directly below the high grade orebody will ensure that substantial habitat is retained for troglofauna at Mesa A. The troglofauna exclusion area at Mesa A will be managed and monitored to ensure it remains a suitable habitat for subterranean fauna species. With the planned management measures for the project, and information available from other sites where mining has encroached into troglofauna habitat, it appears likely that most of the extraneous impacts of the proposal can be managed effectively through proper project design or operational procedures.

A longer term research program addressing the troglofauna of the Robe Valley mesas will be undertaken by Robe as part of the implementation of the project. This will include monitoring of relevant subterranean habitat characteristics and additional sampling of troglofauna. Robe will also fund further genetics studies and additional morphological and taxonomic descriptive work as part of this initiative. Funding will be provided to assist with the establishment of facilities for DNA analyses with the aim of investigating phylogenetic relationships and to assist in species-level identification and taxonomic work. This funding will form part of the environmental offsets currently planned to accompany the development of the proposal, and will amount to approximately $1M.

Investigations into the ecology and ecosystem processes for troglofauna communities will also form an important component of the planned research program. This research will improve the knowledge base and lead to a better understanding of troglofauna and effective management mechanisms.

LANDSCAPE AND GEODIVERSITY

Landscape and geodiversity values of the project area will be affected by the proposal, however the effects will be mitigated through implementation of a range of management measures. The most significant management measure is maintaining the Mesa A escarpment, including a 50 m mining exclusion zone along most of the length of the escarpment. This will significantly reduce the visual impact of the mine on the surrounding landscape and will protect a number of significant landscape features. Impacts to the geodiversity of the transport corridor will be managed by reducing, as far as practicable, the area of vegetation to be cleared and the area of mesa formations disturbed by construction of the transport corridor. The distance of the transport corridor from the North West Coastal Highway or Pannawonica Road will mitigate the visual impacts of the transport corridor.

SURFACE WATER AND WATER QUALITY

Alterations to surface flows from the mine operations will not have an adverse impact on identified beneficial or environmental uses of the water as they will be mitigated by measures described in the Environmental Management Plan. The general integrity, functions and environmental values of the Robe River system will be maintained through containment of contaminated water, regular monitoring and management of floodwaters. Minor changes in drainage flows associated with earthworks for the mine will not have a significant impact on the quality or quantity of water in the creeks.

The construction of the transport corridor will result in changes in natural surface hydrology in the project area and may result in minor, temporary changes in water quality (e.g. through increased concentration of suspended solids during construction). Design and construction of the transport corridor will be managed to reduce, as far as practicable, the changes in surface hydrology and water quality and to meet the EPA objective for this factor.

GROUNDWATER AND WATER SUPPLY

Abstraction from the deep Warramboo aquifer will result in a localised watertable drawdown with a predicted drawdown after 10 years of 0.5 m at 3 km from the centre of the proposed wellfield. Following completion of mining operations and associated water abstraction, the underlying watertable will return its pre-development levels over time. There is expected to be a negligible impact on vegetation as the vegetation of the proposed wellfield area is not likely to be groundwater dependant as existing groundwater levels are mostly >15 m below ground level.

The abstraction of groundwater from the Warramboo aquifer is not expected to have an adverse impact on vegetation or surface water flows and the EPA objective for this factor will be met.

DUST

A series of tests carried out by CSIRO examining dust generation characteristics of pisolitic material indicated that the Mesa A/Warramboo ore is similar to ore from the upper benches of Mesa J. Therefore, it is believed that conclusions reached for Mesa J during the testwork can be applied directly to Mesa A/Warramboo. Further testwork has indicated that significant reduction in the generation of dust can be achieved by maintaining moisture content above 3%.

The Mesa A/Warramboo operations and transport corridors are relatively remote and are at distance from sensitive premises. Robe will implement dust management actions to ensure that its activities will not create adverse effects on environmental values or the health, welfare and amenity of people and land uses, consistent with the EPA objective for dust. Dust will be minimised by moisture content control or other suitable measures (such as dry-fogging or deluge systems) that will be implemented at the mine site. Experience at Mesa J indicates that these management actions will ensure that dust emissions from the operations will meet statutory requirements and acceptable standards.

The ore from Mesa A/Warramboo project will be sized and loaded for shipment overseas at the Cape Lambert operation. The change in ore source from Mesa J to Mesa A/Warramboo is not expected to result in increased dust emissions at the port. Current dust control measures will be used at the Cape Lambert site and upgrades to dust control systems will be implemented as part of a proposed wider upgrade of the port. The port upgrade was referred to the EPA as a separate proposal for assessment under Part IV of the EP Act in May 2006.

ABORIGINAL HERITAGE

A number of recorded Aboriginal heritage sites will be disturbed by mining. It is likely that most of these sites consist of artefact scatters which have been determined to be of low heritage significance. Through the establishment of a mining exclusion zone, the proposal will avoid disturbance to most of the Mesa A escarpment, which contains numerous rock shelters which have been identified to be of high heritage significance. Some heritage sites on the escarpment may be disturbed through placement of a haulage road through the mesa escarpment.

A number of recorded Aboriginal heritage sites are known to occur in the vicinity of the proposed transport corridor routes (north and south); a large number of these are in proximity to Robe River. It is likely that some heritage sites will be disturbed by the construction of the transport corridor, however, the corridor will avoid disturbance to significant heritage sites where practicable.

Robe will continue to consult and work with Kuruma Marthundunera Native Title Claimant Group regarding management of Aboriginal heritage sites and values and, consistent with the EPA objective for this factor, will manage Aboriginal heritage sites in accordance with the Aboriginal Heritage Act.

REHABILITATION AND CLOSURE

Robe will develop a Closure Management Plan for the Mesa A/Warramboo project. This plan will be reviewed and updated regularly throughout the project, to ensure that rehabilitation and closure is managed appropriately to meet the EPA objective *"to ensure as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values"*.

Borrow pits and decommissioned sections of the transport corridor will be rehabilitated as early as possible and will be addressed in the Construction Environmental Management Plan, Environmental Management Plan and Closure Management Plan.

ENVIRONMENTAL MANAGEMENT

Robe acknowledges the environmental protection principles listed in s4a of the EP Act:

- 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
- principle of waste minimisation.

These principles are reflected in Robe's environmental policy, Iron Environmental Management System and the Rio Tinto corporate environmental standards that are applied across the Rio Tinto Group.

The environmental aspects of the proposal will be primarily managed through the site Iron Environmental Management System (IEMS), the Mesa A/Warramboo Environmental Management Plan (EMP), relevant licences and the implementation of proposed Environmental Management

Commitments for Mesa A/Warramboo. Robe will also ensure an acceptable closure outcome through preparation of a Closure Management Plan for the Mesa A/Warramboo involving key stakeholders.

ENVIRONMENTAL MANAGEMENT SYSTEM

Robe operates under an ISO14001 framework through the IEMS. ISO14001 is an internationally recognised continuous improvement model, the key elements which include assessing environmental risk and legal requirements, developing objectives and targets for improvement, training, operational control, communication, emergency response, corrective actions, audits and review. Robe sites gained ISO14001 certification in July 2005.

ENVIRONMENTAL MANAGEMENT PLAN

An EMP will be prepared to specifically address management of environmental issues arising from the operation of the Mesa A/Warramboo operation. The EMP will also include details of monitoring that will be undertaken and the EMP will be regularly reviewed and revised where relevant.

SUMMARY OF PROPONENT COMMITMENTS

The proponent (Robe) proposes the Environmental Management Commitments for the management of Mesa A/Warramboo that are detailed in Table S2.

Table S2 Proponent's Environmental Management Commitments for the management of Mesa A/Warramboo

No.	Topic	Objective	Commitment	Timing	Advice from
1	Environmental studies	To establish a baseline environmental dataset for the areas affected by the project	Undertake the following surveys of the Mesa A escarpment and other areas of proposed disturbance: a) Aboriginal archaeological and ethnographic surveys b) DRF and Priority Flora surveys c) seasonal component of the terrestrial fauna survey d) terrestrial fauna survey of the southern transport corridor if it is selected.	Prior to ground disturbance	Native Title Claimants, DEC (Nature Conservation Division)
2	Construction Environmental Management Plan (CEMP) (Transport and infrastructure)	To minimise environmental impacts and public risk during construction of the transport corridor and infrastructure	Prepare a CEMP for the construction of the Mesa A/Warramboo transport corridor and infrastructure that addresses the environment management of the following issues: a) flora (avoid DRF and Priority Flora populations where feasible) b) vegetation (minimise clearing as far as practicable and protect the sand sheet with the exception of approximately 3 ha which lies within the mining area) c) weeds d) fauna e) subterranean fauna f) water (surface and groundwater) g) dust prevention h) hydrocarbons i) waste (non-mineral) j) noise k) fire l) rehabilitation of borrow pits and temporary construction areas m) Aboriginal Heritage.	Prior to ground disturbance	DEC (Environmental Management Division & Nature Conservation Division), DIA
3	Construction Environmental Management Plan (CEMP) (Transport and infrastructure)	As above	Implement the CEMP prepared under commitment 2.	During construction	DEC (Environmental Management Division & Nature Conservation Division), DIA
4	Environmental Management Plan (EMP) (Operations)	To minimise environmental impacts and public risk during operation of the project	Prepare an EMP for the operation of the Mesa A/Warramboo project that addresses the following environmental issues: a) flora and vegetation (minimise clearing and protect the sandsheet with the	Prior to operation	DEC (Environmental Management Division & Nature Conservation Division)

No.	Topic	Objective	Commitment	Timing	Advice from
			exception of approximately 3 ha which lies within the mining area) b) weeds c) fauna d) subterranean fauna e) feral animals f) water (surface and groundwater) g) dust during activities related to mining and transport h) hydrocarbons i) waste (mineral and non-mineral) j) noise k) fire l) progressive rehabilitation of mining areas m) Aboriginal Heritage n) greenhouse gas and energy conservation o) auditing and reporting.		
5	Environmental Management Plan (EMP) (Operations)	As above	Implement the EMP prepared under commitment 4.	During operation	DEC (Environmental Management Division & Nature Conservation Division)
6	Public Risk and Safety	To minimise public risk and public inconvenience	Prepare a Public Risk and Safety Management Plan which addresses the following issues: • North West Coastal Highway closure requirements and procedures during blasting and heavy equipment crossing • measures to reduce risk to public safety during blasting • methods to provide advance public notification of highway closures.	Prior to construction	Main Roads Western Australia
7	Public Risk and Safety	As above	Implement the Public Risk and Safety Management Plan prepared under commitment 6.	During construction and operation	Main Roads Western Australia

No.	Topic	Objective	Commitment	Timing	Advice from
8	Subterranean Fauna	To improve scientific knowledge and understanding of troglofauna and to develop and evaluate options for management of troglofauna	Finalise the Troglobitic Fauna Management Plan (TMP) including the following actions: • investigation of the distribution of troglofauna populations in potential exclusion areas at Mesa A • mitigation of indirect impacts to troglofauna habitat including prohibiting clearing (except for access tracks and drill holes required for troglofauna sampling purposes) and hydrocarbon storage in the areas retained as troglofauna habitat • monitoring of biophysical parameters throughout the life of the mine • ongoing troglofauna sampling throughout the life of the mine • undertake geophysical analysis to identify the extent to which vibration may be extending into the adjoining retained mesa habitat • develop criteria to trigger management actions which may include consideration of down-hole trickle irrigation or larger scale groundwater re-injection.	Prior to ground disturbance for mining	DEC (Nature Conservation Division)
9	Subterranean Fauna	As above	Implement the Troglobitic Fauna Management Plan (TMP) prepared under commitment 8.	During construction and operation	DEC (Nature Conservation Division)
10	Rehabilitation & Closure	To satisfactorily decommission the mine and transport corridor and to rehabilitate the site and its environs upon closure	Prepare a Closure Management Plan for Mesa A/Warramboo, the transport corridors and associated infrastructure that addresses the following: • development of suitable end land uses and objectives for closure in consultation with relevant stakeholders and the community • identification and evaluation of closure options and determination of preferred options • establishment of completion criteria • closure monitoring • review and update of the Closure Management Plan.	Two years prior to closure of the operation	DoIR, DEC (Nature Conservation Division)
11	Rehabilitation & Closure	As above	Implement the Closure Management Plan prepared under commitment 10.	Closure	DoIR, DEC (Nature Conservation Division)
12	Mitigation of environmental impacts	To protect identified environmental values of Mesa A, including: • viability of the troglofauna population. • habitat for significant fauna • significant	Establish appropriate exclusion zones including the two sandsheet habitats (except 3 ha which lies within the mining area) and the three identified gullies. Establish an exclusion zone of at least 50 m around the rim of the escarpment (except for the area where the escarpment will be breached to allow access from the pit to the plant area). Retain a volume of pisolite ore body at least 15 x 10^6 m^3 to maintain a viable troglofauna population. The exclusion zone will be determined taking into account the findings of the investigation of the distribution of troglofauna populations in potential exclusion areas at Mesa A that is required under commitment 8.	Prior to ground disturbance	DEC (Nature Conservation Division)

No.	Topic	Objective	Commitment	Timing	Advice from
		populations of DRF and Priority Flora species • significant geodiversity values (escarpment and gullies) • Aboriginal heritage values including rock shelters and other values as identified by the survey required by commitment 1(a).			
13	Environmental Offsets	To improve scientific knowledge and understanding of Pilbara ecology	Fund the establishment of a research facility to assist in the identification of short range endemic species in the Pilbara region, including troglofauna (approximately $1M). Establishment of a fund (of approximately $1M) to support the following studies: a) Longer term research program addressing the troglofauna of the Robe valley mesas, including: • investigation of the characteristics of relevant subterranean habitat • investigations into the ecology and ecosystem processes for troglofauna communities • additional sampling of troglofauna. b) Further genetic studies and morphological and taxonomic descriptive work, including establishment of facilities for DNA analysis of troglofauna. c) Other appropriate ecological research including: unresolved floristic taxonomy of Pilbara flora species and Northern Quoll populations of the Western Pilbara.	Prior to mining	DEC (Nature Conservation Division)

CONCLUSION

ENVIRONMENTAL IMPACTS AND MITIGATION

In summary, the potential environmental impacts of the proposal and proposed management measures are as follows:

- Progressive removal of approximately 2250 ha of native vegetation over the life of the project for mining areas, with eventual rehabilitation to native vegetation. Removal of up to 600 ha of native vegetation for the transport corridor, sidings, borrow pits, laydown areas and construction camp.
- Increased risk of the spread of weeds, however this will be minimised through Robe's weed control and hygiene procedures.
- Loss of fauna habitat leading to the reduction in local abundance of some fauna populations (terrestrial and subterranean), however this will not have a significant effect on representation of fauna at a regional level.
- Potential restrictions on fauna movement from the construction and operation of the transport corridor, however Robe will install culverts to allow the passage of fauna across the corridor.
- Potential for mining operations to have an impact on the surrounding troglofauna habitat, however Robe will mitigate indirect impacts and monitor trogolofauna habitat throughout the life of the mine. Robe will also retain trologfauna habitat at Mesa A.
- Alteration to visual amenity values of the local landscape primarily caused by mining infrastructure and operations.
- Change in the immediate landscape from removal of mined material and the resultant depression in the restored landform.
- Local alterations to surface drainage patterns and diversion of minor drainage lines, however this should not have an impact on the quality or quantity of water in the major waterways themselves.
- Localised drawdown in the deep aquifer, however this will not have a significant impact on regional groundwater.
- Disturbance to a number of Aboriginal heritage sites, however the proposal will avoid disturbance of those sites identified to be of significance where practicable.

Table S3 provides more detail of potential impacts, proposed management and the environmental outcome for each of the environmental factors assessed.

ENVIRONMENTAL OFFSETS

A number of environmental offsets are proposed, including:

- Funding a study of an unresolved floristic taxonomic issue in a Pilbara flora species.
- Funding a study into the Northern Quoll populations of the Robe River locality.
- Undertaking a longer-term research program addressing the troglofauna of the Robe valley mesas, including:
    - investigation of the characteristics of relevant subterranean habitat
    - investigations into the ecology and ecosystem processes for troglobitic communities

    - additional sampling of troglofauna
    - further genetic studies and morphological and taxonomic descriptive work.
- Providing funding to assist with establishment of facilities for DNA analysis of troglofauna.

OTHER LIKELY IMPACTS AND MITIGATION

Other likely impacts and proposed management measures are as follows:

- Inconvenience to users of the North West Coastal highway due to the need for road closures during blasting, however Robe will implement measures to provide advance notice of road closures.
- Potential restriction on or inconvenience to pastoral activities, however Robe will continue to liaise with the pastoral leaseholders to ensure impacts on pastoral activities are minimised.

In addition, the ongoing activities of Robe will continue to support towns in the Pilbara and Robe will also continue to support a variety of community groups and public projects in WA.

ENVIRONMENTAL RISKS AND MANAGEABILITY

The proponent has extensive experience in managing the development, operation and environmental compliance of similar projects (including the existing Mesa J operation) and this experience is anticipated to lead to a greater certainty in achieving desirable environmental outcomes.

The proponent has consulted with stakeholders (including Government agencies) to scope the potential impacts of the proposal and to determine the significance of environmental issues and the acceptability of mitigation. This process substantially improves the likelihood that all significant environmental issues have been identified, investigated and mitigated as far as practicable.

Table S3 Summary of key environmental issues, potential impacts and management

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
Biophysical					
1. Subterranean fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• A range of troglofauna and stygofauna are known to occur within the project area • Troglofauna have not previously been documented from mesa formations on the mainland Pilbara region	• Groundwater drawdown from groundwater abstraction may lower the water table sufficiently to dry the zone in which stygofauna may occur. • Direct habitat removal through mining and construction of the transport corridor will result in habitat loss and the deaths of some individuals of subterranean fauna. • Changes to surface hydrology may lead to a reduction in habitat suitability. • Changes to the subterranean microclimate may lead to a reduction in habitat suitability. • Surface and ground water contamination through spills of hydrocarbons or wastewater has the potential to degrade the subterranean environment. • Reduction in organic inputs through clearing of vegetation beyond the mine footprint may lead to a reduction in the availability of inputs to the foundation trophic levels. • Vibration from blasting activities has the potential to cause collapses of strata and mesocaverns within the remnant mesa formation.	• Conduct an additional round of stygofauna sampling at Warramboo. • Establish a habitat retention zone at Mesa A, which includes any area that troglofauna studies find are essential for the viability of the troglofauna species at Mesa A. • Finalise and implement the Troglobitic Fauna Management Plan including actions to: - Investigate the distribution of troglofauna populations in potential habitat retention zones at Mesa A - Mitigate indirect impacts to troglofauna habitat by prohibiting clearing (except for access tracks and drill holes required for troglofauna sampling purposes) within the mining exclusion zone and hydrocarbon storage in the areas retained as troglofauna habitat - Undertake monitoring of biophysical parameters throughout the life of the mine - Undertake ongoing troglofauna sampling throughout the life of the mine - Undertake geophysical assessment to identify the extent to which vibration may be extending into the adjoining retained mesa habitat - Undertake backfilling in sections of the pit where mining has been completed in such a way as to create re-constructed habitat which is similar in physical and chemical composition to the existing mesa, including revegetation - Develop criteria to trigger management actions which may include consideration of down-hole trickle irrigation or larger scale groundwater re-injection. • Undertake a longer term research program addressing the troglofauna of the Robe valley mesas, including: - Investigation of the characteristics of relevant subterranean habitat - Investigations into the ecology and ecosystem processes for troglobitic	• The proposed development is unlikely to have a significant impact on stygofauna in the Warramboo area. • The proposal will result in the loss of some troglofauna habitat at Mesa A. • Data gathered indicate that remnant areas without significant surface disturbance on previously mined mesas continue to support troglofauna following mining activities. The proposed troglofauna habitat retention zone at Mesa A will ensure the retention of a significant portion of the troglofauna habitat. • Management measures will mitigate the risks of indirect impacts to troglofauna, ongoing sampling, ongoing research activities and reconstruction of subterranean habitat. • The construction of the transport corridor will potentially lead to disturbance to relatively small areas of troglofauna habitat. Disturbance of these areas may result in some localised deaths of individuals of troglofauna species, however the conservation status of the species involved will not be affected.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
				communities - Additional sampling of troglofauna - Further genetic and morphological identification. • Provide funding to assist with establishment of facilities for DNA analysis.	
2. Terrestrial fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• The range of habitats found over the project area are known to support a range of fauna species, including several that are endemic to the region and/or listed for protection under State and Federal conservation legislation. • The sand sheet habitat is considered to be of very high conservation value. The, edge of Mesa A, in particular the northern gorge on the eastern escarpment of Mesa A, is also considered to be important. • Fauna habitat of conservation significance at Warramboo includes the vegetation and soils of creeklines through stony plains, which may support short-range endemic invertebrates.	• Vegetation clearing for mine pit, waste dumps and associated infrastructure such as plant, access roads and workshops, will disturb terrestrial fauna habitat and may result in fauna deaths. • Alterations to surface water flows may affect fauna habitats that rely on surface water flows. • Vehicle movements in mining areas and on mine access roads could potentially result in fauna deaths particularly of less mobile species.	• Ensure no direct disturbance to the sand sheet with the exception of approximately 3 ha which lies within the mining area. • Demarcate and install signage on the main sand sheet area adjacent to Mesa A. • Maintain at least a 50 m mining exclusion zone around the Mesa A escarpment (including the three identified gullies), except for the area where the escarpment will be breached to allow access from the pit to the plant area. • Develop and implement an environmental management plan which includes feral animal control. • Provide funding and support for ongoing fauna surveys and research to increase knowledge of the faunal ecology of the region, including further research into the Northern Quoll populations in the Robe River locality. • Ensure vegetation clearing is kept to the minimum necessary for safe construction and operation of the project, particularly in areas adjacent to habitat of higher conservation significance. • Design levees and drains so as to ensure natural drainage flows are maintained wherever possible and to avoid ponding of water. • Implement standard dust suppression measures across the project area during construction and operation to minimise effects on surrounding vegetation and fauna habitat. • Undertake progressive rehabilitation.	• The proposal will result in the progressive loss of fauna habitat over the life of the project and as a result will potentially affect the local abundance of fauna populations. • Negligible amount of fauna habitats of high conservation significance will be affected, and there will be no significant impacts on fauna which are of conservation significance at a regional, state, national or international level. • Areas of habitat disturbance will be progressively rehabilitated to restore the original fauna habitat values. • Robe's commitment to retain the majority of the escarpment of Mesa A, the northern gorge on the eastern escarpment and the majority of the unique sand sheet habitat at Mesa A will reduce the impacts on sensitive fauna in the region. • Increased knowledge of the faunal ecology of the region.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
3. Vegetation and flora	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• The vegetation of the project area is open and dominated by spinifex, *Acacias* and occasional open eucalypt woodlands in major creeks. • No Declared Rare Flora or Threatened Ecological Communities have been recorded from the area. Several Priority Flora species occur in the project area. Several other species considered of conservation significance also occur in the project area. • All vegetation types, except one – vegetation of the sand sheets, in areas proposed for disturbance are considered likely to be more widely represented in the western section of the Hamersley sub-region. • The vegetation of the sand sheets is likely to be restricted in distribution in both the local area and region and is consequently considered to be of *very high* conservation significance.	• Loss of flora and vegetation from clearing for mining areas, transport corridor and associated infrastructure. • Disturbance to riparian vegetation for transport corridor crossings. • Minor changes in surface drainage flows caused by diversions, which could impact on vegetation dependent on surface sheet flows or susceptible to ponding. • Spread and introduction of weeds from mining activities. • Localised retardation of vegetation growth due to smothering from dust generated around roads and bare surfaces.	• Undertake Declared Rare Flora and Priority Flora surveys of areas proposed for disturbance which have not already been surveyed prior to ground disturbance activities in those areas. • Prepare and implement separate Construction Environmental Management and Environmental Management Plans which include flora and vegetation management actions to: - minimise clearing - avoid disturbance to significant populations of Priority Flora as far as practicable - avoid disturbance to significant populations of Declared Rare Flora should they be present or apply for appropriate permits if disturbance cannot be avoided - avoid disturbance to Threatened Ecological Communities should they be present. • Prepare and implement separate Construction Environmental Management and Environmental Management Plans which include weed and fire management actions in all operational and adjacent areas. • Ensure no direct disturbance to the sand sheet vegetation with the exception of approximately 3 ha which lies within the mining area. • Prevent access to the main sand sheet area adjacent to Mesa A by demarcating the area and installing signage. • Indicating the main sand sheet area as an 'environmentally sensitive area' on the Pilbara Iron GIS system, with no disturbance allowed. • Implement drainage measures to divert potentially sediment contaminated run-off away from the main sand sheet area. • Monitor the condition of the vegetation on the sand sheet. • Support research of an unresolved floristic taxonomic issue in a Pilbara flora species.	• Progressive removal and rehabilitation of 2250 ha for mining areas and associated infrastructure. • Removal of up to 600 ha for the transport corridor and associated infrastructure. Disturbed areas associated with the corridor will be rehabilitated once they are no longer required (e.g. borrow pits). • No significant impact on regional flora and vegetation values due to the expected wider distribution of most vegetation types and flora species found in the project footprint and the control measures that will be implemented to minimise impacts on flora and vegetation values. • Minimal disturbance to the vegetation of the sand sheet vegetation and ongoing protection measures. • Risk of the spread and introduction of weeds mitigated through weed hygiene and control measures. • Increased knowledge of a floristic taxonomic issue for a Pilbara flora species.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
4. Surface water quantity and quality	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	• The majority of the proposed mine infrastructure is located in the Robe River drainage catchment, however, the proposed Warramboo Pit is located in the Warramboo drainage catchment. • Significant waterways in or near the mining area are the Robe River and the Warramboo Creek. • As for most parts of the Pilbara, the normal condition for creeks is dry. Runoff is ephemeral, occurring only after significant and intense rainfall events. • Robe River is an intermittent river, which carries a significant underflow in its alluvial bed.	• Drainage management will alter flow paths with construction of diversion channels and mine pit and infrastructure. • Disposal of stormwater has the potential to affect water quality through contamination by sediments and hydrocarbons. • Disturbance to watercourses from transport corridor crossings. • Construction of the transport corridor may increase sediment loads in runoff. • Changed landform after closure will alter natural surface water flows.	• Stabilise diversion structures and drains to minimise erosion and associated water quality impacts. • Design waste dumps to incorporate water management features to minimise the potential for sediment-laden surface water runoff. • Design flow diversion at Warramboo such that flow is directed back into the same catchment further downstream. • Install sediment traps/basins where appropriate to reduce sediment loads from the mine area. • Install settling pond to allow sediment in stormwater to be reduced prior to re-use/discharge. • Undertake progressive backfill of pits at Mesa A and Warramboo.	• The project will result in the diversion of a number of minor creeks in the Warramboo drainage catchment • The project will require river crossing(s) in the Robe River drainage catchment. • Where diversions are required, they will be designed to direct flow back into the same catchment further downstream, thereby reducing impacts to the integrity, functions and environmental values of the watercourse. • Drainage management measures will be installed, where required, to minimise erosion and sediment loads in wastewater and stormwater, and thereby maintaining water quality.
5. Groundwater	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.	• The Yarraloola Conglomerate underlies the Robe Pisolite and the surface alluvium (e.g. mining will occur above the water table). • The Yarraloola Conglomerate forms the main aquifer at Warramboo, known as the deep Warramboo aquifer. • Hydrogeological investigation indicated that the Warramboo aquifer is permeable enough to deliver suitable production well yields required by the mining operations.	• Groundwater drawdown from abstraction and impacts on ecosystems.	• Prepare and implement a Water Management Plan for the operation. • Prepare and implement a Groundwater Operating Strategy. • Develop a water balance for the operation.	• Abstraction from the deep Warramboo aquifer will result in a localised watertable drawdown with a predicted drawdown after 10 years of 0.5 m at 3 km from the centre of the proposed wellfield. • Following completion of mining operations and associated water abstraction, over time the underlying watertable will return to its pre-development levels. • No adverse impact on vegetation and surface water flows.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
Pollution management					
6. Greenhouse gases	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	• Greenhouse gas emissions from the current Mesa J operation are estimated at 154,400 tonnes of CO_2 equivalents (CO_2-e) per year. • Major greenhouse gas emission sources from the project include fuel and energy usage by vehicles, equipment and plant and explosives.	• Increase in greenhouse gas emissions from fuel and energy use requirements.	• Conduct an energy efficiency audit. • Develop and implement an Environmental Management Plan which includes greenhouse gas and energy conservation actions such as: - maintaining an inventory of greenhouse gas emissions - reporting greenhouse gas emissions and greenhouse intensity in its annual Social, Safety and Environment Report - imposing contractual conditions on road train contractor (if road train option selected) to demonstrate how Rio Tinto and Pilbara Iron principles, strategies and guidelines for greenhouse gas emissions will be met to improve greenhouse performance - maintaining membership of the Australian Greenhouse Challenge Plus program. • Evaluate and adopt appropriate technology to improve greenhouse efficiency during the detailed design phase.	• Construction of the Mesa A/Warramboo proposal will result in a net increase in peak annual greenhouse emissions from Robe operations in the Robe Valley of up to approximately 73,500 t CO_2-e for a worst case scenario using road train transport of ore from Mesa A to Mesa J. • Should the rail option be selected the greenhouse emissions from the proposal would be significantly lower. • Greenhouse gas emissions will continue to be minimised by implementing Robe's greenhouse gas and energy conservation measures.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
7. Dust	To ensure that emissions do not adversely affect environment values of the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Mining areas and transport corridor: • The Mesa A/Warramboo area is an arid environment that is subject to naturally high background dust levels when compared to the south-west of Australia. • The generation of airborne dust from mining and ore handling operations will depend on: - the frequency at which a dust generating activity takes place - meteorological conditions, such as wind speed - composition of dust, including particle size distribution, particle density and moisture content - the condition of the source.	Dust emissions from mining and transport have the potential to: • Have physical effects on vegetation, such as smothering.	Mining areas and transport corridor: • Control dust generation through ore moisture content control or other suitable measures. • Apply water or other suitable dust suppressants to minimise dust generation from unsealed areas. • Install signage and enforce speed limits to minimise dust generation from roads. • Minimise clearing of vegetation. • Undertake regular inspections to visually assess dust generation and to ensure the correct functioning of dust suppression equipment. • Undertake progressive rehabilitation to minimise total exposed area.	Mining areas and transport corridor: • The transport corridor options are relatively remote and are at distance from any sensitive premises. • Dust management measures will be implemented to ensure dust emissions are minimised as far as practicable.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
Social surrounds					
8. Aboriginal heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	• Archaeological and ethnographic studies identified numerous Aboriginal archaeological sites within the Mesa A/Warramboo project area. Most of these sites comprised artefact scatters with some scar trees; most sites were considered to be of low archaeological significance • The Mesa A escarpment was not specifically surveyed however, rock shelters considered to be of high archaeological and ethnographic significance are known to be present. • The transport corridor routes have not been surveyed. Based on results from the Department of Indigenous Affairs Sites Register, the majority of recorded sites in the vicinity of the corridors were located along Robe River and its tributaries with other sites at Mesa A and Warramboo, Mesa J and other mesa formations. • As a general observation, ethnographic associations typically relate to the creeks beds in the project area.	• Disturbance of Aboriginal archaeological and ethnographic sites due to mining activities and construction of the transport corridor.	• Undertake Aboriginal archaeological and ethnographic surveys of the Mesa A escarpment and other areas of proposed disturbance not yet surveyed, in consultation with Kuruma Marthundunera. • Avoid disturbance to significant heritage sites where practicable. • Where avoidance of a site is not practical, seek consent to disturb the site from the Minister for Indigenous Affairs through a section 18 application under the Aboriginal Heritage Act 1972, in consultation with Kuruma Marthundunera. • Maintain a 50 m mining exclusion zone around the Mesa A escarpment (including the three identified gullies), except for the area where the escarpment will be breached to allow access from the pit to the plant area, to protect Aboriginal heritage values of the escarpment.	• A number of recorded Aboriginal heritage sites will be disturbed by mining activities and the construction of the transport corridor. • The proposal will avoid disturbance to most of the Mesa A escarpment through the establishment of a mining exclusion zone. Some heritage sites on the escarpment may be disturbed due to the requirement for a passage through the mesa escarpment. • Management of Aboriginal heritage sites will be undertaken in accordance with the *Aboriginal Heritage Act 1972*. • Robe will continue to consult and work with Kuruma Marthundunera regarding management of Aboriginal heritage sites and values. • Disturbance to significant Aboriginal heritage sites will be avoided where practicable.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
9. Public risk and safety	To ensure that risk from the proposal is as low as reasonably achievable and complies with acceptable standards and EPA criteria.	• The North West Coastal Highway passes between the Mesa A and Warramboo mining areas and a haul road will pass under the highway to transport product from Warramboo. • Fuel will be supplied to the Mesa A/Warramboo operations along the North West Coastal Highway and explosives will be stored at the existing facilities utilised by the Mesa J mine site and transported along the Pannawonica Road to Mesa A and Warramboo.	• Mine operations, particularly blasting, in proximity to the North West Coastal Highway may pose a risk to users of the highway. • Transportation of fuel and explosives may pose an increased risk to users of the North West Coastal Highway and Pannawonica Road. • Increase in traffic volumes on public roads due to the project may pose an increased risk to users of the North West Coastal Highway and Pannawonica Road.	• Develop and implement a Public Risk and Safety Management Plan in consultation with Main Roads. The plan will include: - North West Coastal Highway closure requirements and procedures - other measures to reduce risk to public safety during blasting - methods to provide advance public notification of highway closures (e.g. roadside signage and signage at appropriate roadhouses). • Ensure, in consultation with Main Roads, that appropriate turn-off lanes and signage are installed on the North West Coastal Highway.	• The project will result in an increase in general traffic volumes and freight movement on North West Coastal Highway and Pannawonica Road during construction and operation. However, the increase in traffic volumes will be within the current capacity of the public roads. • Through implementation of risk mitigation measures potential risk to road users will be reduced as far as practicable.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
Other					
10. Landscape and geodiversity	Maintain and protect any significant landscape and geoheritage values, and maintain the integrity, ecological functions and environmental values of the soil and landform.	• The proposed mine is at the western extremity of a series of pisolite, mesa formations associated with the Robe River. • The North West Coastal Highway is the main travel route through the region. • Panoramic, long distance views over the surrounding country are generally available throughout the area, due to the open nature of the landforms and sparse vegetation. Views become confined close to, and between, mesa formations, in gullies and near the riverine vegetation. • Mesa A is a partial mesa, which is not common in the Robe River/Deepdale formations, and has three distinct gullies. • Terrain at Warramboo is relatively flat and slopes away to the north-north-west. • The transport corridor will be located in an area that is relatively flat except for the presence of mesas.	• Mining and backfill, including removing topsoil, overburden and ore during mining will create a void in the landscape. • Placement of drainage structures (e.g. bunds) and waste dumps will place new raised landforms in the landscape. • Placement of other mining infrastructure will temporarily alter the appearance of the natural environment. • Construction and operation of the transport corridor will alter the appearance of the natural environment.	• Maintain a 50 m mining exclusion zone around the Mesa A escarpment (including the three identified gullies), except for the area where the escarpment will be breached to allow access from the pit to the plant area. • Position the Western waste rock dump at Mesa A to restrict public access to the site and provide a visual barrier from the North West Coastal Highway. • Restrict waste dump height to a maximum of 10 m. • Form and revegetate diversion drains to resemble natural drainage lines of the area. • Undertake progressive backfill and rehabilitation of mine. • Commence rehabilitation of waste rock dumps by the third year of mine operation. • If the construction camp/FIFO village is located adjacent to Pannawonica Road, design it to blend in with the surrounding landscape as far as practical (e.g. through colour schemes and landscaping). • Form and revegetate drainage structures to resemble natural topography. • Undertake progressive rehabilitation of borrow pits.	• Landscape and geodiveristy values of the project area will be affected by the proposal, however the effects will be mitigated through a range of management measures. • The most significant management measure is the retention of the Mesa A escarpment, through creation of a 50 m mining exclusion zone. This will significantly reduce the visual impact of the mine on the surrounding landscape and will protect a number of significant landscape and geodiversity features. • Impacts to the geodiversity of the transport corridor will be managed by minimising the area of vegetation to be cleared and the area of mesa formations disturbed by construction of the transport corridor. • The distance of the transport corridor from the North West Coastal Highway and Pannawonica Road will mitigate the visual impacts of the transport corridor.

Environmental factor	EPA objective	Existing environment	Potential impacts	Potential management	Predicted outcomes
11. Rehabilitation/ closure	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.	• The area of Mesa A/ Warramboo and the transport corridor is relatively undisturbed, with the exception of a number of mining exploration tracks and pastoral activities.	• Mining and the establishment of associated infrastructure will result in clearing of vegetation and disturbance of soil profiles and landforms.	• Robe will develop and implement an Environmental Management Plan which will address rehabilitation for the project, including: - description of the rehabilitation process - development of completion criteria in consultation with the Department of Industry and Resources (DoIR), Department of Environment and Conservation (DEC) (Nature Conservation Division & Environmental Management Division) - the use of local provenance seed in rehabilitation where topsoil is considered insufficient - monitoring of rehabilitation - establishment of recalcitrant species in rehabilitation. • Robe will develop and implement a Closure Management Plan for Mesa A/Warramboo, the transport corridors and associated infrastructure, which will address the following: - development of suitable end land uses and objectives for closure in consultation with relevant stakeholders and the community - identification and evaluation of closure options and determination of preferred options - establishment of completion criteria - closure monitoring - review and update of the Closure Management Plan. • Retain topsoil during site clearing activities and use immediately on restored landforms or store in low lying stockpiles. • Construct waste rock dumps such that they have a maximum height of 10 m and are profiled to an average slope of 18-20 degrees. • Commence rehabilitation of waste rock dumps by the third year of mine operation. • Undertake progressive backfill of pits at Mesa A and Warramboo. • Undertake rehabilitation of borrow pits, tracks and other cleared areas that are not required following completion of transport corridor.	• Rehabilitation will be addressed in the Construction Environmental Management Plan and Environmental Management Plan. • Progressive rehabilitation of disturbed areas will be undertaken once the areas are no longer required. • Robe has prepared a Closure Statement for the Mesa A/Warramboo project. • Robe will develop and regularly review, in consultation with relevant stakeholders, a Closure Management Plan for the Mesa A/Warramboo project to ensure that rehabilitation and closure issues are addressed at the earliest stage in the mine life.

MESA A / WARRAMBOO IRON ORE PROJECT
PUBLIC ENVIRONMENTAL REVIEW

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2. Supporting studies and investigations (contained on CD inside back cover of PER)

PART 1 INTRODUCTION AND THE PROPOSAL

1. INTRODUCTION

This document is a Public Environmental Review (PER) prepared in accordance with the *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002* of the *Environmental Protection Act 1986* (EP Act) for the Robe River Mining Company Pty Limited's (Robe) proposed Mesa A/Warramboo Iron Ore Project, in the Pilbara region of Western Australia. Robe River Mining Company Pty Limited acts as the Manager for Robe River Iron Associates.

1.1 THE MESA A / WARRAMBOO IRON ORE PROJECT

1.1.1 Location

The Mesa A/Warramboo deposit is located in the Robe Valley area of the Pilbara region of Western Australia (Figure 1 and Figure 2). It is approximately 38 km north-west of the existing Mesa J mine site, 43 km west of Pannawonica town and 245 km by rail from the Cape Lambert port facilities.

Existing mining operations at Mesa J

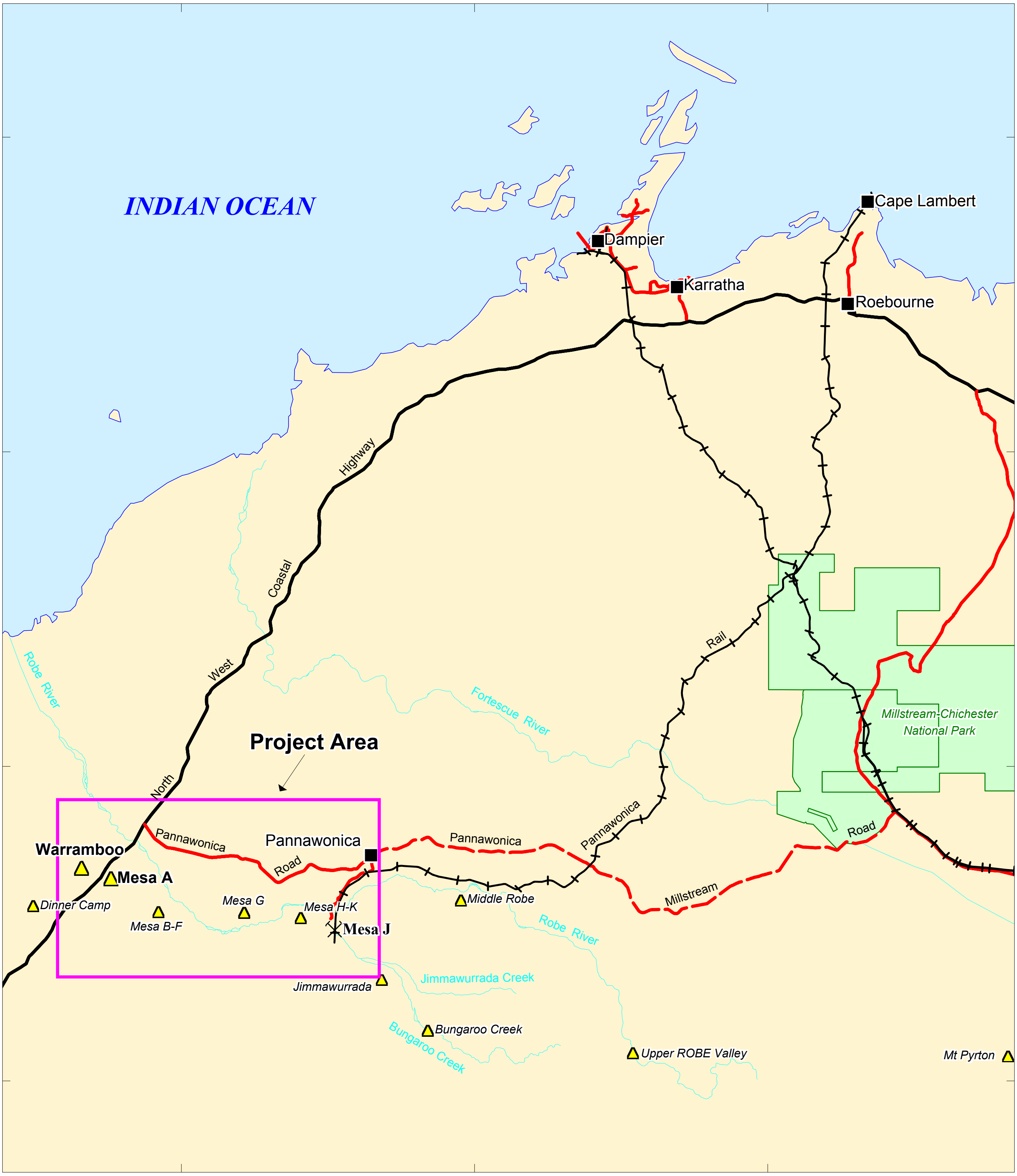
The Mesa A deposit and approximately 70% of the Warramboo deposit is within the Mining Lease AML70/00248 Sec 100. The remaining area of the Warramboo deposit (approximately 12 million tonnes of ore) is held under Exploration Licence EL08/789 (Mining Lease applications M08/426-M08/428). All mine related infrastructure (plant and waste dumps) will be located within the mining leases, with the exception of the proposed transport corridor from Mesa A to Mesa J and access roads. Miscellaneous licence applications for the proposed southern transport corridor (L08/29 and L08/30) were lodged in February 2005. Additional tenure applications are required for the groundwater abstraction areas and northern transport corridor routes.

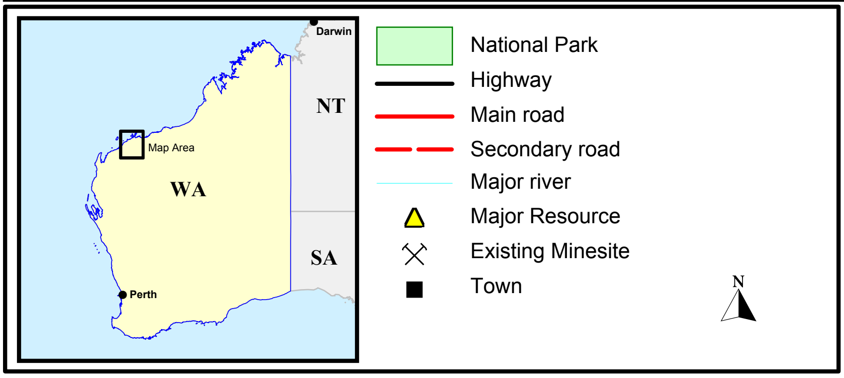
1.1.2 Description

The Mesa A/Warramboo project area is defined as two main areas: the Mesa A and Warramboo mining areas (and associated infrastructure), and the transport corridor(s), as shown in Figure 2. The Mesa A/Warramboo Iron Ore Project proposal comprises:

- The development of new mining pits (and associated infrastructure) at Mesa A and Warramboo to supplement and eventually replace the existing Mesa J mine site.
- Construction of an ore transport corridor from Warramboo to Mesa A, and from Mesa A to existing infrastructure at Mesa J.

The Mesa A/Warramboo project will not change throughput at Cape Lambert port, as ore from the Mesa A/Warramboo mine site will replace ore currently sourced from the Mesa J mine.

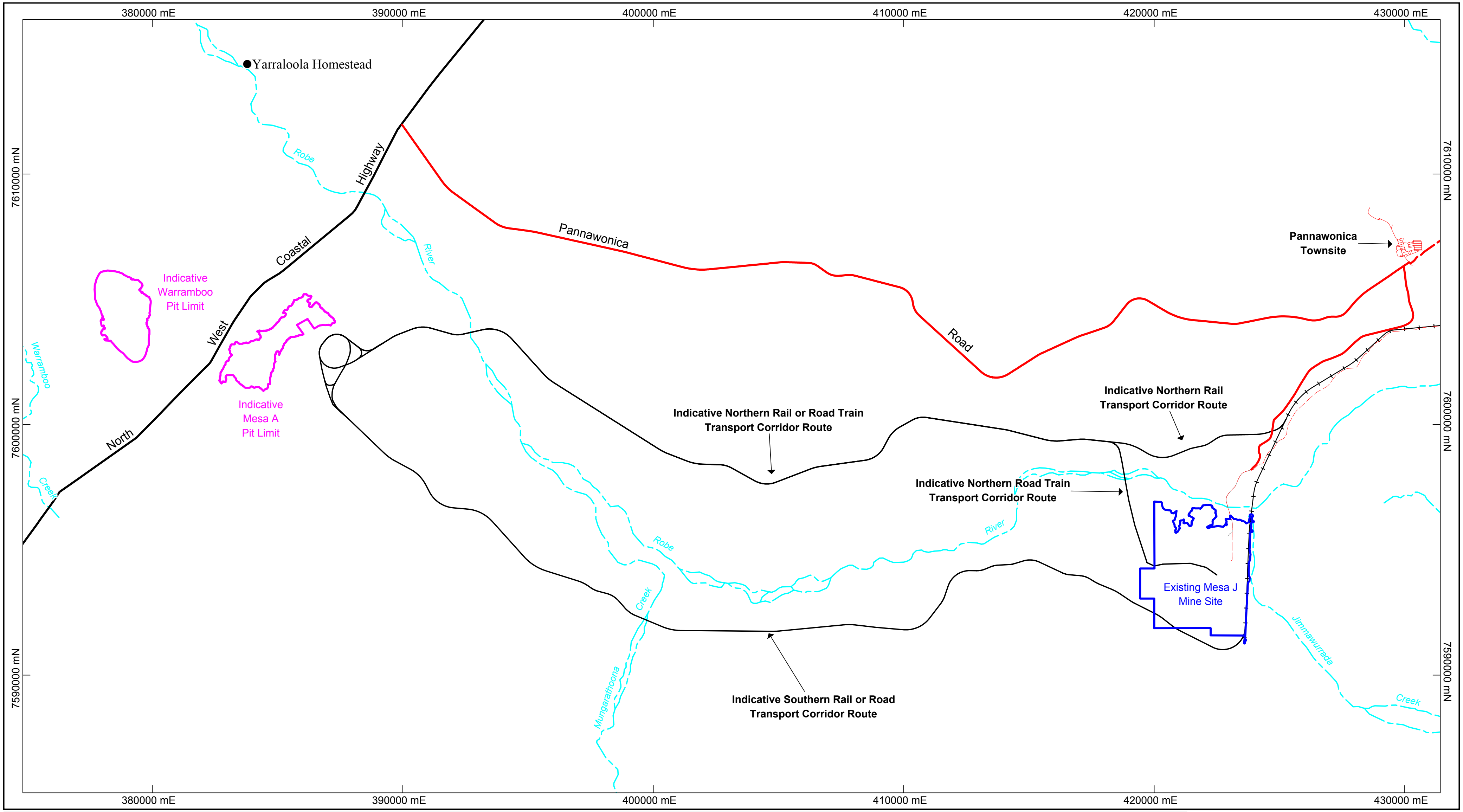


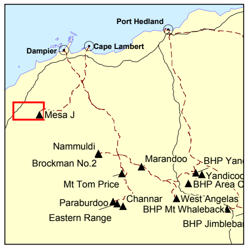


Pilbara Iron
A member of the Rio Tinto Group

Figure 1 Location of Mesa A/Warramboo

Author: FB	Date: January 2006
Drawn: GC	Revised:
Dwg No.: rp113949v1_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:





Highway
Main Road
Existing Rail
Major River/Creek

N

5 0 5 10
Kilometers

Pilbara Iron

Figure 2 Mesa A Warramboo general location plan

Author: FB	Date: January 2006
Drawn: CB/GC	Revised:
Dwg No.: 113949v2_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

1.2 THE PROPONENT

The project proponent is the Robe River Mining Company Pty Ltd (Robe), as Manager for Robe River Iron Associates. The project will be managed by Pilbara Iron Company (Services) Pty Ltd (Pilbara Iron) on behalf of Robe. Pilbara Iron is a member of the Rio Tinto Group, and was established in 2004 to manage the group's Western Australian iron ore operations on behalf of their asset owners.

The key contact for the proposal is:

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1.3 JUSTIFICATION FOR PROPOSAL

Robe currently produces approximately 32 million tonnes per annum (Mtpa) of pisolite ore from the Mesa J mine site which was approved under Ministerial Statement 208 in January 1992. Current projections show that the Mesa J deposit will be mined to its maximum extent by 2010. Production from the Mesa J mine site is predicted to begin to decline in 2008 as the ore available at Mesa J decreases. Approximately 7 Mtpa of sub-grade material will continue to be processed through the existing scrubber plants until 2015. A replacement mine for Mesa J is required to be available to produce pisolite ore by 2008.

The Mesa A/Warramboo deposit has been identified as the next deposit for the potential development in the Robe Valley. A pre-feasibility study concluded that the Mesa A/Warramboo deposit provides the highest value and lowest risk alternative replacement to Mesa J. Potential production from Mesa A/Warramboo is critical to ensure sustainability of Robe's business activities in the region.

Robe has undertaken a thorough assessment of potential environmental impacts of the proposal, and has undertaken a range of surveys including flora, fauna, surface water and groundwater, and landscape and geodiversity surveys. Robe will ensure strategies are in place to mitigate environmental impacts. As an example, Robe has committed to retaining the escarpment of Mesa A, to reduce the impact on landscape, biodiversity and Aboriginal Heritage values.

1.3.1 Demand for iron ore

Robe Valley pisolite iron ore is currently supplied to many steel producing companies in Japan, Korea, China and Europe. The unique technical properties of Robe Valley iron ore established it as an important component of the iron ore blend in customers' blast furnace feedstock. With the loss of access to this material, these customers would not be in a position to source alternative iron ore from other major suppliers, as all are, like Robe, basically in a "sold out" position.

Recent growth in world seaborne trade in iron ore has been driven by China, whose imports have risen from 70 millions tonnes in 2000 to 208 million tonnes in 2004. This rapid growth in Chinese iron ore imports has been driven by the compound effect of an acceleration in finished steel consumption, which grew at an average rate of 20% year-on-year between 2000-2003. Domestic steel production has moved in step with this growth in demand. As domestic ore production is constrained by resource and cost issues, and scrap availability is low, most of the consequential increase in demand for iron units was realised by imports of iron ore.

Resource statistics released by the Department of Industry and Resources (DoIR) showed that in 2004, Western Australian iron ore sales reached record volumes for a fifth consecutive year, and pushed sales values to a record of $6190 million (DoIR 2004a).

Robe pisolites have a firm position in the market as a consistent and cost competitive product. With growth in most Asian markets, market share for Robe pisolites is forecast to drop although saleable tonnes are likely to continue at a stable level due to its value-in-use. The Mesa A/Warramboo deposit will provide replacement tonnes for Mesa J to meet this demand.

1.3.2 Alternative deposits considered

In 2001 Robe undertook a study to determine the best option for a new mine development to replace Mesa J. Apart from Mesa A/Warramboo, the alternate deposits that were analysed included:

- Bungaroo
- Mesa G
- Mesa F.

This study recommended that Mesa A/Warramboo proceed as the next Robe Valley development on the basis of the following:

1. None of the other deposits are sufficiently well understood in terms of the intensity of drill holes to develop a saleable product in the time frame required.
2. The Bungaroo deposit is below the watertable, and therefore represents a much more operationally difficult deposit to mine.
3. Mesa G only holds resources of approximately 150 Mt (compared to approximately 270 Mt at Mesa A/Warramboo), and its grade is only 56% Fe (compared to 57%).
4. Mesa F is only a small deposit (<100 Mt) and is therefore difficult to justify as a new mine at this stage.

Once Mesa A/Warramboo was determined to be the best option for the development of a new mine, an order of magnitude study was conducted to determine the best arrangement for Mesa A/Warramboo as a cost competitive replacement for ore tonnes for Mesa J. A series of alternatives were investigated to identify the optimum business plan including different production schedules, materials handling and ore transportation options. Attention was also given to the effect into downstream operations, such as the railway and Cape Lambert port. Results indicated the highest value options consisted of a 25 Mtpa run of mine operation, with either ore transportation by railway or road train from Mesa A to Mesa J. A pre-feasibility study was then conducted for these two options, which indicated that road train transport was preferred over rail from both an economic and strategic perspective as the ore transport mechanism from Mesa A. However, given the lack of familiarity with road train operation within Rio Tinto, it was considered that further analysis would be required during the feasibility study to determine its acceptability.

1.3.3 Benefits of proposal

Demand for iron ore continues to be strong, particularly from the Asian market. Feasibility studies have indicated that this demand is sufficient to warrant the development of mining operations at Mesa A/Warramboo.

The proposal will result in economic benefits for Australia and Western Australia through:

- contribution to the value of mineral exports
- royalties and taxation payments
- capital investment
- increasing direct and indirect employment opportunities in the region
- increasing demand for goods and services supporting the regional economy.

Construction of the infrastructure associated with the development of the Mesa A/Warramboo mine site is likely to make other deposits along the Robe Valley viable for potential future development as it will be possible to utilise the infrastructure put in place for the Mesa A/Warramboo mine site.

The ongoing activities of Robe in the Pilbara region will continue to support a range of social and economic development projects, including:

- funding for a range of organisations in the region, including sporting and cultural groups
- increasing the education, training and employment options for local Aboriginal people.

Robe's contributions to the social and economic development of local and regional communities of Western Australia are detailed in Section 5.2.1.

1.4 PURPOSE AND SCOPE OF THIS DOCUMENT

The purpose of this document is to present a Public Environmental Review of the principle components of the Mesa A/Warramboo Iron Ore Mine project and associated infrastructure project.

1.5 STRUCTURE OF THIS DOCUMENT

The document is structured as follows:

Part 1 – Introduction and the proposal

- Introduction
- Overview of existing environment
- Description of proposal

Part 2 – Environmental impact assessment approach and assessment of project-wide environmental factors

- Stakeholder consultation
- Environmental principles and sustainability

- Assessment of environmental impact of proposal

Part 3 – Mining and process operations – Assessment of key environmental factors

- Factor by factor assessment of key environmental impacts

Part 4 – Ore transport corridor – Assessment of key environmental factors

- Factor by factor assessment of key environmental impacts

Part 5 – Proposed environmental management program and environmental outcomes of project

- Environmental Management Commitments
- Environmental Costs and Benefits of Project.

1.6 ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The Mesa A/Warramboo Iron Ore Mine project was referred to the Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act) on 27 May 2005. On 27 June 2005, the EPA advised the level of assessment for the project was a Public Environmental Review (PER) with an eight week public review period.

An Environmental Scoping Document was prepared to seek EPA endorsement regarding the scope of the assessment of the project as well as providing an indicative timeline for the assessment process. The Environmental Scoping Document was submitted to the EPA on 15 August 2005 and included a summary of the potential environmental impacts, their significance and possible management responses, proposed scope of work to obtain information for the PER, key legislation, stakeholder consultation programme, project and assessment schedule, study team and peer review mechanisms. The Scoping Document was approved by the EPA on 21 December 2005.

The PER and Scoping Document were prepared in accordance with the *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002* (the Administrative Procedures) for environmental assessment prescribed under the EP Act. Figure 3 outlines the procedure for a PER level of assessment.

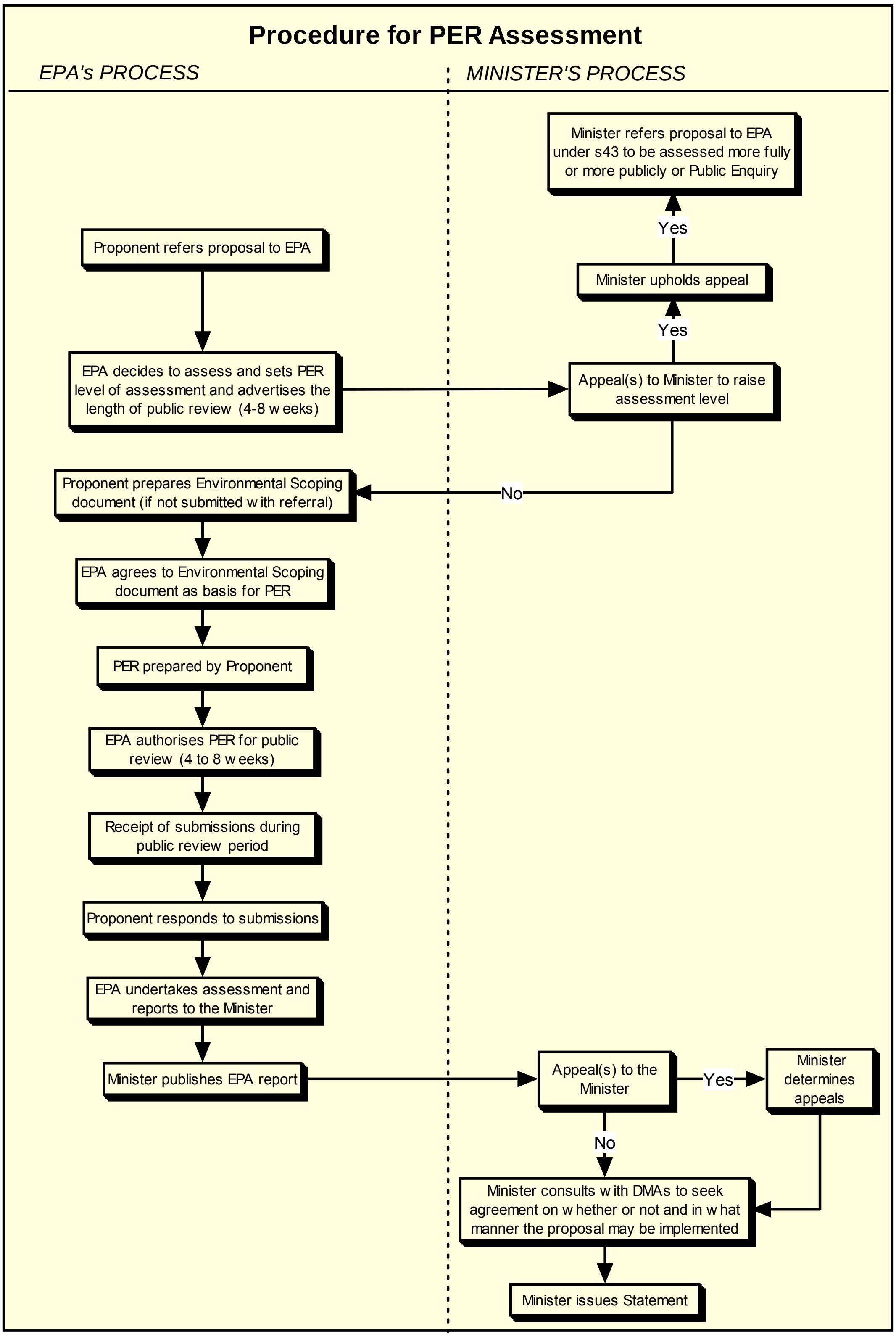


Figure 3 Flowchart of Public Environmental Review Procedure

1.7 RELEVANT LEGISLATION AND POLICY

Western Australian legislation, policy and strategies

Western Australian legislation relevant to the project includes the following:

- *Aboriginal Heritage Act 1972*
- *Agricultural and Related Resources Protection Act 1976*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Contaminated Sites Act 2003*
- *Country Areas Water Supply Act 1947*
- *Dangerous Goods and Safety Act 2004*
- *Electricity Act 1945*
- *Environmental Protection Act 1986*
- *Explosives and Dangerous Goods Act 1961*
- *Dangerous Goods (Transport) Act 1998*
- *Health Act 1911*
- *Iron Ore (Robe River) Agreement Act 1964*
- *Land Administration Act 1997*
- *Local Government Act 1995*
- *Main Roads Act 1930*
- *Mining Act 1978*
- *Native Title (State Provisions) Act 1999*
- *Occupational Safety and Health Act 1984*
- *Rail Safety Act 1998*
- *Rights in Water and Irrigation Act 1914*
- *Soil and Land Conservation Act 1945*
- *Waterways Conservation Act 1976*
- *Wildlife Conservation Act 1950.*

In addition to existing legislation, the following government agency strategies and policies are of relevance to the environmental assessment and management of this proposal:

- Western Australian State Sustainability Strategy
- Draft Greenhouse Strategy for Western Australia 2003
- 1987 State Conservation Strategy

- EPA Red Book recommendations for Conservation Reserves of Western Australia
- State Water Quality Management Strategy.

Commonwealth legislation, policy and strategies

Commonwealth legislation relevant to the project includes the following:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (which operates concurrently with any existing State laws in so far as those laws would not be consistent with this Act)
- *Environment Protection and Biodiversity Conservation Act 1999*
- *Native Title Act 1993.*

Referral of the project to the Commonwealth Department of the Environment and Heritage (DEH) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was required as a number of nationally-listed threatened fauna species have been identified as potentially occurring within the project area (Section 10.1.3). These species are considered to be matters of national environmental significance[2], and therefore the impact of the proposal on these matters may require assessment under the EPBC Act. The project was referred to the DEH on 9 March 2006 to determine whether the proposal is considered to be a controlled action and if so, what level of assessment would apply. On 13 April 2006 the DEH advised that the action is not considered to be a controlled action under the EPBC Act (Appendix 1).

The following national strategies may also be relevant to the proposal:

- National Strategy for Ecologically Sustainable Development
- Intergovernmental Agreement on the Environment
- National Greenhouse Strategy
- National Conservation Strategy for Australia
- National Strategy for Conservation of Australia's Biological Diversity.

International agreements or treaties

International agreements or treaties that may directly or indirectly affect this project include:

- Montreal Protocol on Substances that Deplete Ozone
- Convention on Biodiversity
- United Nations Framework Convention on Climate Change and Kyoto Protocol (although not ratified by Australia).

[2] Matters of national environmental significance include World Heritage Properties, RAMSAR wetlands, nationally threatened species and ecological communities, migratory species, Commonwealth marine areas and nuclear actions.

2. OVERVIEW OF EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT OVERVIEW

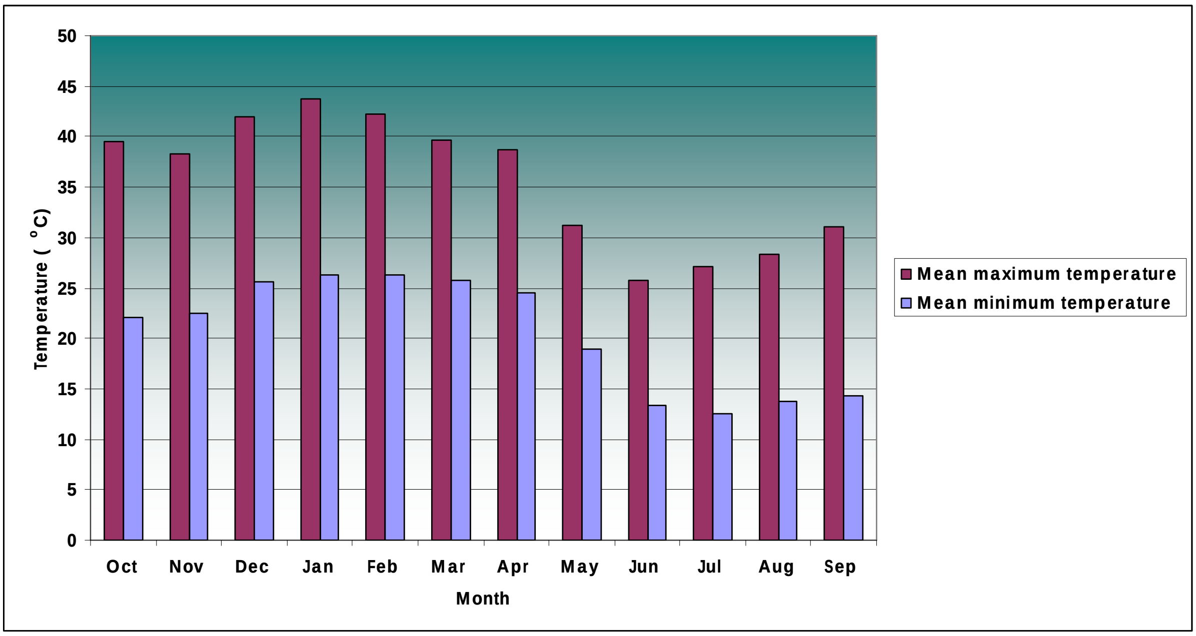
2.1.1 Climate

The Pilbara region has an arid tropical climate with two distinct seasons (Gentilli 1972). The region experiences a very low rainfall, high evaporation and high daytime temperatures.

The summer months extend from November to April and have daily maximum and minimum temperatures ranging from 25°C to 44°C (Figure 4). Winter months extend from May to September and have temperatures ranging from 12°C to 26°C.

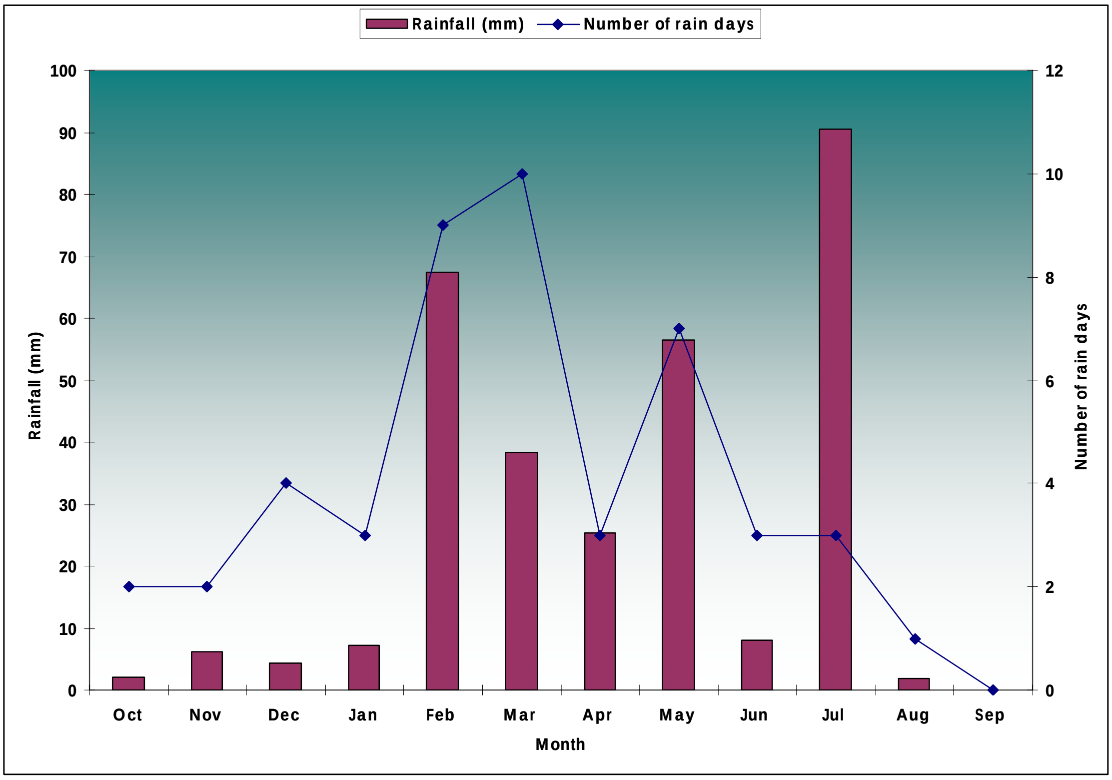
Average annual rainfall is approximately 300-350 mm, however is very erratic (Figure 5). Average monthly rainfall typically varies from almost zero in September and October to around 100 mm in February. Intense rainfall events occasionally occur as a result of cyclonic activity, and mainly occur during the months of January to March. Cyclones can result in more than 100 mm of rain falling within a 24-hour period. These intense rainfall events can cause sheet flooding and extensive mechanical erosion. The annual evaporation is approximately 2400 mm.

Winds are predominately east-north-easterly between March and August, and west-north-westerly between September and February.



Source: Bureau of Meteorology (2005a)

Figure 4 Mean monthly maximum and minimum temperatures (°C) for Pannawonica in 2004 – 2005



Source: Bureau of Meteorology (2005a)

Figure 5 Monthly rainfall data showing rainfall (mm) and number of rain days for Pannawonica in 2004 – 2005

2.1.2 Landform

Major physiographic unit

The project area lies towards the western end of the Hamersley Plateau as defined by Beard (1975a, 1975b). The Hamersley Plateau is characterised by rounded hills and ranges, consisting mainly of jaspilite and dolomite with some shale, siltstone and volcanics.

Land system (rangelands)

The project area includes sections of the following land systems as described by Department of Land Information geographic information system mapping:

Peedamulla	Gravelly plains supporting hard spinifex grasslands and minor snakewood grasslands
River	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands; only where the corridor crosses the Robe River channel
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands

Cane	Alluvial plains and flood plains supporting snakewood shrubs, soft and hard spinifex grasslands and tussock grasslands
Stuart	Gently undulating stony plains supporting hard and soft spinifex grasslands and snakewood shrublands
Capricorn	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands
Sherlock	Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands
Urandy	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands
McKay	Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands
Nanutarra	Low mesas and hills of sedimentary rocks supporting soft and hard spinifex grasslands

The major landforms of the Mesa A/Warramboo area are shown in Figure 6.

Landscape and geodiversity is further described in Section 12 and surface hydrology in Section 13.

2.1.3 Local geology

The Mesa A/Warramboo deposit is a pisolite deposit. Pisolitic ore consists primarily of a mixture of the iron minerals, goethite and hematite, with minor clay and silica. The bulk of the pisolite is made up of spherical accretions of iron minerals called pisoliths. These pisoliths consist of a hematite nucleus coated by concentric growths of goethite.

The Robe Pisolite is believed to have been deposited in the paleaeo-valley of the original Robe River system in the late Mesozoic to early Tertiary period. In the vicinity of Mesa A, the Robe River is thought to have flowed across the broad Jurassic Yarraloola Conglomerate Formation. Subsequent rejuvenation is thought to have caused lateral migration and downward erosion into the conglomerate. The channel at Mesa A is incised into the Yarraloola Conglomerate (which is part of the Mesozoic Nanutarra formation) into sediments interpreted to be part of the older Proterozoic Ashburton Formation, which forms most of the basement to Mesa A. Quaternary erosion has resulted in planation of the area with varying cover of alluvium, colluvium and aeolian sands. The more resilient iron rich channel fill remains as elongate topographic highs (mesas) along the current erosional surface.

The Warramboo deposit forms part of the buried downstream continuation of the Robe Pisolite deposit in Mesa A, which are both located downstream from the currently exposed mesa deposits of the main Robe River palaeochannel.

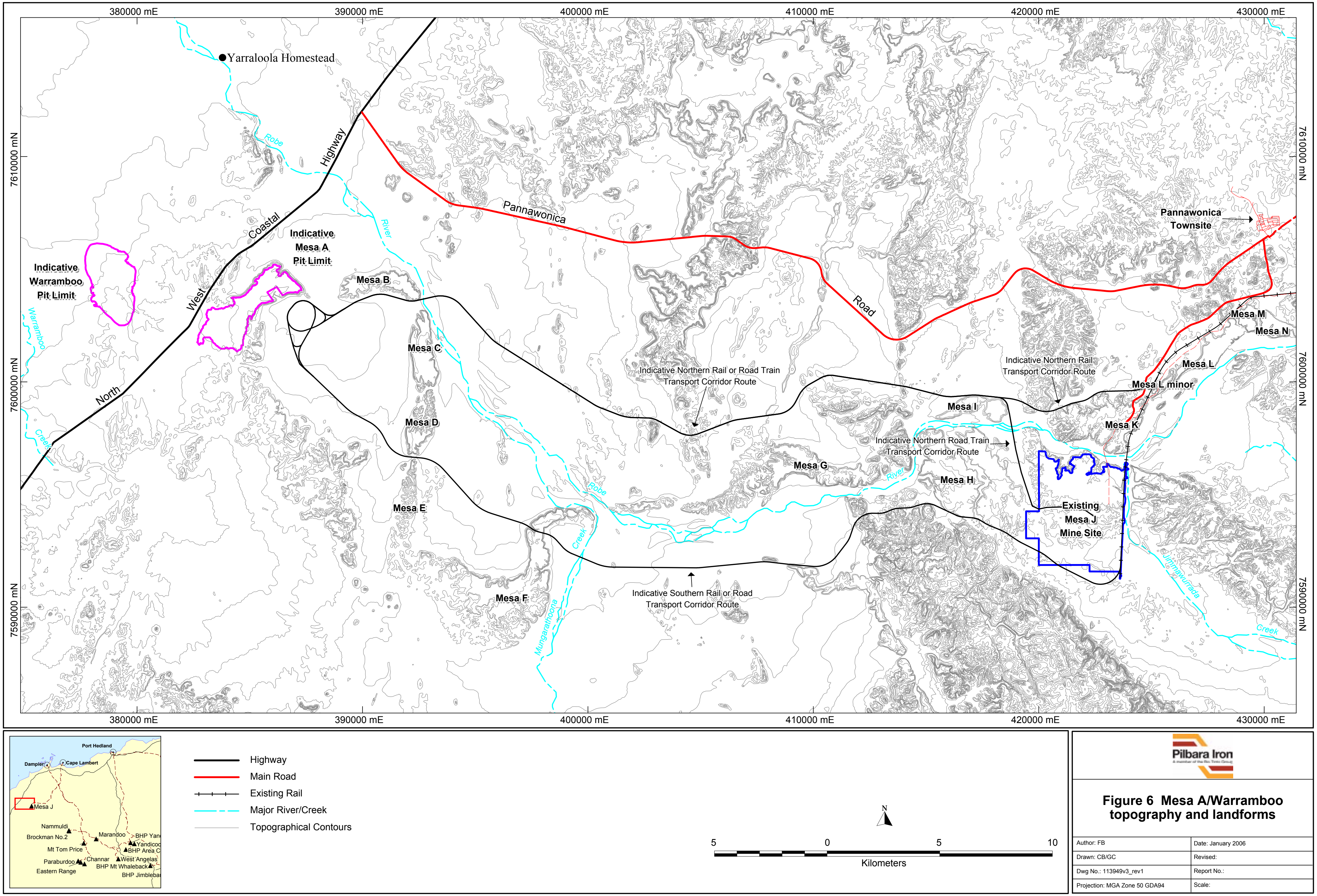


Figure 6 Mesa A/Warramboo topography and landforms

Author: FB	Date: January 2006
Drawn: CB/GC	Revised:
Dwg No.: 113949v3_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

2.1.4 Surface hydrology

Robe River is the major river system in the region and covers a linear distance of approximately 190 km. Surface flows in Robe River are intermittent but the river has significant underflow in its alluvial bed which maintains permanent pools in the river channel. The positions of these pools within the valley change following seasonal floods (BBG 1991). The river typically flows at least once a year, only after significant and intense rainfall events.

The Robe River catchment drains generally from east to west through the high relief areas of the Hamersley Ranges onto the more gently sloping areas in the coastal plain before discharging into the ocean (Aquaterra 2005a). The river has many tributaries that originate or cross the project area. The largest of these tributaries are the Warramboo and Mungarathoona creeks (Figure 6).

Warramboo Creek discharges into the poorly defined scrubland on the coastal plain. It is likely that during large floods, the downstream section of Warramboo Creek on the coastal plain becomes part of the Robe River floodplain (Aquaterra 2005a).

Mungarathoona Creek has its headwaters in the Hamersley Ranges about 50 km to the south of the catchment outlet. The confluence of Mungarathoona Creek with Robe River is near the Goldfields Gas Transmission Pipeline.

The majority of the proposed mine infrastructure is located in the primary Robe River drainage catchment with the exception of the proposed Warramboo pit, which is located in the adjacent Warramboo drainage catchment (Aquaterra 2005a).

Sections 13.1 and 22.1 describe surface hydrology of the Mesa A/ Warramboo project area in more detail.

2.1.5 Hydrogeology

The Mesa A/Warramboo project area lies on the eastern edge of the Carnarvon Basin where it abuts the Pilbara Craton. The Carnarvon Basin comprises sediments of the Holocene to Silurian age that form an extensive groundwater basin stretching onshore from Northhampton to Exmouth. Groundwater occurs as part of a regional flow system that drains westwards to the coast. Groundwater is recharged by rainfall and via infiltration beneath ephemeral rivers. In the west of the basin artesian conditions are encountered at relatively shallow depths (<100 m below ground level). In the eastern margins of the basin around the project area the upper sediments are dissected by several phases of marine regression and transgression resulting in a complex watertable owing to discontinuous sediments.

Water quality is generally fresh to brackish in the eastern basin and increases in salinity towards the coast. Groundwater with lower total dissolved solids concentrations is generally found in association with ephemeral river courses.

Groundwater in and near the project area is mainly used for pastoral activities. The project proposes to abstract groundwater from sediments of Cretaceous age within the top most 100 m of the basin.

Section 14.1 describes the hydrogeology of the Mesa A/ Warramboo project area.

2.2 BIOLOGICAL ENVIRONMENT OVERVIEW

The Mesa A/Warramboo project area is mostly located within the Hamersley sub-region of the Pilbara Biogeographic Region as recognised by the Interim Biogeographic Regionalisation (IBRA). The IBRA identifies 85 bioregions across Australia (Environment Australia 2000). The Warramboo deposit extends into the Roebourne sub-region of the Pilbara Biogeographic Region.

The Pilbara Biogeographic Region is listed as a medium priority for funding for land purchase under the National Reserves System Co-operative Program due to the limited representation of areas in conservation reserves. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015. None of the proposed exclusions are located in the vicinity of the project area.

2.2.1 Terrestrial vegetation and flora

The Mesa A/Warramboo project area is located within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975a, 1975b). The vegetation of this province is typically open and frequently dominated by spinifex, *Acacias* and occasional eucalypts.

The vegetation of the project area can be broadly described as belonging to five vegetation groups, related to topography (Biota 2005a; Biota 2006a; Biota 2006b):

Stony hills and plains

- Hummock grasslands with a variable shrub overstorey (sometimes dominated by *Acacia* species) and scattered Snappy Gums.

Clayey soils

- Tall Snakewood (*Acacia xiphophylla*) shrublands over herbs or open spinifex.

Minor creeklines

- Tall shrublands over hummock grasslands with an overstorey of scattered ecualypts.

Major rivers (Robe River)

- Open River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*Eucalyptus victrix*) forests.

Vegetation of the project area

Sand sheets

- Scattered low trees (*Corymbia zygophylla*) over a high shrubland and hummock grassland.

The combined number of taxa recorded from Mesa A and Warramboo is relatively low compared to areas further east, mainly reflecting low rainfall and subdued topography.

No Threatened Ecological Communities (TECs) or Declared Rare Flora (DRF) are known from the project area, however, several Priority (P) Flora species are known to occur (Biota 2005a; Biota 2006a; Biota 2006b), including:

- *Abutilon trudgenii* (P3)
- *Sida* sp. Wittenoom (P3)
- *Hibiscus brachysiphonius* (P3)
- *Rhynchosia bungarensis* (P3)
- *Phyllanthus aridus* (P3).

In addition, several vegetation types found in the project area are considered to be of high conservation significance (Biota 2005a; Biota 2006a; Biota 2006b), including:

- vegetation of the sand sheets
- vegetation of the cracking clays.

Section 9.1 and Section 18.1 contain more detailed descriptions of the vegetation and flora of the Mesa A/Warramboo mining areas and the transport corridor options respectively.

2.2.2 Terrestrial fauna

The range of habitats found over the project area are known to support a range of fauna species, including several that are endemic to the region and/or listed for protection under State and Federal conservation legislation (Biota 2005b; Biota 2006c).

Fauna surveys (Biota 2005b; Biota 2006c) of the Mesa A/Warramboo area recorded a range of fauna, including over 30 species of birds and reptiles, over 10 species of mammal, including 5 species of bat, and a range of invertebrates. Fauna surveys (Biota 2006c) of the transport corridor and surrounding areas recorded a range of fauna, including approximately 90 species of bird, 18 mammals, including three bats, 60 reptiles, 7 fish and a range of invertebrates.

Mammals of particular conservation significance recorded or likely to be found in the project area include (Biota 2005b; Biota 2006c):

- *Macroderma gigas* Ghost Bat (Schedule 1 species under the *Wildlife Protection Act 1950-1979*)
- *Dasyurus hallucatus* Northern Quoll (Listed as 'Endangered' species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act))
- *Rhinonicteris aurantius* Orange Leaf-nosed Bat (Listed as 'Endangered' under the EPBC Act)
- *Ningaui timealeyi* and *Dasykaluta rosamondae* considered to be near endemics in the Pilbara bioregion
- *Pseudomys chapmani* Western Pebble-mound Mouse (Priority 4 species).

Western Pebble-mound Mouse

A number of bird species of conservation significance could potentially occur in the project area (Biota 2005b; Biota 2006c). Three of these species, the Australian Bustard, the Bush Stone-curlew and the Star Finch (all Priority 4 taxa) were recorded during the survey of the northern rail corridor. The Striated Grasswren *Amytornis striatus whitei* was the only bird species of conservation significance recorded in the Mesa A fauna survey; it is considered endemic to the Pilbara bioregion. The only other regional near endemic that is likely to occur in the project area is the Black-tailed Treecreeper *Climacteris melanura wellsi*.

A number of herpetofauna species of conservation significance have been recorded or have potential to occur within the area (Biota 2005b; Biota 2006c). Three herpetofauna species considered to be endemic or near endemic to the Pilbara bioregion were recorded during surveys of Warramboo (*Diplodactylus savagei*, *Delma elegans*, *Ramphotyphlops pilbarensis*). *Acanthophis wellsi* (Pilbara Death Adder) was recorded during the Mesa A survey, and is endemic to the Pilbara. One species of reptile of conservation significance, *Notoscincus butleri*, was recorded during the survey of the northern rail transport corridor. Two further species listed as Schedule or Priority Fauna, the Pilbara Olive Python *Liasis olivaceus barroni* and a blind snake *Ramphotyphlops ganei*, have not been recorded, but may occur in the project area.

Section 10.1 contains a more detailed description of the terrestrial fauna of the Mesa A/ Warramboo areas while Section 19.1 contains more detailed descriptions of the terrestrial fauna of the transport corridor options.

2.2.3 Subterranean biota

Subterranean invertebrate fauna (stygofauna and troglofauna) are known to occur in the alluviums and mesa formations within the region (Biota 2006d; Biota 2006f). Sampling for subterranean fauna in the project area was first completed in 2004 and focussed on stygofauna sampling at Mesa A as part of exploration stage environmental surveys. No stygofauna were collected from the boreholes sampled, however this initial study unexpectedly recorded four troglobitic taxa during the haul net sampling. This was recognised as an outcome of considerable significance, as troglofauna had never before been documented from mesa formations in the mainland Pilbara region (Biota 2004).

Further subterranean fauna sampling therefore focussed on troglofauna at Mesa A and at similar sites (i.e. mesas, hills) within the Robe valley. This sampling program (Biota 2005b; Biota 2006c) recorded a total of 3892 invertebrate specimens (both troglobitic and non-troglobitic), representing 23 orders. Eight of the 23 orders contained specimens that were troglobitic, and of the 197 specimens in these orders, a total of 159 were troglobitic.

The troglobites recorded represented eight orders Schizomida, Pseudoscorpionida, Araneae, Scolopendrida, Polydesmida, Diplura, Thysanura and Blattodea.

Section 11.1 and Section 20.1 contain a more detailed description of the subterranean fauna of the Mesa A/ Warramboo areas and the transport corridor options respectively.

2.3 SOCIAL ENVIRONMENT OVERVIEW

2.3.1 Socio-economic setting

Local government and towns

Mesa A/Warramboo is within the Shire of Ashburton, approximately 43 km west of the town of Pannawonica. Pannawonica currently has a population of around 700 residents and is totally reliant on the continuation of Robe's mining operations in the area. The closest regional centre to Pannawonica is Karratha, which is approximately 200 km north-east. Other regional centres in the Pilbara are Tom Price, Paraburdoo, Roebourne and Port Hedland. These centres provide services to the pastoral, natural gas, salt, iron ore and other mining industries within the Pilbara.

Robe's Cape Lambert port operations are approximately 3.5 km north-west of the coastal township of Point Samson in the Shire of Roebourne. The townships of Wickham and Roebourne lie approximately 10 and 20 km to the south of the Cape Lambert operations respectively and Karratha is approximately 40 km due-west.

Economic activity

Robe contributes substantially to the economy of the Pilbara region, State and National levels. For example, in 2004 Pilbara Iron paid salaries and benefits of A$589 million to its Western Australian workforce. Payments to the State Government for royalties, rentals and payroll tax totalled more than A$300 million and gross turnover from Pilbara Iron's operations in 2005 was in excess of A$6.5 billion.

Employment

Pilbara Iron directly employs 3850 people with an additional estimated 6100 jobs created through indirect employment. Robe's current operations at the Mesa J mine directly employ 250 people, with a further 200 people indirectly employed as contractors to the company or through the provision of support activities in the local community.

Section 5.2.1 contains more detail of the socio-economic aspects of the project.

2.3.2 Adjacent land use and tenure

The land use/tenure in the Mesa A/Warramboo area is shown in Figure 7, and comprises:

- pastoralism (Pastoral Lease 3114/1127, De Grey Mullewa Stock Route Reserve No. 9701)
- mining lease (Lease ML248SA)
- mineral exploration (Live Exploration Leases E08/789, E08/01196, E08/1148; Pending Exploration Leases E 08/1028, E 08/1060, E 08/1406)
- miscellaneous licences (Pending Licences L08/29, L08/30, L08/32, L08/33, L08/34)
- infrastructure (Roads and gas pipeline)
- Unallocated Crown Land (UCL)

Pastoral activities occur throughout the area, under Pastoral Lease 3114/1127.

The closest National Park is the Millstream-Chichester National Park, located approximately 75km north-east of Pannawonica (Figure 1).

2.3.3 Aboriginal heritage, culture and native title

Numerous Aboriginal Heritage sites have been identified within the project area. These sites mainly consist of artefact scatters, rock shelters and scarred (modified) trees.

The Native Title Claim of the Kuruma Marthudunera Native Title Claimant Group (the Kuruma Marthudunera) covers approximately 15,759 km^2 of land in the Pilbara region, incorporating Robe's Mesa A/ Warramboo project area. Robe, as part of Pilbara Iron, is currently negotiating a native title agreement with Kuruma Marthudunera representatives regarding all Robe/Pilbara Iron interests within the bounds of the Kuruma Marthudunera claim. Among other things, the proposed native title agreement will address all matters required pursuant to the *Native Title Act 1993*.

Section 16 and Section 24 contain more detailed descriptions of Aboriginal heritage values for the Mesa A/Warramboo areas and transport corridor options respectively.

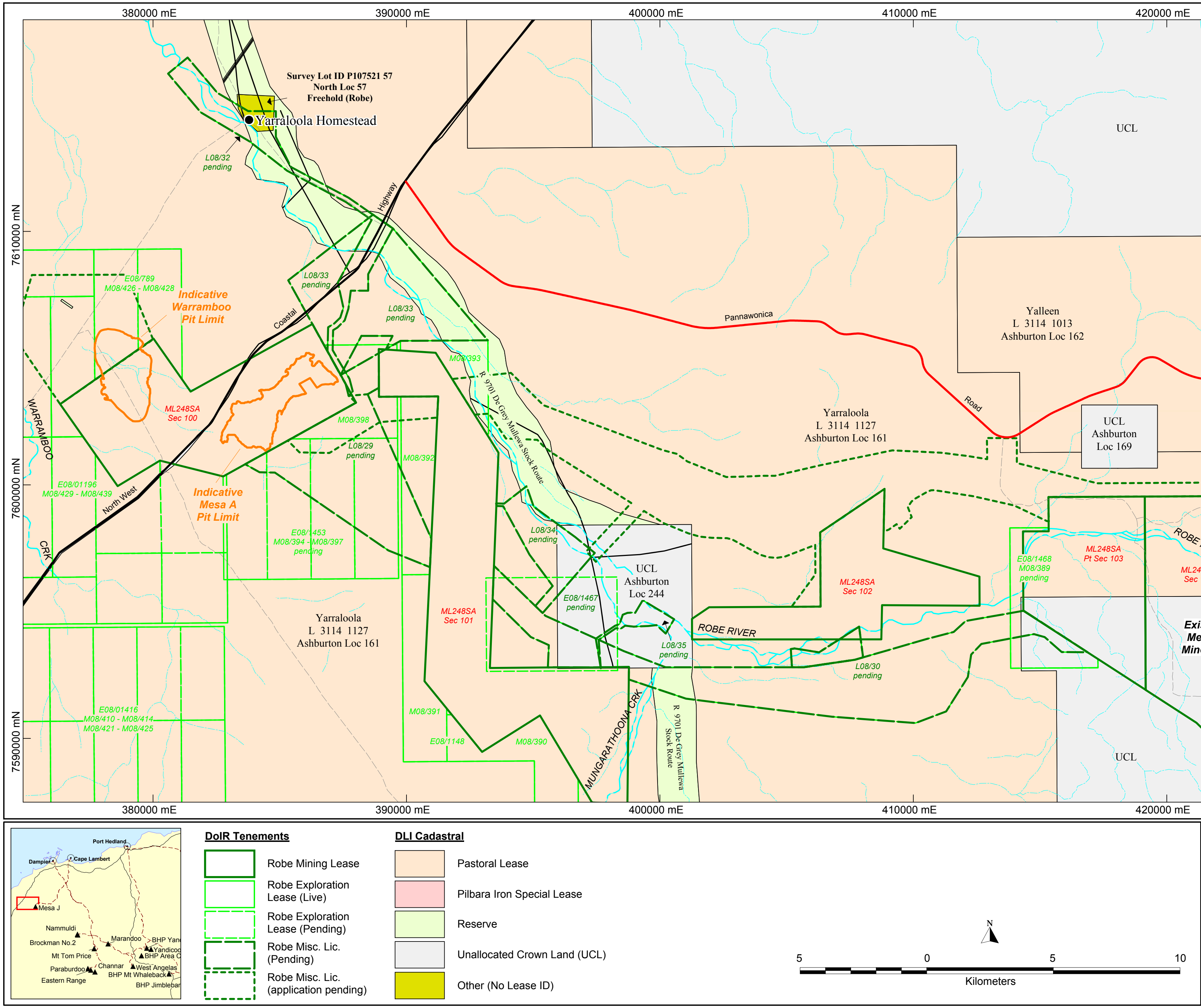
2.3.4 European heritage and culture

A search of the Australian Heritage Database, which includes the Register of the National Estate, the Commonwealth Heritage List, the National Heritage List and the World Heritage List, was completed for the area defined by the 1:250,000 Yarraloola Map Sheet (sheet number SF-50-06). No listings were present in the database for places or objects within 35-40 km from the Mesa A/Warramboo project area.

A search of the Heritage Council of Western Australia's Places Database for the Ashburton Shire provided three listings within 50 km of the project area:

- Yarraloola Homestead (place number 15398)
- Red Hill Homestead (place number 15375)
- Pannawonica Fire Station (place number 14628)

The Yarraloola Homestead is approximately 10 km from the proposed mine site. The Red Hill Homestead is approximately 21 km from the nearest point of the proposed southern rail corridor and approximately 36 km from the proposed mine site. The Pannawonica Fire Station is location within Pannawonica town.



Pilbara Iron

Figure 7 Mesa A/Warramboo land use / tenure

Author: FB	Date: January 2006
Drawn: CB/GC	Revised:
Dwg No.: 113949v4_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

3. DESCRIPTION OF PROPOSAL

3.1 KEY CHARACTERISTICS OF PROPOSAL

The proponent currently operates the Mesa J iron ore mine 15 km south west of Pannawonica town. The mine currently produces pisolite ore at a rate of 32 Mtpa, which is railed approximately 200 km to the port at Cape Lambert. Production from Mesa J will begin to decline in 2008, with active mining scheduled to cease in 2010. At that time wet processing of stockpiled sub-grade ore will continue at Mesa J for a further five years at a rate of 7 Mtpa. In order to maintain its current production rate, the proponent proposes to develop its Mesa A/Warramboo resources by 2008, to produce primary sized pisolite ore at a rate of 25 Mtpa.

Mesa A is located approximately 38 km north-west of Mesa J and 43 km west of Pannawonica. Warramboo is located immediately west of Mesa A on the western side of the North West Coastal Highway.

The new operation may utilise existing infrastructure and services associated with the Mesa J operation, however there will be a requirement to construct new infrastructure to service the Mesa A and Warramboo mines. The key components of the Mesa A /Warramboo mines are summarised below, with a more detailed description in Section 3.3:

- single open cut pit at Mesa A with associated Run of Mine (ROM) and sub-grade ore stockpiles, waste dumps, and drainage management structures; selected progressive backfilling of mine pit where practicable
- single shallow open cut pit at Warramboo with associated ROM ore stockpile and waste dumps, creek diversion, flood protection levees and other drainage management structures; selected progressive backfilling of mine pit where practicable
- unsealed haul road for transport of ore from Warramboo to Mesa A with construction of an overpass to carry the North West Coastal Highway
- new facility to transport primary sized ore from Mesa A to Cape Lambert, including new crossings of either the Robe River or Mungarathoona Creek; transport options are:
    - new sealed road located mainly to the north of the Robe River from Mesa A to Mesa J followed by rail to Cape Lambert on the existing rail line
    - new rail line located mainly to the north of the Robe River from Mesa A to north east of Mesa J linking to the existing rail line to Cape Lambert
    - new sealed road located to the south of the Robe River from Mesa A to Mesa J followed by rail to Cape Lambert on the existing rail line, or
    - new rail line located to the south of the Robe River from Mesa A to south east of Mesa J linking to the existing rail line to Cape Lambert
- ROM bin with primary sizer to be constructed at Mesa A. Secondary and tertiary crushing and screening will be conducted at Cape Lambert using existing facilities
- new wellfield and associated pipeline to Mesa A/Warramboo to supply 1.5 GL/yr water to the operation; the preferred option for the wellfield is the Warramboo aquifer

- support infrastructure including; administration buildings, workshop, hydrocarbon storage facility, waste water treatment, sewage treatment, landfill, accommodation.

The key characteristics of the proposal are listed in Table 1 and shown in Figure 8. Locations and layout of proposed infrastructure, stockpiles, waste dumps and bunds may change during detailed design.

Table 1 Key characteristics of the Mesa A/Warramboo proposal

Component	Project characteristic	Detail
General	Project life	About 10 years
	Ore deposit	Approximately 270 Mt high grade ore
	Ore production rate	Approximately 25 Mtpa
Clearing of native vegetation	Area of disturbance	2870 ha
Mine and mining	Ore type	Pisolite
	Ore location	Ore above watertable
	Stripping ratio	0.4:1 (waste:ore)
	Waste rock disposal	Out of pit waste rock dumps Selected progressive backfilling of mine pit where practicable
Processing	Primary sizer	Primary sizer located at Mesa A
Product transport	Product transport	By road from Warramboo to Mesa A minesite, then options from Mesa A to Cape Lambert are; • rail directly to Cape Lambert; • road train to Mesa J then rail to Cape Lambert.
Workforce	Workforce	Total operational personnel 250, with approximately 150 personnel at Mesa A during operation and an additional 100 personnel at Mesa J Approximate peak workforce during construction and shutdown of 650 personnel
	Accommodation	Camps near Mesa A and the transport corridor during construction Existing and upgraded accommodation in Pannawonica or fly-in fly-out to a residential village, near Mesa A or between Mesa A and Mesa J during operation

Abbreviations
Mt million tonnes
Mtpa million tonnes per annum
ha hectares

3.2 DESCRIPTION OF RESOURCE

The deposit lies approximately 38 km north-west of the existing operation at Mesa J and straddles the North West Coastal Highway.

Mineable reserves total 270 Mt, with approximately 100 Mt of mixed pisolite sub-grade (process) ore. The waste:ore ratio is predicted to be 0.4:1 across both operations, with an estimated 75 Mt of waste material to be mined at Mesa A and 24 Mt at Warramboo. Approximately 8 Mt of overburden will be removed progressively at Mesa A and 3.5 Mt at Warramboo, as the area of active mining in each operation advances over the mine life.

The Mesa A deposit consists of two main horizons of interest; the upper pisolite (high grade, run of mine (ROM) ore), and the mixed pisolite (sub-grade ore) which also includes the lower pisolite (a lens of high grade ROM pisolite). Mining will occur in the top horizon only (upper pisolite). Mining and processing of sub-grade material is not part of the scope of this proposal. All mining is above the watertable.

The Warramboo deposit consists of one horizon of interest, the upper pisolite (ROM ore).

Mining at the two sites is not expected to present any geotechnical difficulties; this is largely due to the simple flat-lying stratigraphy, inferred competence of materials and the relatively shallow depth of mining.

The geology comprises Tertiary Robe Pisolite, which exists as thin sheets filling the palaeochannel where erosion has not reached the total depth of the original river channel. The deposit is predominantly goethitic, with oolitic textures and fragments of fossil wood. The mesa escarpment comprises semi-hardcapped pisolite, and has little pisolite texture preserved. Irregular patches/lenses of clay are prevalent through the sub-grade ore, and also occur in minor amounts through the upper (ROM) pisolite. Vugs and cavities occur throughout the pisolite, with the majoritiy of larger cavities occurring within the sub-grade ore.

The pisolite overlies Proterozoic shales (Ashburton Formation) at Mesa A, and Mesozoic conglomerate (Yarraloola Conglomerate) at Warramboo.

Given the age of the deposit (Tertiary) no significant through-going geological structures have been observed or are anticipated. It is expected that material properties at Mesa A/Warramboo will be much the same as those already being mined at Mesa J.

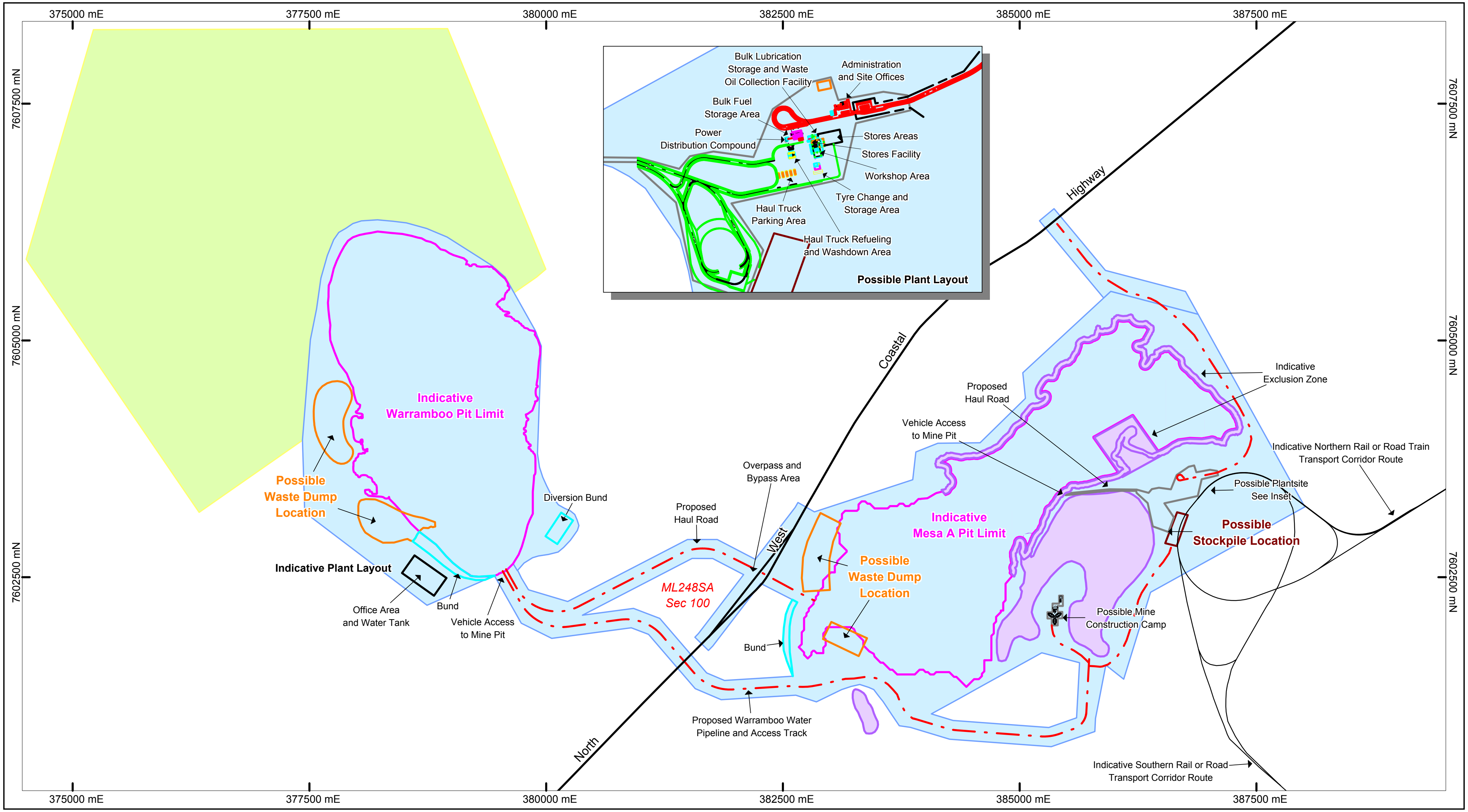
All of the proposed mining will be above the water table, although due to the porous nature of the pisolite, it is expected that localised pockets of water may exist within voids.

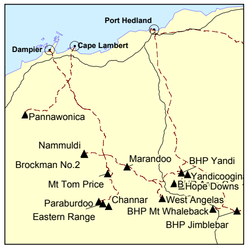
3.3 DESCRIPTION OF MINING, PROCESSING AND ORE TRANSPORTATION OPERATIONS

The approximate area of disturbance for each major component of the proposal is shown in Table 2. These estimates are based on preliminary designs and may change during detailed design work.

Table 2 Preliminary estimates of areas of disturbance of vegetation

Project component	Approximate area of disturbance (ha)
Pits, haul roads, stockpiles and waste dumps	2250
Transport corridor, borrow pits and rail construction camp (if required)	Up to 600
Other (access roads, wellfields and pipelines)	20
Total	**2870**





Mine Footprint

Proposed Borefield Area

Exclusion Zone

N

1000 0 1000 2000 3000

metres

Pilbara Iron

Figure 8 Mesa A/Warramboo Conceptual Mine Site Layout

Author: FB	Date: November 2005
Drawn: CB/GC	Revised:
Dwg No.: 113949v5	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

3.3.1 Site preparation

Construction is scheduled to begin Q2 2007, with pre-stripping activities starting Q2 2008 and commissioning in Q4 2008.

Removal of overburden

Prior to mining activities overburden will be removed to allow access to the ore as part of the initial stages of pit development. Overburden includes soils and subsurface material which may be sub-grade ore or waste. Only topsoil is removed from areas used for laydown, infrastructure construction or borrow pits.

Soils are an important resource for use in rehabilitation, and as such will be temporarily stockpiled separate from sub-surface materials. Sub-grade ore will be transferred to temporary stockpiles, for potential recovery and processing in the future. Initially waste rock material will be directed to permanent waste dumps and thereafter will be used in progressive backfilling of mine pits and directed to permanent waste dumps.

Removal of overburden soils is conducted progressively over the life of the mine to allow the direct placement of soils onto rehabilitated areas during the development of later stages of the operation. To maintain the value of soils for use in rehabilitation, all topsoil and subsoil that has been removed is stored according to the Robe's Procedure for Soil Resource Management.

Topsoils will be bulldozed into windrows to allow the subsoils beneath to be removed. Where possible subsoils and then topsoils will be transferred directly to newly shaped areas which are being rehabilitated. If direct placement of soils is not possible they are stockpiled, for use in future rehabilitation. Topsoil storage is conducted in a manner that avoids compaction of the topsoil, facilitates drainage and encourages revegetation to reduce the risk of erosion and to maintain an active population of soil microbes.

Following the removal of soils, any remaining overburden will be removed and transferred to permanent above ground dumps. Overburden at Mesa A/Warramboo is expected to be up to a depth of 4 m, with an average thickness of 2 m at Mesa A and less than 500 mm at Warramboo.

Diversion of creek lines

The proposed Warramboo pit outline intersects a number of minor creeks in the Warramboo Creek catchment. It is likely that a diversion bund will be used to divert water around the pit. If necessary a diversion channel will be installed.

3.3.2 Mining operations

A mining rate of 25 Mtpa has been selected for Mesa A/Warramboo. This will be supplemented by wet processing of sub-grade stockpiles from the existing Mesa J operation at an average rate of 7 Mtpa to maintain the pisolite delivery rate to Cape Lambert of 32 Mtpa.

Initially mining will be conducted solely at Mesa A where the maximum mining rate is expected to be achieved by year three. Pre-stripping is scheduled to begin at Warramboo in year three and mining is intended to commence immediately thereafter at a rate of up to 10 Mtpa. The mining rate at Mesa A will then be progressively reduced as Warramboo output increases, such that the total pisolite output from the two operations remains at 25 Mtpa.

Mining will involve conventional drill and blast, load and haul with a single open cut pit being developed at each operation.

The Mesa A escarpment will be retained along the north western, north eastern and south eastern sides with mining being carried out behind the escarpment. Operations will be setback from the escarpment, with a minimum mining exclusion zone of 50 m established to protect the Aboriginal heritage and biodiversity values of the Mesa face. Vehicular access to the mine pit will be established through the escarpment at a point between the gully and the larger eastern sand sheet.

Preliminary mine designs indicate that mining will commence in the central area of Mesa A, moving north-east and south-west with several pit faces being active at any one time in order to achieve the required grades. Vertical batters will be to heights of approximately 10 m with bench widths to broadly match the geometry of the deposit. The maximum depth of the Mesa A Pit will be 50 m, while the average depth will be approximately 20 – 25 m.

Mining at Warramboo will be conducted in a single shallow open cut pit, with a maximum depth of 20 m. Mining will begin in the south of the deposit and move progressively northwards throughout the life of the mine.

Table 3 shows the indicative mine development schedule subject to final design. This sequence of extraction allows production rate and grade criteria to be met, whilst removing the requirement for long-term stockpiling and allowing a practical and orderly method of pit backfilling.

Table 3 Location and indicative timing of pit development

Stage	Pit	Area	Year starts	Year ends
1	Mesa A Pit 1	Central	0	3
2	Mesa A Pit 2	North – east of Mesa A	5	10
3	Mesa A Pit 3	South – west of Mesa A	3	8
4	Mesa A Pit 4	Southern end of Mesa A	5	10
6	Warramboo	Southern area	3	5
6	Warramboo	Eastern area	4	8
7	Warramboo	Western area	5	10
8	Warramboo	Northern area	8	10

Mineral waste dumps

The predicted stripping ratio for both Mesa A and Warramboo is expected to be 0.4:1 (waste:ore). Grade variation within the orebodies will require that sub-grade and waste rock be placed in above ground dumps at Mesa A. Waste rock will then be used to progressively backfill sections of both Mesa A and Warramboo as far as practicable without sterilising the resource.

Some above ground dumps will be positioned to restrict public access to site and to provide a visual barrier from the North West Coastal Highway. The outer toes of dumps will be established early in the mine life and rehabilitation of these waste dumps will commence within three years of the commencement of mining to reduce their visual impact, minimise dust emissions and to promote stability. Above ground dumps will be constructed in accordance with Robe’s Waste Dump Design Guidelines, which stipulate key design principles, including:

- construction to meet the requirements of the final rehabilitation design

- inclusion of drainage and erosion management features (perimeter bunding, shaping and rock armouring of drainage convergences, installation of wide drainage berms, consideration of material type in selection of slope gradient and length)
- minimisation of dump height
- shaping of the dump to blend with the surrounding natural topography.

Blasting

Periodic interruptions to traffic using the North West Coastal Highway will be required during operation, to allow blasting to be conducted in the vicinity of the road and to allow the movement of some heavy equipment from Warramboo to Mesa A. It is estimated that closure of the highway to allow blasting will occur for approximately 0.5 hours, on average once a week over a period of several months during years 4 and 5 of the operation.

Robe has initiated consultation with Main Roads of Western Australia regarding this aspect of the proposal.

Wet ore processing

The Mesa A and Warramboo resources contain an estimated 100 Mt of mixed pisolite (sub-grade ore). This proposal does not include the option for wet processing facilities for treatment of this ore. A separate application for wet processing facilities will be submitted should they be required.

3.3.3 Ore handling and transportation

Run of Mine ore will be transported a distance of 7 km from Warramboo to Mesa A by haul trucks or road trains on internal mine haulroads. Ore will then be primary sized and transported either via road train from Mesa A to Mesa J then via rail to Cape Lambert, or directly by rail from Mesa A to Cape Lambert.

Warramboo to Mesa A

Section 12.4.4 contains a conceptual view of the proposed overpass to facilitate the transportation of ore from Warramboo to Mesa A, Robe proposes to construct an overpass on the North West Coastal Highway to allow the mine haul road to pass under the highway.

Mesa A to Cape Lambert

The area between Mesa A and Mesa J is relatively flat except for the presence of mesas and remnants of cliffs. Three routes for the transport corridor are being considered as part of the current feasibility study (Figure 9):

- **northern road route** (43 km): the road would extend from Mesa A in the west, cross to the north of the Robe River and run eastwards for approximately 30 km before re-crossing to the south of the river to reach Mesa J. This option would involve the construction of a levee bank between Mesas B and C, construction of a river crossing approximately 7 km east of Mesa A and construction of two river crossings immediately north-west of Mesa J, and four minor creek crossings in its eastern half. The majority of the route would be fenced and the haul road would be sealed. It is likely that 2 m high chain mesh fencing would be used.

- **northern rail route** (39 km): the rail would follow a similar route to the northern road route, to a point north-west of the Mesa J operation. The rail route would then continue eastwards and would be connected to the existing Mesa J/Cape Lambert rail line at a location to the north-east of Mesa J. This route would involve the construction of a levee bank between Mesas B and C and construction of a single river crossing approximately 7 km east of Mesa A and four minor creek crossings in its eastern half.
- **southern road/rail route** (45 km): the southern transport corridor would be developed as either a road or a rail option. The corridor extends south-eastwards from Mesa A and then approximately eastwards for 25 km. The corridor would extend around the southern edge of the Mesa J operation and then connect to the existing rail line to Cape Lambert. This route would necessitate a cut through Mesa F and the crossing of the major Mungarathoona Creek, which flows northwards into Robe River, and several minor creeks in its eastern half. If the road option were selected the majority of the route would be fenced and the haul road would be sealed. It is likely that 2 m high chain mesh fencing would be used.

All of the above transport corridor options would necessitate the crossing of the Goldfield Gas Transmission Mainline which extends approximately north-south across the broad project area.

The environmental issues associated with each option have been assessed for the purposes of this proposal and these are described in Part 4, Sections 18 to 25.

Option 1: Road train from Mesa A to Mesa J, rail to Cape Lambert

If one of the road train options is selected, it is anticipated that road trains would consist of between five and seven trailers. At a production rate of 25 Mtpa it is estimated that a maximum of 250 road train trips per day would be required to transport ore from Mesa A to Mesa J. Road trains would either be manned or operated autonomously.

Ore from the Warramboo and Mesa A pits would be hauled to the Mesa A ROM pad, where it would be tipped into the primary ROM receiving bin. An apron feeder would then feed the ore into the primary sizer or place it onto a temporary ROM stockpile. After passing through the sizer, the crushed ore would be placed onto a crushed ore stockpile prior to loading onto the road train. Upon arrival at Mesa J the ore would be dumped directly into a hopper and transferred to the existing train loading system by conveyor. Once loaded into rail cars the ore would be transported directly to port facilities at Cape Lambert via the existing railway. This option would require the construction of;

- sizing, stockpiling, loading and turning facilities at Mesa A
- sealed haulroad from Mesa A to Mesa J
- unsealed service road parallel to the haulroad
- fencing of the majority of the transport route from Mesa A to J
- construction of a levee bank between Mesas B and C (northern route only)
- removal of some material from the southern end of the Mesa B escarpment (northern route only)
- cut through Mesa F (southern route only)
- river crossings at two locations (northern route only)
- major creek crossing at one location (southern route only)
- numerous minor creek crossings (northern and southern route)

- transfer facilities at Mesa J.

An 80 m wide corridor would be required to accommodate the haulroad and service road. Additional clearing would be required at intervals along the length of the corridor to excavate borrow pits for construction of the roads.

Construction of the northern road train transport corridor will result in an estimated 680,000 m^3 of cut material which is unsuitable for use as fill. Construction of the southern road train transport corridor is likely to result in a greater volume of material which is unsuitable for fill. Estimates of the volume of unsuitable material may change during detailed design. Unsuitable material will be used to backfill borrow pits or will be laid out to blend with existing hillsides and rehabilitated.

Option 2: Rail from Mesa A to Cape Lambert

Should the rail option be selected it is expected that approximately five trains per day would be required to transport ore from Mesa A at a production rate of 25 Mtpa. Ore from the Warramboo and Mesa A pits would be hauled to the Mesa A ROM pad, where it would be tipped into the primary ROM receiving bin. An apron feeder would then feed the ore into the primary sizer or place it onto a temporary ROM stockpile. Sized ore would be stockpiled or held in a bin prior to loading into rail cars for transportation. The rail option would require the construction of:

Existing rail infrastructure

- rail loop and loading facilities at Mesa A
- rail line from Mesa A to connect to the existing line north east of Mesa J (northern route only)
- rail line from Mesa A to connect to the existing line at the southern end of Mesa J (southern route only)
- unsealed service road parallel to the rail
- construction of a levee bank between Mesas B and C (northern route only)
- removal of some material from the southern end of the Mesa B escarpment (northern route only)
- cut through Mesa F (southern route only)
- river crossing at one location (northern route only)
- major creek crossing at one location (southern route only)
- numerous minor creek crossings (northern and southern route)
- a passing loop at the 204 km mark or a siding extension at Murray Camp.

A corridor of approximately 80 m in width will be required to accommodate the rail and service road in areas where little cut and fill is required. A greater corridor width will be required in areas where significant cut and fill is required. Additional clearing will be required at intervals to excavate borrow pits along the length of the corridor for construction of the rail and road.

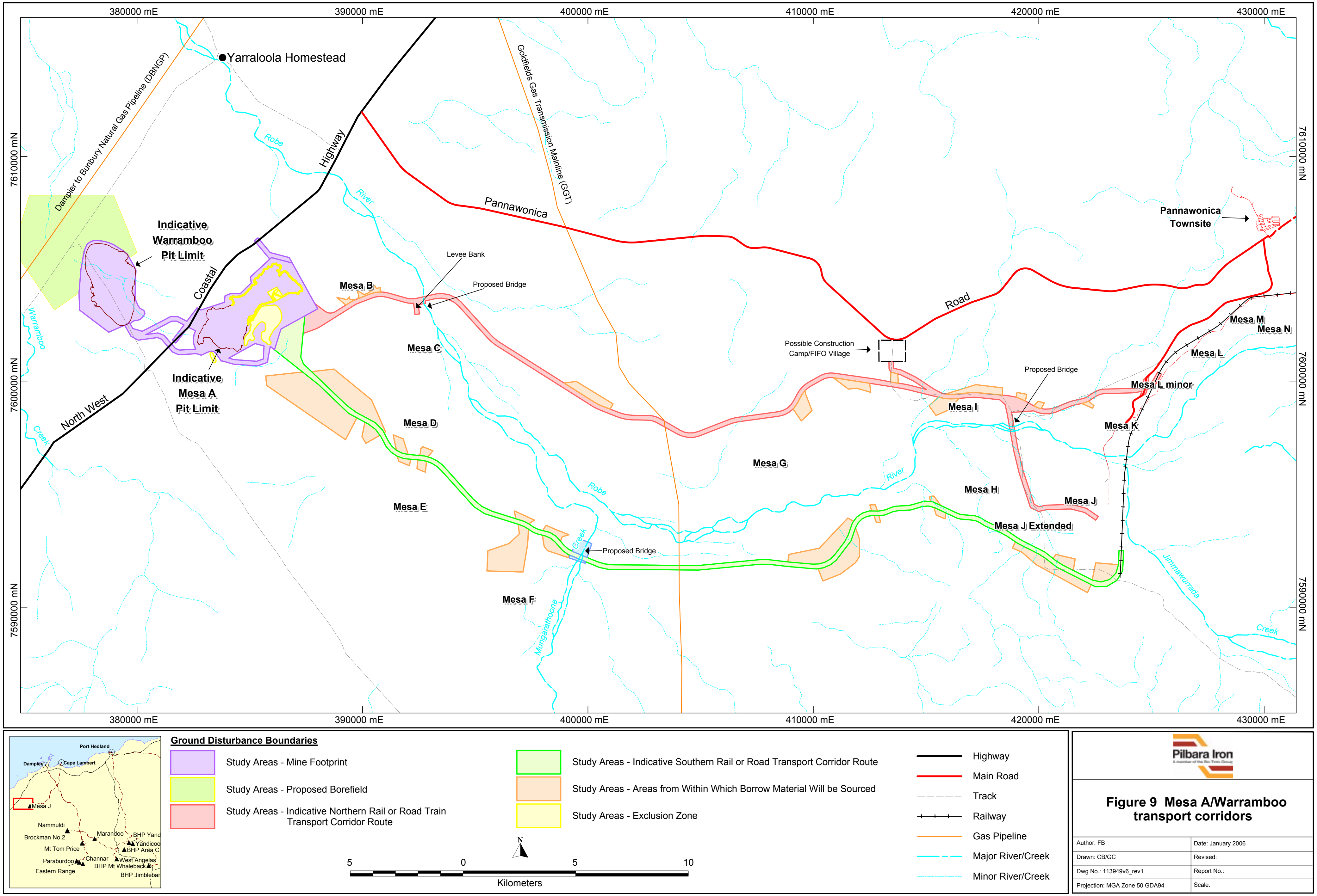


Figure 9 Mesa A/Warramboo transport corridors

Author: FB	Date: January 2006
Drawn: CB/GC	Revised:
Dwg No.: 113949v6_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

The construction of any of the transport corridors will require the development of borrow pits at intervals along the length of the corridor. The location and frequency of these will be dependent on the transport route and method selected.

Construction of the northern rail transport corridor will result in an estimated 450,000 m^3 of cut material which is unsuitable for use as fill. Construction of the southern rail transport corridor is likley to result in a greater volume of material which is unsuitable for fill. Estimates of the volume of unsuitable material may change during detailed design. Unsuitable material will be used to backfill borrow pits or will be laid out to blend with existing hillsides and rehabilitated.

3.3.4 Support infrastructure and consumables

The Mesa A /Warramboo development will require a number of support facilities and the provision of a variety of consumables during the life of the mine. Where possible existing facilities and services in use at Mesa J will be modified or extended to accommodate the requirements of the new operations, however new facilities will also need to be constructed. The proposed arrangements for support services, facilities and provision of consumables are described in the following sections.

Water supply and use

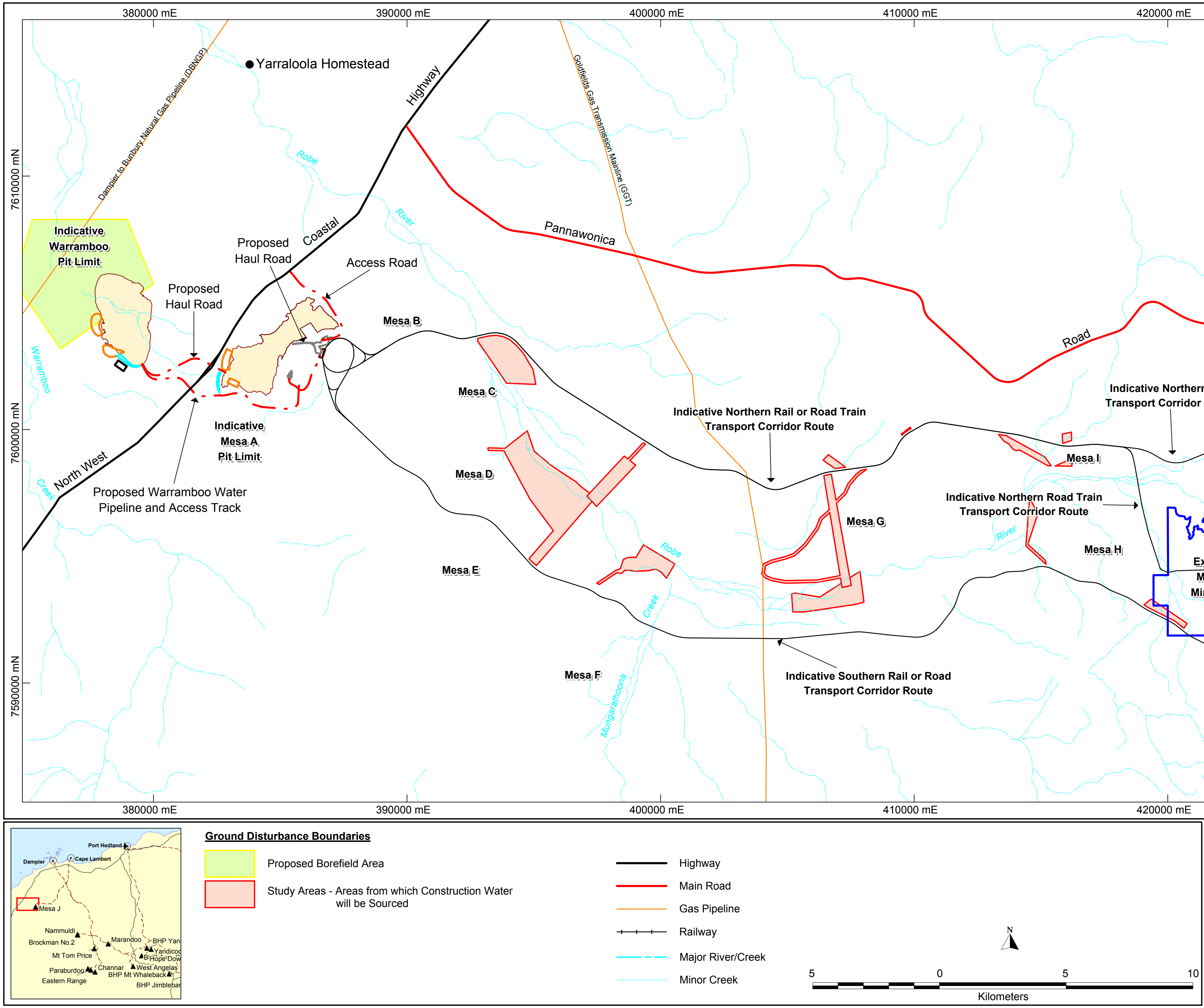
Approximately 1.5 GL/yr of water will be required for potable use on site and for dust suppression within the proposed mining areas. A breakdown of water use based on preliminary estimates is as follows:

- maximum requirement for control of ore moisture content: approximately 820 ML/yr
- dust suppression: approximately 420 ML/yr
- plant and vehicle washdowns: approximately 80 ML/yr
- potable water supply: approximately 180 ML/yr.

Water will be sourced from the deep Warramboo aquifer (Yarraloola Conglomerate), an option which was selected following detailed hydrogeological assessment during the Pre-feasibility study. Detailed design of the borefield will be undertaken during the Feasibility Study. The proposed borefield will consist of approximately ten bores which will be located within the mine footprint and the proposed borefield area (Section 14).

A water supply pipeline will be required to transfer water from the wellfield to Mesa A. Pumps, tanks and water treatment facilities will also be required at Mesa A and Warramboo.

Water for use during construction will be supplied from the Warramboo aquifer and from wells which will be constructed close to the chosen ore transport corridor (Figure 10). It is estimated that approximately 2000 kL/day will be required during construction. Water abstraction from the Robe River alluvium will occur for a period of approximately 18 months during construction. Thereafter water abstraction from the Robe River alluvium will reduce to that required for maintenance activities and for the possible fly-in fly-out village between Mesa A and Mesa J. Water requirement for the fly-in fly-out village is anticipated to be in the order of 5-6 ML/yr. Water abstraction from the Robe River alluvium will be subject to any licence issued under the *Rights in Water and Irrigation Act 1914*.



Pilbara Iron
A member of the Rio Tinto Group

Figure 10 Mesa A Warramboo Potential water source areas

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Drawn: CB/GC	Revised:
Dwg No.: 113949v6	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

Consumables

The proposed project involves the mining, primary sizing and transportation of ore. Secondary and tertiary crushing and screening will be conducted using existing facilities at Cape Lambert. As this proposal does not include beneficiation of ore there is no requirement for large scale usage of reagents and therefore the major consumables are electrical energy, diesel and explosives (ANFO) as listed in Table 4.

Table 4 Projected annual average uses of major consumables

Consumable	Unit	Quantity	Source
Electrical energy	GWh/a	18	On-site diesel generators at Mesa A and Warramboo
Diesel for power generation	kL/a	5500	Supplied by Robe via road from Dampier or Cape Lambert
Diesel for mining	kL/a	15,200	Supplied by Robe via road from Dampier or Cape Lambert
Diesel for road haulage [a]	kL/a	6300	Supplied by Robe via road from Dampier or Cape Lambert
Explosives (ANFO)	t/a	15,000	Transported via road from facilities used by the existing Mesa J operation

[a] diesel consumption is dependent on the selection of road train haulage of ROM ore between Mesa A and Mesa J

Power supply

The annual power requirement for Mesa A/Warramboo is estimated to be approximately 18 GWh/a. Electrical power will be generated by on-site diesel generators at Mesa A and Warramboo with an installed capacity of 5 MW.

Power will be required primarily for primary sizing at Mesa A, but will also supply the support facilities (e.g. offices, workshops) at both Mesa A and Warramboo. Additional diesel generators of a smaller capacity will be required for any camps/villages that are established.

Fuel storage

Fuel will be supplied to the Mesa A/Warramboo operations along the North West Coastal Highway from either Dampier or Cape Lambert. Deliveries will be made approximately every two days to a new bulk fuel storage facility which will be constructed at Mesa A. This facility will have an approximate capacity of up to 600 kL and will be used to supply diesel to the mining fleets for both mining areas and to road trains or rail transporting ore from Mesa A.

Diesel will be stored and handled in accordance with the appropriate Australian Standards. New facilities that will be constructed at Mesa A are:

- 600 kL above-ground diesel storage facility
- separate refuelling facilities for heavy vehicles, road trains and light vehicles incorporating hardstanding with perimeter bunding and spill collection and containment
- electronic tank stock management control and fuel issue systems
- above ground pipework
- clean stormwater diversion
- contaminated water collection and treatment facilities.

In-pit facilities will be provided at Mesa A and Warramboo for refuelling of track-mounted equipment (excavators, dozers, drill rigs).

Explosives transport and storage

Ammonium nitrate will be stored at the existing facilities used by the Mesa J operation. The projected annual usage of ANFO is approximately 15,000 t which will be transported by licensed vehicles along the (public) Pannawonica Road at a rate of approximately five trucks per week.

Non-mineral waste

Sewage treatment plants will be established adjacent to the construction camps, office areas and any permanent mine village. Clean effluent (water) will be discharged via reticulation to garden/lawn areas where practicable. Sewage treatment facilities will be registered or licensed if required.

Operation of a permanent mine village would require a landfill facility near Mesa A for the disposal of putrescible and inert waste. The potential location of a landfill facility, if required, will be determined during detailed engineering design. The landfill will be registered or licensed as required.

Communications

Fibre optic cabling will be installed in the selected transport corridor as part of the communication infrastructure.

If the rail transport option is selected the cable would most likely be buried between the rail line and the service road, and for the road option cabling would be laid adjacent to the road within the road reserve. The cable would typically be laid towards the end of the earthworks required for construction of the transport facilities and would not necessitate additional clearing of vegetation.

Other facilities

New facilities will be required for vehicle wash down and maintenance, administration, warehousing and materials laydown and traffic management. These will be constructed mainly at Mesa A with some duplication of administration facilitites at Warramboo (Figure 8).

Table 5 Proposed support facilities

Area	Indicative facilities included
Mesa A	
Administration facilitiy	Offices, crib room, first aid post, ablution block, parking
Maintenance facility	Heavy equipment workshop, fabrication/tooling and warehouse, bulk lubricant and waste oil handling and storage, hardstanding (with contained drainage)
Washdown facilities	Heavy and light vehicle pads with water collection and settling sumps, decontamination and oily water separation plant
Tyre management facility	Jacking pad and new tyre storage area
Warramboo	
Administration Facilities	Offices, crib room, ablution block

3.3.5 Workforce and accommodation

A transport construction camp will be required during the construction of the selected transport corridor between Mesa A and Mesa J (rail or road). A separate construction camp will be located near Mesa A during construction of the mine. Personnel will access the camps by road from Pannawonica and Karratha. A maximum of approximately 650 people will be accommodated in the two camps (approximately 200 people at Mesa A and approximately 450 people in the transport corridor construction camp).

The permanent workforce for Mesa A/Warramboo will comprise approximately 250 personnel. Two options are under consideration for accommodation of the permanent workforce, these are:

1. Fly-in fly-out on a roster to a residential village near Mesa A or between Mesa A and Mesa J.
2. Bus-in-bus-out on a daily basis from permanent accommodation in Pannawonica.

The mine construction camp/permanent village may be located at Mesa A (Figure 8). The transport corridor construction camp/permanent village may be located between Mesa A and Mesa J (Figure 9). Further studies are required before a decision regarding accommodation can be made.

3.3.6 Cape Lambert

Operation of the Mesa A/Warramboo mine is designed to supplement production from the Mesa J operation so that the throughput at Cape Lambert remains at current levels. The proposal therefore does not require additional processing or handling facilities at the port.

Stacker-reclaimer at Cape Lambert

In May 2006 Robe referred a proposal to the EPA under Part IV of the EP Act to carry out a substantial upgrade to the facilities at Cape Lambert. Included in that proposal were modifications to improve the management of dust that may be generated through the handling of Mesa A/Warramboo ore. Upgrades will be made to the dust extraction systems at Car Dumper 1, the Pisolite Plant and the Coarse Ore 2 Tripper.

Robe will continue to manage dust at Cape Lambert in accordance with the Cape Lambert Dust Management Strategy through the use of dust control methods such as water sprays, wet scrubbers, water cannons, dust suppressants and the road sweeper.

PART 2 ENVIRONMENTAL IMPACT ASSESSMENT APPROACH, SUSTAINABILITY AND ASSESSMENT OF PROJECT-WIDE ENVIRONMENTAL FACTORS

4. STAKEHOLDER CONSULTATION

4.1 IDENTIFICATION OF STAKEHOLDERS

Key stakeholders identified and consulted during the preparation of the PER were:

Government agencies

- Environmental Protection Authority Service Unit (EPASU)
- Department of Environment (DoE)[3] – Northwest regional office (Karratha) and Perth office
- Department of Conservation and Land Management (CALM)[3] – Pilbara regional office (Karratha) and Perth office
- Department of Industry and Resources (DoIR)
- Department of Indigenous Affairs (DIA)
- Main Roads Western Australia
- Western Australian Museum
- Conservation Commission.

Non-government organisations

- Pilbara Native Title Service (PNTS) and Native Title Claimant Group
- Kuruma Marthundunera Working Group
- Conservation Council
- Wildflower Society
- Agility.

Local Government

- Shire of Ashburton.

Community

- Yarraloola Pastoral Station
- Point Samson community.

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[3] As of 1 July 2006 the Department of Environment and Conservation (Western Australia) (DEC) was formed by merging the Department of Environment and the Department of Conservation and Land Management.

4.2 FORM AND TIMING OF CONSULTATION

Robe initiated a stakeholder consultation program for the Mesa A/Warramboo project towards the end of 2004, prior to the submission of the environmental referral of the project to the Environmental Protection Authority Service Unit (EPASU) in May 2005. The timing of the consultation program enabled the issues raised to be taken into account in the design of the project and preparation of the PER. A summary of the consultation program is contained in Table 6.

Table 6 Summary of consultation undertaken to date

Date	Stakeholder	Purpose
6 May 2004	Native Title Claimant Group	Working Group meeting to choose negotiation team
7, 8 Septmeber 2004	Native Title Claimant Group	Commercial agreement meeting
9, 10 September 2004	PNTS and Native Title Claimant Group	Site tour of Mesa A, J & Bungaroo Valley
28, 29 October 2004	Native Title Claimant Group	Commercial agreement negotiation/information session
29 November 2004	Native Title Claimant Group	Commercial agreement negotiation/information session
8 December 2004	EPASU	General overview of Mesa A project
14 December 2004	DIA	Land Title and section 18 process
12 January 2005	PNTS and Native Title Claimant Group	Survey request of Mesa A-J rail project
21 January 2005	DoE (Karratha) CALM (Karratha)	General overview of Mesa A project
6 February 2005	PNTS & Native Title Claimant Group	Survey request of Mesa A/ Warramboo project
9 February 2005	DoE (Perth)	Proposal to investigate the Robe River alluvium as a potential water supply
13 February 2005	PNTS & Native Title Claimant Group	Fly-over of Mesa A-J rail proposed route
14 February 2005	Kuruma Marthundunera Working Group	General overview of Mesa A project and discussion of survey request
16 February 2005	DoE (Karratha)	Proposal to investigate the Robe River alluvium as a potential water supply
21 February 2005	CALM (Karratha)	General overview of Mesa A project Proposal to investigate the Robe River alluvium as a potential water supply
10 March 2005	EPASU	Inclusion of Warramboo Discussion of troglobitic fauna, landscape and geodiversity assessment and potential water resources
17, 18 March 2005	Native Title Claimant Group	Commercial agreement negotiation/information session
21 March 2005	PNTS	General overview of all proposals linked to Mesa A/ Warramboo project
13 May 2005	EPASU	Update on progress of investigations Discussion of geodiversity and landscape assessment study
27 June 2005	CALM (Karratha)	General overview of progress Current status of troglofauna sampling and identification Conservation status of sandsheet vegetation community

Date	Stakeholder	Purpose
21 July 2005	DoIR	Discussion of troglofauna
9 August 2005	Native Title Claimant Group	Informal discussion with some Kuruma Marthundunera members re negotiations
10 August 2005	CALM (Karratha)	Current troglofauna taxonomic work being undertaken Discussion of offsets – preliminary ideas (e.g. quarantine of troglofauna)
29 August 2005	Native Title Claimant Group	Informal discussion with some Kuruma Marthundunera members re negotiations
12 September 2005	DoE (Karratha) CALM (Karratha)	Update on troglofauna sampling and identification program Revision of infrastructure layout to avoid sand sheet Northern Quoll survey Visual impacts Greenhouse gas emissions
27 September 2005	DoE (Perth)	Discussion of fauna survey work
28 September 2005	Point Samson community	Overview of project Dust upgrades and dust modelling at Cape Lambert
17 October 2005	DoE (Perth)	Overview of groundwater situation at Mesa A and Warramboo
18 October 2005	Wildflower Society	Telephone briefing of the project
19 October 2005	Native Title Claimant Group	Commercial agreement negotiation/information session
21 October 2005	Shire of Ashburton	Project briefing as part of regular meetings with the Shire
27 October 2005	Yarraloola Station	Stock movement requirements and access across the proposed northern transport corridor
27 October 2005	Main Roads	Overview of project Requirement for North West Coastal Highway to go over the mine haul road The need to stop traffic on the highway from time to time to allow large equipment to cross that is too large for the underpass
10 November 2005	Native Title Claimant Group	Informal discussion with some Kuruma Marthundunera members re negotiations
14 November 2005	CALM (Karratha) DoE (Karratha)	Water supply – findings of drilling at Warramboo and modelling at Yarraloola Lighting along transport corridor
21 November 2005	Native Title Claimant Group	Information session with majority of K&M community members - Employment/Training/Community Development/Heritage presentations
22 November 2005	Conservation Council	Overview of project Landscape – retention of escarpment Results of trologfauna studies Discussion of sand sheet vegetation and the Northern Quoll
4 January 2006	Conservation Commission	Overview of project Landscape – retention of escarpment Results of trologfauna studies Discussion of sand sheet vegetation and the Northern Quoll
30 January 2006	Native Title Claimant Group	Informal discussion with some Kuruma Marthundunera members re negotiations
7 February 2006	Agility	Overview of project
7 February 2006	DoE (Perth) EPASU	Discussion of flora and fauna survey results

Date	Stakeholder	Purpose
5 April 2006	DoE (Perth) EPASU CALM (Perth) Western Australian Museum (WAM)	Troglofauna sampling, mitigation and management
11 May 2006	CALM	Discussion of draft PER
19 June 2006	Department of Water (DoW)	Water use and management
11 July 2006	EPASU	Discussion of draft PER Troglofauna mitigation and management
14 July 2006	EPASU	Discussion of draft PER Troglofauna mitigation and management

4.3 STAKEHOLDER COMMENTS AND RESPONSES OF PROPONENT

The main issues raised by stakeholders related to sourcing water, flora and fauna (terrestrial and subterranean) impacts, retention of important features of the landscape and Aboriginal heritage. Table 7 summarises those issues raised by stakeholders during consultation sessions and Robe's responses to these issues. The issues raised by stakeholders have been addressed in this PER, and specifically, the following studies investigated key areas of concern:

- **Terrestrial vegetation and flora studies** to assess potential impacts on the conservation status of those species known or likely to occur in the project area (Biota 2005a, 2006a, 2006b).
- **Terrestrial and subterranean fauna (including short-range endemics, troglobites and stygofauna) studies** to assess the potential impacts on the conservation status of those species known or likely to occur in the project area (Biota 2005b, 2005c, 2005d, 2006a, 2006c, 2006d, 2006f).
- **Hydrogeological studies** to investigate potential water supply options, water supply potential and the possible impacts related to the use of the water resources (Aquaterra 2005a, 2005b).
- **Landscape and geodiversity studies** to assess potential impacts on the landscape and geodiversity values of the project area (John Cleary Planning 2005).
- **Aboriginal heritage studies,** in close consultation with the Kuruma Marthudunera, investigating the presence and significance of Aboriginal heritage features of the Mesa A/ Warramboo project area (Wood and Westell 2003, 2005 and Stevens 2003, 2004a, 2004b, 2005).

The above mentioned flora, fauna, hydrogeological, and landscape and geodiversity studies are contained in Appendix 2.

Table 7 Key issues raised during consultation specific to the Mesa A/ Warramboo project

Stakeholder	Key issues	Responses
Government agencies		
EPA Service Unit	Must include study of short range endemics.	See PER Sections 10, 11, 19 and 20.
	Ensure fauna studies include snails and bats.	See PER Sections 10 and 19.
	Drainage shadow issues from transport corridor must be addressed.	Robe has committed to design the drainage for the transport corridor on advice of CALM to minimise the disturbance to natural surface water flows and reduce drainage shadow effects.
	Closure strategy will be required.	See PER Sections 17 and 25.
	Formal description of troglofauna not necessary however need to be able to identify each specimen to species level for all specimens collected.	See PER Sections 11 and 20.
	Stygofauna possible in Robe River alluvium.	The Warramboo aquifer is now the preferred operational water supply (rather than the Robe River alluvium). Stygofauna sampling in the Robe River alluvium is discussed in PER PER Section 11.
	Must address Aboriginal issues (e.g. general access and bush tucker) if raised.	See PER Sections 16 and 24.
	Must consider intrinsic value of landscapes.	See PER Sections 12 and 21.
	Retention of escarpment faces, need for geodiversity assessment if removal considered.	See PER Sections 12.5 and 21.4.1.
	Need to ensure no increase in issues such as dust at the port.	See PER Sections 3.3.6.
	Mitigation, management and monitoring of troglofauna at Mesa A	See PER Section 11.
Department of Environment (Karratha)	Water Corporation may be investigating developing areas of the Robe River alluvium so Robe should discuss plans for water sources with Water Corporation.	Robe contacted Water Corporation and provided outline of water source investigation in the Yarraloola area. Water Corporation indicated that they did not see any need to further discuss Robe's water exploration/use in the Yarraloola area.
	Need to investigate possible drawdown to river system and the possible impacts to surface expression of groundwater and riparian vegetation.	See PER Section 14.4.3.
	DoE unlikely to accept impact to surface water expression if there are other options available.	See PER Sections 3.3.4 and 14.
	Include indication of environmental management tools that will be used to manage environmental aspects.	See PER Tables S2 and S3 in Executive Summary and Section 26.
	Consideration of cumulative impacts from several mine sites in a locality (e.g. start to look at a geographic perspectives rather than a project by project basis).	The flora and fauna reports place the Mesa A/Warramboo survey data in a regional context. Through study of numerous mesas in the Robe Valley region (many of which won't be affected by the Project) the troglobitic fauna study took a broader geographic perspective. Through study of numerous mesas in the Robe Valley region and other formations in adjacent areas the landscape assessment took a broader geographic perspective. Based on the current data, the Project design recognised that wet processing of sub-grade ore would require a greater volume of water than could be sustainably supplied from currently

Stakeholder	Key issues	Responses
		identified water sources near Mesa A/Warramboo. Wet processing is therefore not part of the current proposal. Robe is, however, examining the possibility of sub-grade processing in a more regional perspective, which includes the possibility of conducting this activity at other mine sites where water is more readily available.
Department of Environment (Perth)	Local impacts of water use from Robe River Alluvial aquifer need to be examined if this is to be used as a water source.	See PER Sections 3.3.4 and 14.
	May not have sufficient alluvium in the Robe River aquifer to south-west of the highway to supply the required volume of water.	See PER Sections 3.3.4 and 14.
	Need to justify choice of transport corridor route selected.	See PER Section 3.3.3.
	Need to demonstrate that groundwater abstraction from the Warramboo aquifer will not dewater the entire aquifer such that it won't recover (i.e. demonstrate that sufficient aquifer thickness will remain to allow recovery).	See PER Section 14.4.
	Need to demonstrate the groundwater abstraction from Warramboo aquifer will not create a long term salinity problem.	Resource is large in comparison to the proposed volume of draw. The area of potential impact is small in comparison to the area of the Carnarvon basin. See PER Section 14.4.
	Mitigation, management and monitoring of troglofauna at Mesa A	See PER Section 11.
CALM (Karratha)	Within and between mesa variability of troglobitic fauna.	See PER Sections 11 and 20.
	Need to examine potential impacts on riparian vegetation, surface water expressions of groundwater and stygofauna.	See PER Sections 9.4, 11.4 and 14.4.
	Need to sample previously disturbed areas for troglofauna as much as possible and to survey previously surveyed holes (to understand temporal and spatial variation).	See PER Sections 11 and 20.
	The full project footprint to be included in the PER (i.e. to include borrow pits etc.).	See PER Section 3.1 and Figure 8.
	Weed management required for entire site but particularly along the transport corridor and sand sheet.	See PER Sections 9.4.3 and 18.4.3.
	If lighting is required for transport corridor, need to minimise impacts on fauna.	It is unlikely that lighting will be required along the transport corridor. Should lighting be required along the transport corridor it will be designed to minimise impacts on fauna.
	If fencing is required, avoid using barbed wire as bats become entangled in it.	Barbed wire will not be used in the Project area unless required by other legislation, in which case efforts will be made to reduce the possibility of fauna becoming entangled in the fencing.
CALM (Perth)	Need to investigate possible drawdown to river system and the possible impacts to surface expression of groundwater and riparian vegetation if the Robe River alluvium as used as the water source for the Project.	See PER Sections 3.3.4 and 14.4.
	CALM unlikely to accept impact to surface water expression if there are other options available for sourcing water.	See PER Sections 3.3.4 and 14.4.
	Need to check for stygofauna in the proposed water source aquifer.	See PER Section 11.4.

Stakeholder	Key issues	Responses
	Mitigation, management and monitoring of troglofauna at Mesa A	See PER Section 11.
Department of Industry and Resources (Perth)	Consider quarantining an area of troglofauna habitat.	See PER Sections 11.5 and 20.4.
Conservation Commission	Troglofauna management plan to consider re-creation of habitat during/post mining.	See PER Sections 11.5 and 20.4.
Department of Water	Additional groundwater pump test work and modelling	See PER Section 14.4.2.
	Potential impacts to be covered under water management plan	See PER Section 14.4.
Non-government organisations		
Conservation Council	Weed management – spraying must occur before seeding.	See PER Sections 9.4.3 and 18.4.3.
	Size and location of FIFO village if required	See PER Sections 3.3.5 and 18.4.1
	Water consumption	See PER Section 3.3.4
	Clarification regarding whether more than one transport option would be developed	Substantial capital investment would be required to construct either a haul road or a rail link between Mesa A and Mesa J due to the grade requirements and other minimum specifications. Due to the substantial capital investment required for either option, Robe intends to construct either a haul road or a rail link between Mesa A and Mesa J.
	Waste dump and stockpile footprint sizes	See PER Sections 3.1, 3.3 and 17.3.1
	Clarification regarding sub-grade processing	See PER Section 3.3.2
Kuruma Marthudunera Working Group	Sensitivity of mesa escarpment faces.	See PER Section 16.4.1.
	Sensitivity of proximity of Northern transport corridor to the Robe River and sites of cultural significance.	See PER Section 16.4.1.
	Effects of groundwater abstraction on water levels within the pools and rock holes of the Robe River.	Water abstraction from the Robe River alluvium will occur for a period of approximately 18 months during construction. Thereafter water abstraction from the Robe River alluvium will reduce to that required for maintenance activities and for the possible fly-in fly-out village between Mesa A and Mesa J. Water abstraction from the Robe River alluvium will be subject to the appropriate licensing approvals under the *Rights in Water and Irrigation Act 1914*. Robe, as part of Pilbara Iron, is currently negotiating a native title agreement with Kuruma Marthudunera representatives regarding all Robe/Pilbara Iron interests within the bounds of the Kuruma Marthudunera claim. Robe has also requested involvement from Kuruma Marthudunera in ethnographic and archaeological surveys of the Project area to assist in the identification of areas of significance. Robe will continue to work with Kuruma Marthudunera to arrive at satisfactory outcomes regarding environmental and Aboriginal heritage concerns.
	Access to water, plants and animals in and near the Project area (food and resource use).	See PER Section 5.2.1.
	Loss of landscape to mining activities (social impact).	See PER Section 16.4.1.
	Noise may drive wildlife away from the area.	See PER Section 6.3.1.

Stakeholder	Key issues	Responses
	Involvement in decision making and implementation of rehabilitation activities.	Robe, as part of Pilbara Iron, is currently negotiating a native title agreement with Kuruma Marthudunera representatives regarding all Robe/Pilbara Iron interests within the bounds of the Kuruma Marthudunera claim. Robe has also requested involvement from Kuruma Marthudunera in ethnographic and archaeological surveys of the Project area to assist in the identification of areas of significance. Robe will continue to work with Kuruma Marthudunera to arrive at satisfactory outcomes regarding environmental and Aboriginal heritage concerns.
	Safety when accessing the Robe River area	See PER Section 5.2.1.
	Noise and dust generation near the house used by the Native Title Claimants and their families on UCL Loc. 169 if the Northern corridor route is selected.	Robe, as part of Pilbara Iron, is currently negotiating a native title agreement with Kuruma Marthudunera representatives regarding all Robe/Pilbara Iron interests within the bounds of the Kuruma Marthudunera claim. Robe has offered to organise a field trip to inspect the road route and its location relative to the house. Robe will continue to work with Kuruma Marthudunera to arrive at satisfactory outcomes regarding environmental and Aboriginal heritage concerns.
Local Government		
Shire of Ashburton	There needs to be planning to renovate the facilities of Pannawonica should the proposed workforce be predominately residential.	See PER Sections 3.3.5 and 5.2.
Community		
Point Samson community	Dust management at Cape Lambert.	See PER Section 3.3.6.
Yarraloola Station	Need to develop stock crossing capability along the proposed northern transport corridor.	If the northern transport corridor is selected Robe will incorporate stock crossing capabilities at locations determined in consultation with the Station Manager
	If the transport corridor is fenced, gate access will be required.	If the transport corridor is fenced, Robe will provide gate access or underpasses at locations determined in consultation with the Station Manager
	Dependent on the transport option selected, there may be a need to relocate Ashley well.	If the selected transport corridor prevents suitable access to Ashley well, Robe will relocate Ashley well to a location agreed in consultation with the Station Manager

5. ENVIRONMENTAL PRINCIPLES AND SUSTAINABILITY

Robe recognises that environmental responsibilities go beyond those required under statutory regulation and encompass strong commitments to environmental management, leadership in sustainable development and social obligations.

5.1 PRINCIPLES OF ENVIRONMENTAL PROTECTION

In 2003, the EP Act was amended to include a core set of Principles that are applied by the EPA in formal assessments (EPA 2004a). As listed in s4a of the EP Act, these environmental protection principles are:

- 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
- principle of waste minimisation.

Robe has considered these principles in its assessment of the environmental impacts associated with the Mesa A/Warramboo Iron Ore Project (Table 8).

Table 8 Principles of environmental protection

Principle	Consideration given in project	Section addressed in PER
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: a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment b. an assessment of the risk-weighted consequences of various options.	Robe includes a risk assessment process in the development of all new projects with the intention of identifying issues early in the process to enable planning for avoidance and/ or mitigations. Part of this process includes undertaking detailed site investigations of the biological and physical environs. Where these investigations identify significant conservation issues, management measures are incorporated into the project design to avoid, where practicable, and/or minimise any potential impacts. For example, the sand sheet vegetation communities recorded at Mesa A, which are locally restricted, will be almost entirely excluded from the disturbance footprint and appropriate measures implemented to ensure the vegetation community is not adversely affected by construction and operation activities at Mesa A.	See PER Section 6.3 and detailed assessment of factors in PER Sections 7 through to 16 and 18 through to 24.
2. Intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhances for the benefit of future generations.	Robe integrates the principles of sustainable development into all aspects of their operations to contribute to sustainable development in Australia. These principles ensure that Robe operations deliver more value with less impact, where: *Value* = long-term financial outcomes + social outcomes + environmental outcomes *Impact* = financial cost + social impact + environmental impact Integration of these sustainable development principles ensures the environment in which Robe operates is maintained and, where possible, enhanced for future generations.	See PER Sections 17 and 25 (rehabilitation and closure) and proponent commitments to conservation of biological diversity in Section 26.6.

Principle	Consideration given in project	Section addressed in PER
3. Conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Conservation of biological diversity and ecological integrity is fundamental to Robe's approach to environmental management and is a major environmental consideration for the project. This is reflected in Robe's well established approach to environmental management: '*Protect – Restore – Do it Better*'. Biological investigations are undertaken by Robe early in the project planning process to identify aspects of the environment of conservation significance that are required to be protected from disturbance. For example, the need to protect DRF and Priority Flora species has resulted in GPS plotters being fitted into all dozers working in the Robe exploration project areas. These plotters show exclusion and restricted zones in a graphic form and help the operators easily avoid them. Robe has well established rehabilitation guidelines for restoring disturbed environments upon decommissioning, the aim of which is to *establish sustainable endemic vegetation communities consistent with reconstructed landforms and surrounding vegetation*. Robe also actively undertakes and/ or contributes to biological research (e.g. stygofauna and short-range endemic research; plant-water relationship studies along riparian systems) to improve the understanding and management of these biological aspects.	See references in No. 1 above, *Precautionary Principle*, and rehabilitation and closure Sections in PER, Sections 17 and 25, and proponent commitments to conservation of biological diversity in Section 26.6.
4. Improved valuation, pricing and incentives mechanisms a. Environmental factors should be included in the valuation of assets and services. b. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. c. 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. d. Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	Robe acknowledges the need for improved valuation, pricing and incentives mechanisms and endeavours to pursue these principles when and where ever possible. For example: • Environmental factors have played a major part in determining preferred operational options. • Robe has designed the project to ensure that pollution type impacts are minimised as far as practicable. • Environmental goals will be pursued in the most cost effective way. • Costs are provided for over the life of each operation on a unit of production basis.	See PER Section 3 (determination of preferred development options), and Sections 6.3, 15, 23 (pollution prevention).
5. Waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Robe's approach to waste management is to, in order of priority: • avoid and reduce at source • reuse and recycle • treat and/ or dispose. Robe operates appropriately licensed landfills for the disposal of general domestic solid wastes and recycles scrap metal, rubber, waste oil and batteries. Robe continues to investigate other waste management opportunities with the aim of minimising waste generation and disposal requirements.	See PER Sections 3.3.2, 3.3.4 and 6.3.2 (waste management – mineral and non-mineral).

5.2 SUSTAINABILITY

Sustainable development is defined as:

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

In the mining and metals sector, this means that investments should be financially profitable, technically appropriate, environmentally sound and socially responsible (Brundtland Commission 1997).

In September 2003, the Western Australian State Government released the State Sustainability Strategy. The strategy establishes a high level approach to applying sustainability principles across government operations, including expectations for and regulation of the mining industry. The strategy recognises that '*the international minerals sector has been one of the most pro-active industries in embracing sustainable development'.*

The strategy also recognises that a number of key sustainability innovations have been developed in the Western Australian resources sector, including land and water rehabilitation, eco-efficiency in mineral processing and, more recently, a range of social innovations. The training and employment of Aboriginal people is a recent example.

Robe undertakes all operations with consideration of the Rio Tinto sustainable development policy:

> *Rio Tinto businesses, projects, operations and products should contribute constructively to the global transition to sustainable development.*
>
> *We contribute to sustainable development by helping to satisfy global and community needs and aspirations, whether economic, social or environmental. This means making sustainable development considerations an integral part of our business plans and decision making processes.*
>
> *By focusing on people, the environment, resource stewardship and management systems, we can better manage risk, create business options, reduce costs, attract the best employees, gain access to new markets and resources and deliver a better product to our customers.*
>
> *In practice, this depends on the active awareness of and support for Rio Tinto's principles and policies by each of us as individuals.*

Robe also applies sustainable development principles in the development (planning and decision-making) of all major projects:

Sustainable development principles

Environment

- reduce water use
- reduce net land disturbances and disruption of natural water bodies
- reduce net biodiversity loss
- reduce net emissions, particularly dust and greenhouse gases

Social

- reduce injury and illness incidents
- improve equal employment opportunities
- improve contribution to community capacity building
- reduce impact on heritage

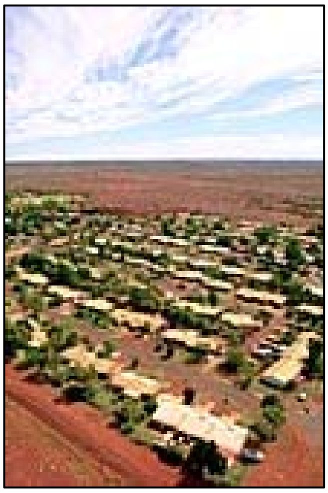
Economic

- optimise long term economic value.

Through the application of these principles, Robe has ensured that, as far as practicable, the Mesa A/ Warramboo Iron Ore Project is consistent with the sustainability principles of the WA State Sustainability Strategy and the Rio Tinto sustainable development policy.

5.2.1 Social and economic costs and benefits

The regional social setting of the proposal is described in Section 2.3. The proposed transport corridor is relatively remote from any settlements, being at its closest, 8 km to the townsite of Pannawonica. Similarly, the Mesa A/ Warramboo mine sites are relatively remote with the townsite of Pannawonica approximately 43 km to the east. The nearest residence to the proposed mining areas is the Yarraloola Homestead, which is approximately 10 km to the north of Warramboo mine site. The nearest residence to the proposed transport corridor is a house used by the Native Title Claimants and their families on UCL Loc. 169 which lies approximately 2 km north of the proposed northern corridor transport centre-line.


Pannawonica

The social and economic context of the project presents a number of benefits and costs which Robe will consider in planning for the project. A summary of the key benefits and costs are outlined below.

Social and economic benefits

Contribution to Western Australia

The Western Australian iron ore industry contributed around A$6.2 billion or around 22% of the total value of mineral and petroleum sales in the State in 2004 (DoIR 2004a, 2004b). Pilbara Iron is one of the major iron ore producers in Western Australia.

Pilbara Iron directly employs 3850 people with an additional estimated 6100 jobs created through indirect employment. In 2004 Pilbara Iron payments to the State Government for royalties, rentals and payroll tax totalled more than A$300 million.

Robe will continue to support a variety of community groups and public projects in WA through the Rio Tinto WA Future Fund. Major programs supported by the Rio Tinto WA Future Fund include:

- *Rio Tinto Child Health Partnership* focusing on improvements in the health and well-being of Indigenous children

- *Learning for Life*, an educational scholarship program operated by the Smith Family
- *Kids Science State* with Scitech
- *Designing Futures* with FORM to stimulate growth in creative industries
- *Better Beginnings* with the WA State Library for early intervention literacy
- *Biomaps* with the Australian Museum conducting a biodiversity and regional mapping of the Pilbara.

Contribution to the Pilbara region

Pilbara Iron has been active in the Pilbara region for 40 years, establishing the towns of Dampier, Tom Price, Paraburdoo, Wickham and Pannawonica. Pilbara Iron provides support to infrastructure and service provision in the Pilbara towns with which it is associated. In most towns Pilbara Iron owns and operates critical service infrastructure such as electricity, water, drainage and sewerage.

Robe's Mesa J operations directly employ around 250 personnel and engage around 200 people either as contractors to the company or through the provision of other support activities in the local community. The Mesa A/Warramboo project will require approximately 650 personnel during construction and 250 full time operational employees. Approximately 150 operational personnel will be required at Mesa A, while 100 personnel will be required at Mesa J while sub-grade processing activities are underway.

Pilbara Iron provides direct funding to a range of community organisations in the region, including sporting and cultural groups.

Contribution to the Pannawonica community

The Pannawonica town was constructed in 1972 by Robe to house employees for the adjacent mine. The town remains a Robe community with a population of approximately 700 residents. Robe provides all infrastructure in the town, including housing, electricity, sewerage and drainage. Other services supported by Robe include:

- community library
- lifestyle centre and sporting facilities
- childcare facilities and primary schooling
- health and emergency services.

In 2005 Robe upgraded the Pannawonica primary school's classrooms and common room and is assisting the funding of an increase in the teacher capacity at the school by 0.5 Full Time Equivalent (FTE) staff.

As part of Pilbara Iron's infrastructure maintenance programme, housing in Pannawonica is currently being upgraded as necessary to support current and likely future mining operations. Should the Mesa A/Warramboo project not proceed, the viability of Pannawonica as a regional town would decrease. As there are no provisions for normalisation of Pannawonica in the Robe State Agreement, it has generally been recognised that the town will close after the eventual cessation of mining in the immediate region.

Contribution to local Indigenous communities

Robe aims to increase the education, training and employment options for local Aboriginal people, through the provision of educational scholarships for secondary and tertiary education, and by offering training and employment at Robe's operations. Robe, as part of Pilbara Iron, continues to support the Aboriginal Training and Liaison Unit (ATAL).

Established in 1992, ATAL is based in Dampier and is responsible for helping Aboriginal communities maintain traditions and structures of cultural significance as well as accessing opportunities for training and employment. ATAL provides support for lore and culture activities, support for oral history recording project, help to establish traditional artefact and art enterprises and support for cross cultural enterprises. The group recently undertook surveys for an evaluation drilling program and artefact salvage program at Mesa A. Several thousand artefacts were collected and will be recorded and relocated to a cultural storage facility near Pannawonica.

ATAL have recently developed an archaeological assistants training course, at the request of members of the Indigenous community. The course will provide training in the field of archaeology and will teach skills including identification, recording and management of archaeological sites and artefacts. The course will improve career prospects of the indigenous community in the field of archaeology.

Pilbara Iron is committed to increasing employment and business development opportunities for Indigenous people of the Pilbara region. Pilbara Iron's Indigenous Employment Strategy has four main strategic action areas:

1. Capacity building including education initiatives, scholarships, pre-employment training, fitness for work programs.
2. Training and direct employment including traineeships, apprenticeships, earthworks, clerical training and direct employment strategies.
3. Improving retention through cross-cultural training across the workforce.
4. Business development to work with individuals and groups to develop viable business enterprises.

As of April 2005 Pilbara Iron had 97 Indigenous staff in direct employment or training with the company. This represents approximately 4.5% of the total workforce. Pilbara Iron has a target to increase its Indigenous employees by 100 by the end of 2006 and a longer term target of its Indigenous employment rate equalling the demographic representation of Indigenous people in the Pilbara.

In addition to direct employment, Pilbara Iron supports Indigenous business development in the area of contracting. Companies that Pilbara Iron has actively supported and worked with include:

- *Gumala Contracting*, arising from the 1997 Yandicoogina Land Use Agreement
- *Brida Contracting*, established in a collaboration between ATAL and the Roebourne community
- *Ngarda Civil and Mining*, which has Indigenous employees working at Pannawonica.

Pilbara Iron is currently in negotiation with the Kuruma Marthudunera with the intention of finalising a land use agreement for Pilbara Iron and Robe's interests within the claim area, including the development of the Mesa A/Warramboo deposit. This agreement will provide an array of benefits to the Kuruma Marthudunera people including employment and training opportunities, protocols for heritage and cultural management and education and financial benefits.

Social and economic costs

Pastoral activities

The Yarraloola Station pastoral lease covers most of the proposal area and pastoral activities will continue in the area. The project will have an impact on stock movement, stock access to pasture and vehicle movement from one side of the transport corridor to the other. To minimise these impacts, Robe will continue to consult with the pastoral station with regard to:

- design and location of culverts along the transport corridor to allow safe passage of stock across the transport corridor
- location of vehicle crossings across the transport corridor (to be appropriately designed and signed in accordance with relevant Australian standards)
- location of gates should the transport corridor be fenced.

North West Coastal Highway

For approximately 20% of the mine life there will be periods where blasting will be required within 1 000 m of the North West Coastal Highway. During these periods, approximately 2 km sections of the North West Coastal Highway will be closed for approximately 0.5 hours on average once a week over a period of several months during years 4 and 5 of the operation. This will be of inconvenience to road users, particularly road freight transport. Robe will consult with relevant Government departments and prepare a Public Risk and Safety Management Plan to minimise both risk and inconvenience to users of the North West Highway (Section 8.5).

Construction of the highway overpass over the transport corridor may also result in road works that could be of inconvenience to road users. There may also be instances when the highway would need to be closed temporarily to allow the movement of large equipment across the highway that is otherwise too large to go through the underpass. Robe will continue to liaise with Main Roads regarding appropriate traffic management measures to reduce possible impacts to traffic flow.

Landscape values and tourism potential

Both Mesa A and Warramboo are visible from parts of the North West Coastal Highway, and will be even more visible with the construction of the elevated highway overpass over the transport corridor. Significant landscape features (e.g. prominent sections of the escarpment, clusters of trees) will be affected wherever the project physically or visually changes these features. Physical change may remove all or part of the significant feature or add a project element close to the feature in a way that affects the appearance of the significant feature (John Cleary Planning 2005).

Mesa A provides a feature that contrasts with the surrounding scenery otherwise experienced by travellers on the North West Coastal Highway. In this regard, Mesa A contributes to the tourism experience of passing travellers in a small way. Mining Mesa A therefore, has the potential to detract from this experience. However, the mine, being the closest Pilbara Iron ore mine to the North West Coastal Highway, may attract interest from travellers (John Cleary Planning 2005).

Robe will protect significant features of the landscape, such as significant gullies and mesa escarpment. See Section 12.5 for more detail of landscape and geodiversity management measures.

Access for traditional purposes

The Traditional Owners and their families currently access the Robe River and nearby areas to participate in traditional and cultural activities such as hunting, fishing and ceremonial duties. Access to the Mesa A and Warramboo mine sites would be restricted throughout the life of the mining operation due to operational safety requirements.

Some restriction to access by Traditional Owners to the Robe River and associated water holes would result if the northern road/rail transport corridor options were selected. Safety exclusions would also apply to construction borefields. If a northern transport option is selected, Robe will provide access past the transport corridor infrastructure to the Robe River by means of culverts or crossings as appropriate. Selection of a southern transport option would not restrict access to the Robe River from the Pannawonica region but would have an impact on hunting and camping access.

Other social and economic management measures

Robe is committed to working with the Pannawonica community to ensure the community is directly involved in project planning. Robe recognises that this community involvement helps to identify opportunities (benefits) for the community and to minimise and address social and economic impacts (costs). Robe maintains regular communication with the Pannawonica community through community meetings and through the community advisory group. Robe is also in the process of appointing a community liaison officer.

These communication mechanisms will ensure that any issues that may arise in the future will be promptly identified and addressed.

6. ASSESSMENT OF ENVIRONMENTAL IMPACT OF PROPOSAL

6.1 SCOPING OF RELEVANT FACTORS

The environmental scoping document was prepared in accordance with the *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002*. The scoping process involved preliminary identification of environmental aspects and an environmental risk assessment to identify key issues and factors associated with the proposal. The scoping process utilised EPA guidelines and preliminary stakeholder consultation to identify those aspects of the proposal that affect environmental factors. This process highlighted environmental factors requiring detailed assessment and factors not requiring detailed investigation, given existing or proposed environmental management and remoteness of the location.

Once key environmental factors were identified, investigations required to understand these factors and predict impacts were developed. The resulting list of environmental factors is shown in Table 9.

Table 9 Environmental factors identified during project scoping

Category	Environmental factor
Biophysical	Fauna – troglobitic
	Fauna – stygofauna
	Surface fauna
	Vegetation and flora
	Surface water
	Groundwater
Pollution management	Greenhouse gases
	Air quality – dust
	Water quality
Social surrounds	Aboriginal heritage
Other	Landscape and geodiversity
	Rehabilitation and closure

6.2 KEY ENVIRONMENTAL FACTORS ADDRESSED

Environmental factors relevant to this proposal were identified through the process described above, and are presented in the PER along with additional environmental considerations identified during the detailed assessment process. Environmental factors are discussed separately in relation to those associated with mining and process operations, ore transport corridors and upgrade of port facilities. The key environment factors that have been addressed in this PER are shown in Table 10.

Table 10 Key environmental factors addressed in detail in the PER

Category	Environmental factor
Biophysical	Landscape and geodiversity
	Surface water and water quality
	Groundwater (including water use)
	Vegetation and flora
	Terrestrial fauna
	Subterranean fauna
Pollution management	Greenhouse gases
	Dust
Social surrounds	Aboriginal heritage
	Public risk and safety
Other	Rehabilitation and closure

Economic and social costs and benefits have been addressed under sustainability in Section 5.2.1. The key environmental factors associated with the proposal are discussed in this PER in the following format:

- description of factor
- potential sources of impact
- key statutory requirements, environmental policy and guidance
- assessment of potential impact, mitigation and residual risk
- predicted outcome.

6.3 MINOR ENVIRONMENTAL FACTORS NOT FURTHER ASSESSED

A number of environmental factors have not been addressed in detail as they are considered to be minor factors given the remoteness of the location and existing management measures in place. These factors are noise and vibration, waste management (including mineral wastes), and European heritage. These factors are addressed briefly in sections 6.3.1, 6.3.2, and 6.3.3 below.

6.3.1 Noise and vibration

Noise and vibration will be generated during construction, mining and ore transport and handling operations. Vibration and ambient noise levels in the vicinity of Mesa A/Warramboo will increase as a result of the project, however due to the remoteness of the operations, noise and vibration impacts will primarily be restricted to health and safety of the workforce.

The predominant land uses surrounding the Mesa A/Warramboo project area are mining exploration and pastoral grazing. The nearest noise sensitive premise to the mine site is Yarraloola Pastoral Station, which is 10 km from the proposed mining area. The NorthWest Coastal Highway is located in close proximity to Yarraloola. The closest town to Mesa A/Warramboo is Pannawonica, approximately 43 km east of the Mesa A/Warramboo area. The mine construction camp and possible fly-in fly-out village will be located approximately 1 km from the nearest point of the mine site.

The nearest noise sensitive premise to the proposed transport corridor is a house used by the Native Title Claimants and their families on UCL Loc. 169, which lies approximately 2 km north of the proposed northern corridor transport centre-line.

Noise emissions from the mining area will vary depending on the aspect of mining being undertaken (e.g. blasting, loading haul trucks), and the resultant tonality of the noise emission, and the duration of the emission. Some noise emissions from a mining operation with varying tones could be considered intrusive (e.g. vehicle reversing beacon or blasting activities), whilst other noise emissions with a continuous tone could be considered less intrusive (e.g. running vehicle engine). The progressive movement of the active mining area will limit the duration of noise emissions from one particular location.

For approximately 20% of the mine life there will be periods where blasting will be required within 1000 m of the North West Coastal Highway. Due to the proximity of blasting to the highway, a Public Risk and Safety Management Plan will be developed (Section 8.5). Blasting activities will only be conducted during daylight hours.

Given the remote nature of the proposed mine site it is anticipated that noise from mine operation will not have a significant impact on any noise sensitive premises. Noise emissions from the Mesa A/Warramboo project will cause localised disruption to fauna in areas adjacent to mining operations and transport corridors. However it is unlikely that the behaviour of fauna will be disrupted by noise emissions in the long term.

Noise emissions from the transportation of ore will vary depending on the method of transport, however, they are not anticipated to cause any significant impacts due to the remoteness of the operations.

If the northern rail route is chosen, the railway will link into the existing rail line approximately 8 km south-south-west of Pannawonica. The existing rail route then runs north-east to within approximately 3 km of Pannawonica, then east away from Pannawonica and north-east towards the Cape Lambert port. If the southern rail route is chosen, the railway will link into the existing rail line at Mesa J, and will follow the route described above. There is not anticipated to be any substantial increase in the volume of rail traffic on the existing rail line, therefore noise impacts are not expected to change. If either rail option is chosen, the rail construction camp will be located approximately 1 km from the nearest point of the rail line.

If the northern transport route is selected, there may be noise impacts on the house used by the Native Title Claimants and their families on UCL Loc. 169. Road train drive-by noise levels are anticipated to be around 87 dB(A). Using the 'inverse square law', whereby sound levels drop by 6 dB every doubling of distance from the source, the noise levels at 2 km from the transport corridor would be 45 dB if the estimate of 87 dB was recorded at 15 m from noise source, or 51 dB if the estimate of 87 dB was recorded at 30 m from noise source. The Western Australian Planning Commission *Statement of Planning Policy: Road and Rail Transport Noise (draft),* require noise management measures to be employed if levels are above 55 dB. Robe will monitor noise from the transport corridor at the house at commissioning of the transport corridor to confirm initial noise level estimations.

There are likely to be some vibration issues with regard to construction of the proposed transport corridor over the Goldfields Gas Transmission Mainline. Robe does not anticipate this to be an issue, however, it will be working with the pipeline owner to agreed specifications to minimise risk.

In accordance with current management practices at Mesa J, Robe will ensure noise and vibration from Mesa A/Warramboo comply with the requirements of the *Environmental Protection (Noise) Regulations 1997* (do not apply to road or rail noise), environmental licence, and the Department for Industry and Resources (DoIR) requirements for mine safety and health.

Noise and vibration will be managed to the requirements of:

- *Environmental Protection (Noise) Regulations 1997*
- Public Risk and Safety Management Plan.

Proposed management actions

Issues relating to noise and vibration at Mesa A/Warramboo will be covered by the following proposed management actions:

- prepare and implement a Public Risk and Safety Management Plan.
- if the northern route is selected, monitor noise from the transport corridor at the house on UCL Loc. 169 upon commissioning of the transport corridor.
- continue to work with the Goldfields Gas Transmission Mainline owner to agree specification to minimise risks to the gas pipeline during construction of the transport corridor.

6.3.2 Waste management (including mineral wastes)

Wastes that will be generated by the Mesa A/Warramboo project will be similar in composition to those generated by the Mesa J mine, and include:

- domestic solid and liquid wastes (including food scraps and sewage)
- washdown water
- general mine-site waste (including scrap metal, drums, conveyor belt sections, tyres and batteries)
- general office waste (including paper, toner cartridges, computers and parts, mobile phones)
- waste oils and lubricants
- mineral waste.

Liquid effluents generated from the Mesa A/Warramboo project will consist of sediment contaminated water from washdown facilities and surface run-off, hydrocarbon contaminated water from workshops and wash-bays, and sewage effluent and grey water from work areas and camps.

Sewage treatment plants will be established adjacent to the construction camps, office areas and any permanent mine village. Clean effluent (water) will be discharged via reticulation to garden/lawn areas as far as practicable.

Sediment control structures will be installed at washdown facilities to reduce the sediment load of discharged water. A facility to treat hydrocarbon contaminated water generated at the workshop and washdown facilities will be installed. Treated water will be pumped into the dust suppression water circuit for re-use on non-pit roads as far as practicable and oily waste from the decontamination plant will be transferred to oily waste disposal bins or the waste oil tank.

Operation of the construction camps, mines site and any permanent village will require landfill facilities for on-site disposal of inert and putrescible waste. Wastes will be segregated to facilitate recycling and appropriate disposal.

Waste will either be removed from the site to a sanitary landfill facility, in accordance with the requirements of the Shire of Ashburton or will be disposed of to an on-site landfill. The potential location of an on-site landfill facility, if required, will be determined during detailed engineering design. The landfill will be registered or licensed as required.

The Mesa A and Warramboo resources contain an estimated 100 Mt of mixed pisolite (sub-grade ore). Whilst this proposal does not include the construction and operation of wet processing facilities for treatment of this ore, mine planning is being undertaken to avoid sterilisation of the sub-grade ore. A separate application for wet processing facilities will be submitted should they be required. Waste management will be controlled through licence conditions and will be undertaken as per Robe's Waste Management Procedure.

Proposed management actions

Issues relating to waste management at Mesa A/Warramboo will be covered by the following proposed management actions:

- install sediment control structures at washdown facilities
- install facility to treat hydrocarbon contaminated water generated at the workshop and washdown facilities
- re-use treated water from the workshop and washdown facilities for dust suppression on non-pit roads as far as practicable
- develop and implement an Environmental Management Plan which includes waste management actions.

6.3.3 European heritage

A search of the Australian Heritage Database, which includes the Register of the National Estate, the Commonwealth Heritage List, the National Heritage List and the World Heritage List was completed for the area defined by the 1:250,000 Yarraloola Map Sheet (sheet number SF-50-06). No listings were present in the database for places or objects within 35 – 40 km of the Mesa A/Warramboo project area.

A search of the Heritage Council of Western Australia's Places Database for the Ashburton Shire provided three listings within 50km of the project area:

- Yarraloola Homestead (place number 15398)
- Red Hill Homestead (place number 15375)
- Pannawonica Fire Station (place number 14628).

The Yarraloola Homestead is approximately 10 km from the proposed mine site. The Red Hill Homestead is approximately 21 km from the nearest point of the proposed rail line and approximately 36 km from the proposed mine site. The Pannawonica Fire Station is location within Pannawonica town. European heritage sites within the region will not be affected by the proposed mining operations.

7. GREENHOUSE GASES

7.1 DESCRIPTION OF FACTOR

The Greenhouse Effect is a natural phenomenon where light energy from the sun passes through the atmosphere and heats the earth's surface. Greenhouse gases in the atmosphere include carbon dioxide, water vapour, methane, nitrous oxide, non-methane volatile organic compounds, halocarbons, carbon monoxide and sulphur hexafluoride. These gases within the atmosphere trap heat reflected from the earth's surface, maintaining temperatures at a level capable of supporting life.

Human activities have increased the amount of greenhouse gases in the atmosphere, enhancing the greenhouse effect, leading to climate change. The main anthropogenic greenhouse gas emission is carbon dioxide (CO_2), which has increased in concentration in the atmosphere by about 31% over the last 200 years (EPA 2002a).

Avoiding human caused changes to climate is an important international goal that requires reduction in the emission of greenhouse gases. Actions are required to improve understanding of the problem and provide solutions for both adaptation and greenhouse gas emissions abatement. Addressing the challenge of climate change imposes costs for greenhouse gas abatement and necessitates a change in the way energy is used.

7.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the proposal that may potentially affect greenhouse gas emissions include:

- **Fuel usage** by mobile plant and equipment, and trains and/or road trains.
- **Energy usage** by processing plants.

Land clearing and revegetation have not been included in greenhouse gas calculations. All land clearing will be done prior to operation of the mine, and the majority of revegetation will occur following mine closure. Including these emissions/sinks would not give an accurate representation of average annual emissions from the Mesa A operation. Emissions resulting from vegetation clearing are addressed separately.

7.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA Objective

The EPA normally applies the following objective in its assessment of proposals with greenhouse gas emissions. This objective is considered relevant to this proposal.

- *To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.*

Federal legislation/policies

The National Greenhouse Strategy (NGS) was released by the Australian Greenhouse Office (AGO) in 1998, and was prepared by the Commonwealth Government, State and Territory Governments. It sets out to provide the strategic framework for effective greenhouse response and for meeting current and future international commitments (AGO 1998). The NGS commits Australia to actively contribute to the global effort to stabilise greenhouse gas concentrations in the atmosphere.

The Greenhouse Challenge Program was established by the Federal Government in 1995, and is a voluntary program between government and industry to abate greenhouse emissions. In 2004, following a review of the Greenhouse Challenge Program, the Federal Government launched the Greenhouse Challenge Plus program. This program builds on the success of the original program and incorporates two industry focussed measures (Generator Efficiency Standards and Greenhouse Friendly initiative), and changes in the Federal Government's energy policy '*Securing Australia's Energy Future*'.

In 2004 the Federal Government released its new energy policy 'Securing Australia's Energy Future'. This policy recognised the importance of effective management of greenhouse gases by major energy users and indicated that the Greenhouse Challenge is to become a 'single entry point' for business reporting on greenhouse and energy.

The Kyoto Protocol is an international treaty designed to limit global greenhouse gas emissions. The agreement was reached in 1997 in Kyoto, Japan, and establishes individual quantified emissions limitations or reduction commitments (emissions targets) for each developed country based on 1990 emissions, for the commitment period of 2008 to 2012. The Federal Government has stated that ratifying the Kyoto Protocol at present is not in Australia's interests. However, it has committed to meeting the target agreed at Kyoto of limiting greenhouse gas emissions to 108% of 1990 levels for the commitment period.

State legislation/policies

In October 2002, Environmental Protection Authority released a '*Guidance Statement for Reducing Greenhouse Gas Emissions*' (Guidance Statement No. 12) (EPA 2002a). The statement sets out objectives regarding the minimisation of greenhouse gas emissions from new or expanding operations.

Carbon rights legislation was passed by the Western Australian Parliament in 2003. The purpose of the Bill is to provide for the registration on land titles and a 'carbon right' and accompanying 'carbon covenant'. The Bill will give certainty to those wanting to trade in carbon rights and gain the credits or emission offsets which arise from sequestration.

The Western Australia Greenhouse Strategy was released in 2004 and sets out the State government's response to climate change. The State recognises the weaknesses and limitations of the Kyoto Protocol, but believes the Protocol represents an essential step towards dealing with climate change. Key components of the Strategy include government leadership, reducing emissions, local government and community involvement, and national and international representation.

7.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

7.4.1 Current greenhouse gas emissions

Robe's current Mesa J mining operation produces approximately 32 Mt of ore per year, but is scheduled to be down sized to coincide with the construction of the Mesa A/Warramboo operation (Table 11). Greenhouse gas emissions from the current Mesa J operation are estimated at 154,400 tonnes of CO_2 equivilants (CO_2-e) per year (Table 12). The carbon intensity of the operation is 4.82 x 10^{-3}t CO_2-e/t of ore produced.

Table 11 Current and predicted product usage at Mesa J

	Current usage	Predicted usage
Ore production	32 Mtpa	7 Mtpa
Diesel for Mining	23,572,184 L	5,500,176 L
Petrol Mine	211,654 L	49,299 L
Train (Diesel)	200 haul km	200 haul km
Cape Lambert Power	29,569 MWh	15,611 MWh
Explosives	30,310 t	-

Table 12 Current and predicted peak annual greenhouse emissions from Mesa J

Emission Source	Estimated emissions (t CO_2-e) at 32 Mtpa ore	Predicted emissions (t CO_2-e) at 7 Mtpa ore
Mobile Minesite (diesel)[1]	66,645	13,922
Mobile Minesite (petrol)[1]	529	116
Train (diesel)[2]	65,958	15,400
Imported Power[3]	19,091	11,167
Explosives[4]	5071	-
Total peak annual emissions	**154,400**	**40,866**

[1] Calculated using procedure in *AGO Factors and Methods Workbook*, December 2005, Australian Greenhouse Office

[2] Calculated using equation supplied by Robe

[3] Calculated for gas-fired electricity generation using equation supplied by Robe

[4] Calculated using procedure for ANFO in *AGO Factors and Methods Workbook*, December 2005, Australian Greenhouse Office.

7.4.2 Predicted greenhouse gas emissions

Once the proposed Mesa A/Warramboo operation begins the Mesa J operation will be scaled back to an operating level of 7 Mtpa ore. This decrease in production will partially offset the emissions generated by the Mesa A/Warramboo project. Mesa A/Warramboo will produce 25 Mtpa iron ore (Table 13).

Table 13 Predicted product usage at Mesa A/Warramboo

	Usage for train only option	Usage for road train and rail option
Ore production	25 Mtpa	25 Mtpa
Diesel for Mining	15,211,654 L	15,211,654 L
Rail (Diesel)	245 haul km	200 haul km
Road train (diesel)	-	45 haul km
Diesel Power generation	5,840,000 L	5,840,000 L
Explosives	15,000 t	15,000 t

At present there are two options for the haulage of ore from the Mesa A mine site to the port at Cape Lambert. The quantity of greenhouse gases produced by the operation will be significantly influenced by which transport option is selected. The options involve up to 245 km to be conducted by rail or for an average 45 km to be by road-train with the remaining 200 km to Cape Lambert to be made by train. The expected peak annual greenhouse emissions for each option are shown in Table 14.

Table 14 Predicted peak annual greenhouse emissions from Mesa A/Warramboo

Emission Source	Estimated emissions (t CO_2-e) with rail only	Estimated emissions (t CO_2-e) with road train and rail
Mobile Minesite (diesel)[1]	41,071	41,071
Road Train (diesel)[2]	-	72,699
Rail (diesel)[2]	67,375	55,000
Power generation[1]	15,710	15,710
Explosives[3]	2510	2510
Total peak annual emissions	**126,666**	**186,990**
Life cycle emissions[4]	**1,266,656**	**1,869,899**

[1] Calculated using procedure in *AGO Factors and Methods Workbook*, December 2005, Australian Greenhouse Office

[2]Calculated using equation supplied by Robe

[3] Calculated using procedure for ANFO in *AGO Factors and Methods Workbook*, December 2005, Australian Greenhouse Office.

[4] Calculated assuming a 10 year life span and a short ramp up period.

Emissions as a result of vegetation clearing will be produced prior to the commencement of mining and will not contribute to the peak annual emissions. For this reason emissions resulting from clearing are not included in the above figures. A conservative estimate of clearing required for the operation is 2870 ha, resulting in a one off clearing emission of 52,617 t CO_2-e over the period of construction and ground preparation. Rehabilitation is also not included in the above calculations as the contribution from this source is relatively small and the majority of rehabilitation will occur post mining.

The most significant single source of greenhouse gas from the proposal will be from the transport of ore between the mining operation and Cape Lambert. In particular the method of transport used between Mesa A and Mesa J will have the most significant effect on the peak annual emission rate and the carbon intensity of the project.

The rail transport option would result in significantly lower CO_2 emissions than the road train/rail option, with total emissions from the latter predicted to be approximately 48% higher. The carbon intensity is also lower for the rail option at 5.07 kg CO_2-e/t of ore produced when compared to 7.48 kg CO_2-e/t of ore produced for the road train/rail option. The actual greenhouse emissions used here is therefore considered to be conservative.

Robe has implemented a number of measures to reduce energy consumption and greenhouse gas emissions from its activities. Robe, as part of Pilbara Iron, sponsored two Masters projects in 2004 to assist in the reduction of energy consumption and emissions, and will consider the findings of the projects in development of its operations.

The single largest source of greenhouse gas emissions from the proposed Mesa A/Warramboo operation will be from diesel consumption for the transport of ore from the mines to the port facilities. If the road train option is selected, transport of ore will be conducted by contractors, conditions will be placed on ore transport contractors (as well as any other contractor providing goods or services that consume energy). All contractors will be made aware of Robe's commitments to the reduction of energy consumption and greenhouse gas emissions and will be required to assist Robe in meeting its targets. Specifically, the road train contractor, if selected, would be required to:

- ensure that all goods and services used or delivered that consume energy will have the best energy efficiency rating / emission rating that might reasonably be expected from provision or operation of those goods and services

- supply Robe full particulars and a schedule of goods and services together with sufficient comparative information relating to similar or like goods and services to enable Robe to be satisfied that the requirement above has been met
- cooperate with initiatives by Robe in meeting its stated energy and greenhouse gas targets, such as the trial of diesel fuel additives
- assist Robe as part of its commitment to Government and Greenhouse Challenge programs to monitor and report fuel usage, maintain records of both usage and actions taken to reduce emissions and make these available for verification should this be required. This also includes assisting with continuous improvement of monitoring and reporting practices
- provide a list all energy efficient features of the proposed fleet and other equipment associated with delivery of the contract or service as part of the tender
- provide details of any optional energy efficiency or greenhouse gas reduction initiatives that could be included as part of their contract - e.g. training of drivers to improve fleet fuel efficiency, and further assist Robe in the reduction of energy use and greenhouse gas emissions.

Emissions from Mesa A/Warramboo will be partially offset by the reduction in peak annual emissions from the Mesa J mine site, with those expected to reduce by 113,534 t CO_2-e (Table 12). Carbon intensity for Mesa J at the lower production rate of 7 Mtpa is predicted to be 5.84 kg CO_2-e/t of ore produced.

Due to the timing of the tender and design processes for the options regarding the transportation of ore it has not been possible to conduct an energy efficiency audit of the project as outlined in the Environmental Scoping Document. The audit will be conducted once sufficient information becomes available through the design and tender processes.

7.5 PROPOSED MANAGEMENT ACTIONS

Robe will implement the following proposed management actions in respect of its energy consumption and greenhouse gas emissions:

- conduct an energy efficiency audit
- prepare and implement an Environmental Management Plan which includes greenhouse gas and energy conservation actions such as:
  - maintaining an inventory of greenhouse gas emissions
  - reporting greenhouse gas emissions and greenhouse intensity in its annual Social, Safety and Environment Report
- imposing contractual conditions on road train contractor (if road train option selected) to demonstrate how Rio Tinto and Pilbara Iron principles, strategies and guidelines for greenhouse gas emissions will be met
- maintaining membership of the Australian Greenhouse Challenge Plus program
- evaluate and adopt appropriate technology to improve greenhouse efficiency during the detailed design phase.

7.6 PREDICTED OUTCOME

Construction of the Mesa A/Warramboo proposal will result in a net increase in peak annual greenhouse emissions from Robe operations in the Robe Valley of up to approximately 73,500 t CO_2-e for a worst case scenario using road train transport of ore from Mesa A to Mesa J. Should the rail option be selected the greenhouse emissions from the proposal would be significantly lower (a net annual increase of approximately 13,100 t CO_2-e compared with existing Mesa J operations).

Implementation of Robe's greenhouse gas and energy conservation measures will enable the company to minimise emissions and provide a mechanism for continuous improvement in greenhouse gas emissions resulting from the proposal. It is considered that this will meet the EPA objective.

8. PUBLIC RISK AND SAFETY

8.1 DESCRIPTION OF FACTOR

There are several aspects of the proposal that could potentially pose an off-site risk to the safety of the general public, not including Robe personnel. These include:

- proximity of operations to the North West Coastal Highway
- the requirement for transportation of fuel and explosives on public roads
- the increase in traffic volumes on public roads.

The North West Coastal Highway passes between the Mesa A and Warramboo mining areas. Mining operations at Mesa A and Warramboo will come within approximately 500 m and 2 400 m of the highway respectively. A transport corridor will pass under the highway to transport product from Warramboo.

Fuel will be supplied to the Mesa A/Warramboo operations along the North West Coastal Highway from either Dampier or Cape Lambert. Deliveries will be made approximately every two days to a new bulk fuel storage facility which will be constructed at Mesa A. Explosives will be stored at the existing facilities used by the Mesa J operation and will be transported along the Pannawonica Road to Mesa A and Warramboo.

The project will result in an increase in general traffic and freight movement along the North West Coastal Highway and Pannawonica Road. Most construction materials will be trucked from Perth and/or Karratha. During operation there will also be a requirement for freight movement and other project related traffic. For example, personnel may be transported by buses along Pannawonica Road between Pannawonica and the mine sites (for a residential workforce).

8.2 POTENTIAL SOURCES OF IMPACT

Aspects of the proposal that pose a potential risk to public safety are:

- **Mine operations, particularly blasting, in proximity to the North West Coastal Highway** may pose a risk to users of the highway.
- **Transportation of fuel and explosives** may pose an increased risk to users of the North West Coastal Highway and Pannawonica Road.
- **Increase in traffic volumes on public roads** due to the project may pose an increased risk to users of the North West Coastal Highway and Pannawonica Road.

8.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA objective

The EPA normally applies the following objective in its assessment of proposals that affect public risk and safety. This objective is considered relevant to this proposal.

- *To ensure that risk from the proposal is as low as reasonably achievable and complies with acceptable standards and EPA criteria.*

State legislation

The transportation of fuel and explosives in Western Australia is managed in accordance with the *Explosives and Dangerous Goods Act 1961* and associated regulations and the *Dangerous Goods (Transport) Act 1998* and associated regulations (expected to be replaced by *Dangerous Goods Safety Act 2004* by mid 2006). These Acts and Regulations aim to protect the community by minimising risks associated with the storage, transport and handling of dangerous goods.

The Resources Safety Division of the Department of Consumer and Employment Protection is responsible for administering the above mentioned legislation and associated regulations, through licensing, assessment, inspection and advisory functions.

Australian standards

Various Australian standards also apply to the transport of dangerous goods, namely procedures for dealing with emergencies involving specific dangerous goods.

8.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

Mining operations

The project has potential to generate off-site risk due to the proximity of mining activities to the North West Coastal Highway during certain parts of mine development, particularly in relation to blasting activities. For 20% of the mine life, there will be periods when blasting will be required within 1000 m of the North West Coastal Highway.

Robe will develop a Public Risk and Safety Management Plan to minimise the risk (and inconvenience) to users of the North West Coastal Highway during these periods. This plan will be developed in consultation with the relevant authorities (e.g. Main Roads) and will include measures for closure of the highway during blasting.

Transportation of fuel and explosives

The primary risk to the public from the transportation of fuel and explosives would be if the fuel or explosives transportation vehicles were involved in an accident. The public roads that would be utilised for the movement of fuel and explosives for the project, North West Coastal Highway and Pannawonica Road, are designed to carry such heavy vehicles and already do so in some sections.

To mitigate risk to public safety, Robe will ensure that transportation of fuel and explosives is in accordance with relevant State legislation and relevant Australian standards (Section 8.3). Requirements of this legislation and standards include, amongst others, vehicle and driver licensing and vehicle placarding.

Increased traffic volumes

Construction and operational phases of the project will result in an increase above current levels in general traffic and freight movement along the North West Coastal Highway and Pannawonica Road.

Traffic increases will be greatest during the construction phase. Anticipated traffic increases will be within the current capacity of the public roads. To minimise risk to traffic from project vehicles exiting the North West Coastal Highway to enter the project sites, Robe will ensure, in consultation with Main Roads, that appropriate turn-off lanes and signage are installed on the North West Coastal Highway.

8.5 PROPOSED MANAGEMENT ACTIONS

Public risk and safety issues for the project will be addressed by the following proposed management actions:

- develop and implement a Public Risk and Safety Management Plan in consultation with Main Roads. The plan will include:
    - North West Coastal Highway closure requirements and procedures
    - other measures to reduce risk to public safety during blasting
    - methods to provide advance public notification of highway closures (e.g. roadside signage and signage at appropriate roadhouses)
- ensure, in consultation with Main Roads, that appropriate turn-off lanes and signage are installed on the North West Coastal Highway.

8.6 PREDICTED OUTCOME

The project will result in an increase in general traffic volumes and freight movement on North West Coastal Highway and Pannawonica Road during construction and operation. However, the increase in traffic volumes will be within the current capacity of the public roads. Through implementation of risk mitigations measures potential risk to road users will be reduced as far as practicable to ensure the EPA objective for this factor is met.

PART 3 MINING OPERATIONS – ASSESSMENT OF KEY ENVIRONMENTAL FACTORS

9. VEGETATION AND FLORA

9.1 DESCRIPTION OF FACTOR

The Mesa A and Warramboo mining areas (project area) are within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The project area is located at the western end of the Hamersley sub-region, with sections of the Warramboo deposit extending into the Roebourne sub-region of the Pilbara Biogeographic Region as defined by the Interim Biogeographic Regionalisation for Australia (Environment Australia 2000).

Beard (1975) broadly mapped the project area as:

- *Acacia pyrifolia* and/or *A. bivenosa* sparse shrubs over *Triodia basedowii* and/or *T. wiseana* hummock grasslands
- riverine woodland dominated by eucalypts in the Robe River.

Given the broad nature of Beard's mapping (mapped at a scale of 1:1,000,000), these units are only broadly applicable to the vegetation occurring in the project area.

Like much of the Pilbara region, the area surrounding and including the project area (until recently) is relatively poorly known. Various areas around Pannawonica have been surveyed as part of baseline vegetation and flora surveys for Robe, including some work at Mesa A (for example, Trudgen 2002; 2003a; 2003b; 2003c and Biota 2003). The Department of Agriculture has carried out a broadscale survey of parts of the Pilbara, however the descriptions of the vegetation are not yet available. DEC (Nature Conservation Division) is also in the process of undertaking the Pilbara Region Biological Survey[4], which is expected to finish in 2007.

Most recently, Biota Environmental Sciences (Biota) conducted flora and vegetation surveys of Mesa A (during 2003 and 2004) and Warramboo (during 2004 and 2005), consistent with:

- EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002b).
- EPA Guidance Statement No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004b).

[4] The Pilbara Region Biological Survey is a five year investigation (2002-2007) being undertaken by DEC (Nature Conservation Division) and the WA Museum. The aim of the Survey is to provide an understanding of the Pilbara biodiversity and its conservation needs. Results from the Survey will provide for the: development of a framework to guide sustainable land-use and conservation planning in the Pilbara; appraisal of the region's conservation reserve system; improvement of the environmental impact assessment of developments; verification of the distributional information for threatened species and ecological communities; provision of detailed information on stygofauna; documentation of new information about flora and fauna.

The following description of vegetation and flora for the project area is from the most recent Biota studies (Biota 2005a; 2006b), unless otherwise stated, and the vegetation and flora is described separately for the Mesa A and Warramboo mining areas. The Biota reports are contained in Appendix 2.

9.1.1 Mesa A

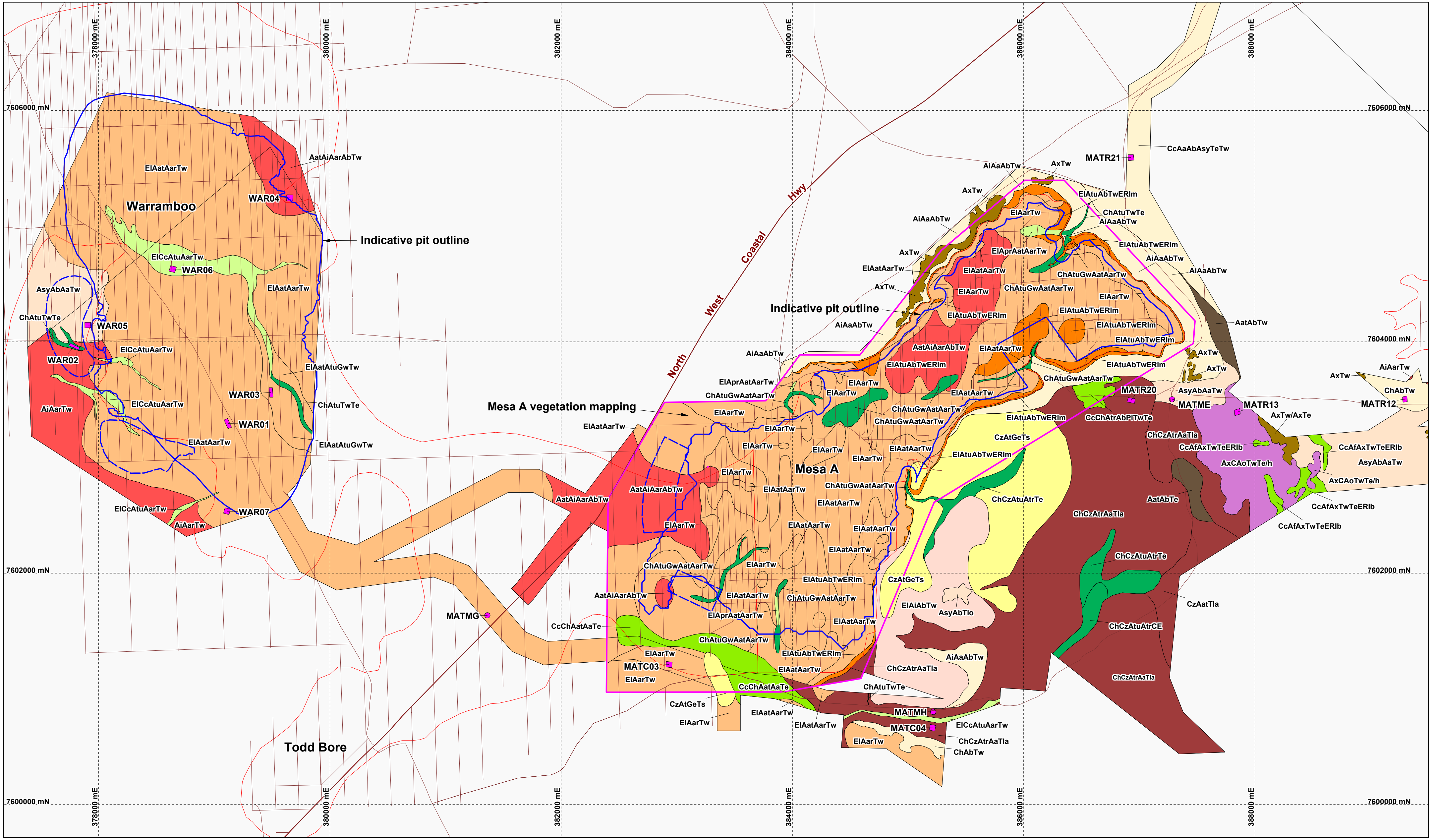
Vegetation

Twelve vegetation types were found to occur at Mesa A (Biota 2005a) (Appendix 2 and Figure 11). It is important to understand the broad nature of these vegetation types, each of which incorporates a range of structural and floristic variants. The units described are considered to range from at, to somewhat higher than, the vegetation association level, although they are not strictly defined as vegetation associations. The structural and floristic variation they include undoubtedly covers a large number of vegetation communities. The broad nature of the units defined needs to be taken into account when using them for assessing conservation value of the vegetation (Biota 2005a). The vegetation types fall into three main vegetation groups relating to topography (Table 15).

No TECs listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or by DEC (Nature Conservation Division) are known from Mesa A.

Table 15 Description of vegetation groups recorded at Mesa A

Vegetation group	Vegetation types	Description
Stony hills and plains	H1: ElAarTw H2: ElAatAarTw H3: ElAtuAbTwERlm H4: AatAiAarAbTw H5/H6: ElAtuAbTwERlm H7: AxTw H8: AiAaAbTw	Stony hills and plains with a scattered overstorey of mainly *Eucalyptus leucophloia* (Snappy Gum) and/or *Acacia atkinsiana, A. pruinocarpa, A. inaequilatera* over tall open shrubland of *Acacia arida, A. bivenosa* over *Triodia wiseana* hummock grassland.
Creeklines and floodplains	C1: ElAprAatAarTw C2: ChAtuGwAatAarTw & ChAtuTwTe C3: CcChAatAaTe	Flowlines and gullies on the crests, slopes and valleys of stony hills comprising of *Eucalyptus leucophloia* (Snappy Gum), *Corymbia hamersleyana* (Bloodwood) over scattered tall shrubs of *Acacia atkinsiana*, *A. arida* over *Triodia wiseana* open hummock grassland and sometimes *Eriachne mucronata* scattered tussock grasses.
Sand dunes and sand sheets	S1: CzAtGeTs	Red sand dune and sand sheet comprising *Corymbia zygophylla* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* high shrubland over *Triodia schinzii* hummock grassland.



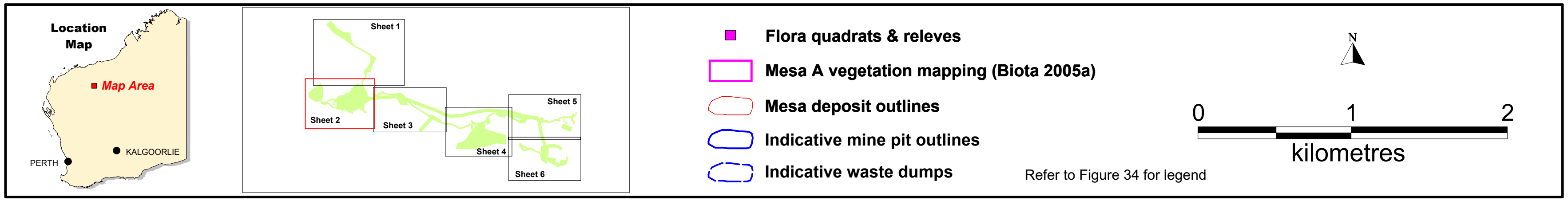


Figure 11 Mesa A/Warrambo vegetation mapping and fauna trapping sites

Adapted from Biota 2006c

Vegetation condition

The vegetation of Mesa A was generally in very good to excellent condition. The main disturbance was from numerous exploration tracks, particularly on the mesa crest. There were no major weed infestations and the weed species recorded are all common and widespread species in the Pilbara. In particular, no significant stands of Buffel Grass (*Cenchrus ciliaris*) were recorded.

Regional representation of vegetation types

Biota (2005a) determined the probable distribution of the vegetation types that occurred at Mesa A based on their correspondence with the Land Systems described in Section 2.1.2[5]. On the whole, the vegetation types identified at Mesa A are compatible with the broad descriptions of their associated Land System(s). The exception is the sand sheet vegetation type S1 (CzAtGeTs), which does not appear to correspond with the descriptions of either the Nanutarra or Stuart Land Systems. It is possible that this sand sheet is an outlier of the Uaroo Land System (broad sandy plains supporting shrubby hard and soft spinifex grasslands), which is broadly distributed along the westernmost edge of the Pilbara bioregion, however without some comparable data it is difficult to be sure. In any case, it appears to be an unusual land unit within the local area.

A floristic analysis (utilising the PATN[6] software package) was also undertaken to provide an understanding of the floristic composition of vegetation at Mesa A and Warramboo in relation to the surrounding region (Section 9.1.2). The PATN analysis indicated that at a broad (20-group) level, none of the floristic groups was restricted to the Mesa A study area. However, at a finer (50-group) level, two floristic groups contained only sites from the Mesa A study area:

- Group 15 comprised the vegetation of the sand dune and sand sheet; the floristic composition of these sites is clearly distinct at a relatively high level from the other sites within the same 20-group cluster.
- Group 38 comprised the four sites from gullies (or creeklines through gullies) at Mesa A. It is not clear which species distinguish these sites from the others assessed in gully habitats in the other study areas included in the analysis.

Conservation significance of vegetation

Vegetation types were ranked into four classes, very high, high, moderate and low, according to their conservation significance (Biota 2005a).

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[5] Given the different scales of the two mapping exercises (vegetation types and Land Systems), an element of discretion has been used to generate the association between vegetation type and Land System to avoid spurious associations. Without some interpretation of the two mapping schemes, vegetation types could be wrongly associated with other Land Systems. For example, an area of the vegetation type H9 defined by this study falls within the River Land System, however it should clearly be associated with a Land System that comprises stony plains supporting spinifex (e.g. Boolgeeda).

[6] PATN is a software package that extracts and displays patterns in complex data. PATN generates estimates of association (resemblance, affinity, distance) between any set of objects described by a suite of variables or attributes. PATN then classifies the objects into groups (Blatant Fabrications 2004). The floristic groups identified through the use of PATN were based on floristic composition of the detailed flora recording quadrats contained in the data set. The floristic clustering was determined from data obtained from a relatively small number of detailed sites, and was limited by the extent of data available for similar landforms/habitats in the locality.

The majority of the vegetation types at Mesa A are likely to be more widely distributed in the Pannawonica locality based on knowledge of the local area and selected other areas in the region. The notable exception is vegetation type S1 (CzAtGeTs), vegetation of the sand dune and sand sheet adjacent to Mesa A, which is considered likely to be restricted in distribution in both the local area and region. It supports species restricted to the deep sands of this particular habitat. This vegetation type is considered to be of very high conservation significance.

The vegetation of flowlines through the sand sheet (ChCzAtuAtrTe) is also considered to be of high conservation significance as it supports species restricted to this habitat, although it is not considered restricted in its distribution.

The remainder of the vegetation types at Mesa A are considered to be of moderate conservation significance.

Flora

Species richness of Mesa A

A total of 181 taxa of native terrestrial vascular flora were recorded from Mesa A.

The main factor driving differences in the number of species recorded in different quadrats seemed to be habitat type. Habitats with generally good conditions (e.g. deep, well-drained soils; more readily available water) typically had more species than habitats with shallow, less favourable soils.

Mesa A is relatively species poor in comparison to areas further east in the Hamersley Range, reflecting a number of factors:

- the relatively low and inconsistent rainfall received by the area
- the low relief of the mesa in comparison to areas further east (altitude has been shown to be a significant contributor to species diversity)
- the relatively small size of the project area, and limited number of habitats present
- the prolonged dry period experienced at Pannawonica prior to the survey work.

Dominant species

The dominant families recorded from Mesa A were Malvaceae (hibiscus family), Poaceae (grass family), Papilionaceae (pea family), Mimosaceae (wattle family) and Amaranthaceae (mulla-mulla family). These families are typically predominant in the vegetation of the Pilbara, and usually have most representatives on flora lists from this region, due to their prominence in the Eremaean flora. Some of the families (e.g. the Amaranthaceae, Malvaceae and Poaceae) are more species rich in the Northern flora and poorer in the Southern flora, while others (such as the Mimosaceae) are abundant in all three provinces.

Several families and genera recorded during the survey were represented by only one taxon. These included *Codonocarpus* (Gyrostemonaceae), *Corynotheca* (Anthericaceae) and *Clerodendrum* (Lamiaceae). Some of the genera are widespread in the State (e.g. *Codonocarpus* and *Corynotheca*). Others have predominantly northern or southern affinities (e.g. *Clerodendrum* has a northern affinity).

The most frequently recorded species at Mesa A were *Triodia wiseana, Acacia atkinsiana, Acacia arida, Cassia notabilis, Corchorus sidoides* subsp. *sidoides, Dysphania rhadinostachya* subsp. *rhadinostachya* and *Mollugo molluginis*. Some of these species are commonly dominant in the vegetation of the area (e.g. *Triodia wiseana*), or at least frequently contribute to its structure (e.g. *Acacia atkinsiana*). Others are species with wide environmental tolerance, but usually with low abundance (e.g. *Cassia notabilis* and *Mollugo molluginis*).

Families under-represented in the flora at Mesa A compared to areas further east were the Chenopodiaceae (saltbush, bluebush etc.) and Goodeniaceae (fan-flowers).

Flora of conservation significance

Neither of the two DRF which occur in the Pilbara were recorded from Mesa A:

- *Thryptomene wittweri* (Mountain Thryptomene) is only known from high-altitude mountain tops further east in the Pilbara, its distribution extending south into the Gascoyne and Great Victoria Desert bioregions. It has not been recorded from the Pannawonica locality to date. Given the absence of suitable habitat within the mining area, this species would not be expected to occur.
- *Lepidium catapycnon* (Hamersley Lepidium) is known from a number of locations further east in the Hamersley Range. Although suitable habitat (low stony hills and plains) occurs around Pannawonica, this species has not been recorded from the area to date. The closest known population is near Tom Price, some 150 km southeast. This species would not be expected to occur in the mining area.

Two species of Priority Flora were recorded at Mesa A. Both of these species have been previously recorded from the locality:

- *Abutilon trudgenii* ms. (Priority 3): low shrub that is poorly collected rather than rare. This species was recorded from numerous sites in the project area and is expected to be widespread in the project area (Figure 12).
- *Sida* sp. Wittenoom (WR Barker 1962) (Priority 3): medium height spreading shrub. This species was recorded from numerous sites in the project area (Figure 12).

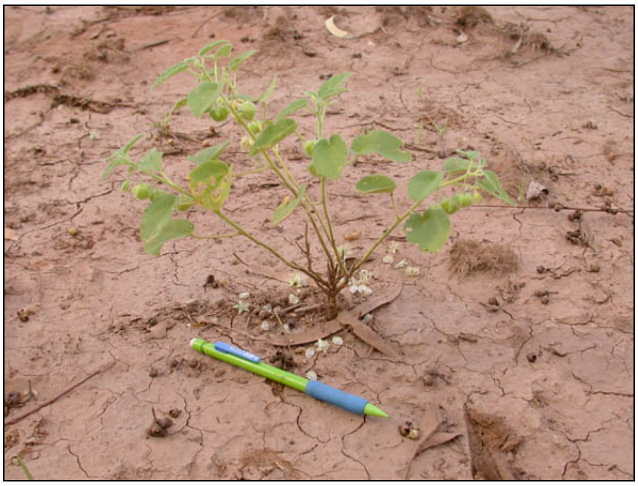
Several additional flora species were identified as being of conservation interest. These are flora species that are not listed as DRF or Priority species by DEC (Nature Conservation Division), but which are poorly known and/or could not be identified to species level for reasons other than poor condition of specimens. These species were:

- *Amaranthus* species: A number of undescribed *Amaranthus* taxa are believed to occur in the Pilbara. The two taxa recorded from the project area have been recorded during other surveys in the region and are considered widespread.
- *Cassia* (*Senna*) species: Numerous undescribed *Cassia* (*Senna*) taxa occur in the Pilbara, including various hybrids between recognised "species". The taxa recorded from the current project area have been recorded during other surveys in the region and do not appear to be geographically restricted.
- *Euphorbia* species: Similar to the previous two genera, there is a large number of undescribed *Euphorbia* taxa in the Pilbara, many of which are poorly collected. The undescribed *Euphorbia* taxa recorded from the project area have been recorded during other surveys in the region, and are not considered to be geographically restricted.

- Malvaceae species (*Abutilon, Hibiscus* and *Sida*): The Malvaceae family has high species diversity in the Pilbara bioregion, with a large number of undescribed taxa. The taxa recorded from the project area have been recorded in other survey areas (particularly at Hope Downs), and are considered poorly collected rather than rare, and not restricted in distribution.
- Papilionaceae (*Indigofera* and *Tephrosia* species): The genus *Indigofera* in the Pilbara contains a number of distinct taxa that are currently undescribed, particularly within *Indigofera "monophylla"*. The *Indigofera* taxa collected from the project area have all been previously recorded elsewhere in the region (M. Trudgen pers. comm. cited in Biota 2005a).

All of the apparently undescribed taxa recorded from Mesa A have been recorded from other survey areas in the region and appear to be widespread.

Most of the species recorded from Mesa A are well within their known ranges (based on voucher specimens lodged with the WA Herbarium). However, the record of *Mukia* sp. D Flora of Australia (A.A. Mitchell PRP 1121) is a small western extension for this species.



Young plant of *Abutilon trudgenii*

Pendant fruit of *Abutilon trudgenii*

Growth form of *Sida* sp. Wittenoom

Fruit of *Sida* sp. Wittenoom

Photos: Biota (2005a)

Figure 12 Priority Flora species recorded from Mesa A

Introduced flora

On the whole, Mesa A was relatively weed free, with only one weed species recorded; *Malvastrum americanum* (Spiked Malvastrum). This species is common and widespread in the Pilbara region and is not listed as a Declared Plant for the East Pilbara under the *Agriculture and Related Resources Protection Act 1976.*

Regional representation of flora

The combined number of taxa recorded from Mesa A is relatively low compared to areas further east, mainly reflecting low rainfall and subdued topography.

No DRF have been recorded from Mesa A, hence there are also no flora listed under the *EPBC Act 1999* within the project area. Two Priority 3 Flora (*Abutilon trudgenii* and *Sida* sp. Wittenoom) have been recorded from Mesa A, both of which have been previously recorded from the local area. Both species are poorly collected rather than rare, and are considered to warrant removal from the Priority listing.

The remaining flora recorded from Mesa A are largely widespread and typical of the Hamersley Range subregion. However, specific areas, such as the sand sheet, have higher conservation value as they support flora restricted to these habitats.

9.1.2 Warramboo

Vegetation

Seven vegetation types were described as occurring at Warramboo (Biota 2006b) (Appendix 2 and Figure 11). The vegetation types fall into three main vegetation groups, related to topography (Table 16).

No TECs listed under the EPBC Act or by DEC (Nature Conservation Division) are known from the Warramboo area.

Table 16 Description of vegetation groups recorded from Warramboo

Vegetation group	Vegetation types	Description
Stony plains	AsAbAaTw	*Acacia* open shrubland over open hummock grasslands (*Triodia wiseana*).
Stony hills and breakaways	ElAatAarTw ElAatAtuGwTw AatAiAarAbTw AiAarTw	Snappy Gum (*Eucalyptus leucophloia*) trees over *Acacia* open shrubland over hummock grasslands (*Triodia wiseana*) and *Acacia* tall open shrubland over open shrubland to heath over hummock grasslands (*Triodia wiseana*).
Minor creeklines and flowlines	ChAtuTwTe ElCcAtuAarTw	*Corymbia hamersleyana* open woodland (sometimes with *Eucalyptus leucophloia*) over *Acacia* shrubland over open hummock grasslands (*Triodia wiseana*).

Vegetation condition

The vegetation types at Warramboo were generally in very good condition. No weeds were recorded; the main disturbance was from vehicle tracks of varying ages.

Probable regional distribution of vegetation types

Biota (2006b) determined the probable distribution of the vegetation types that occurred at Warramboo based on their correspondence with the Land Systems described in Section 2.1.2. On the whole, the vegetation types identified within the study areas are compatible with the broad descriptions of their associated Land System(s).

A PATN analysis was also undertaken to provide an understanding of the floristic composition of vegetation of the wider project area (including Warramboo, northern transport corridor and other areas no longer included in the project) in relation to the surrounding region. The analysis indicated the relationships between sites on the basis of floristic composition.

The PATN analysis indicated that at a broad level, most of the floristic groupings were not restricted to the wider project area. The exception comprised two floristic groupings, one of which included sampling sites from Warramboo:

- Floristic grouping comprising nine sites, consisting mainly of *Acacia ancistrocarpa* and *A. bivenosa* shrublands over *Triodia wiseana* hummock grasslands on stony plains, together with flowlines through these areas. The sites in this floristic group were widespread within the study area, occurring outside the immediate Warramboo area.

It is probable that additional sampling in intervening areas would identify comparable floristic communities in other parts of the region, although these would be unlikely to extend beyond the western Pilbara.

Conservation significance of vegetation

Biota (2006b) considered three categories of information for assessing the conservation significance of the vegetation types at Warramboo:

1. Aspects of the vegetation types (e.g. area, frequency of occurrence, capacity to support rare or restricted flora, condition).
2. Land Systems present in the area.
3. Floristic groups identified by the PATN analysis.

Vegetation types were scored based on the various features within these three categories and ranked into four classes according to a total score; very high, high, moderate, low (Biota 2006b, Appendix 2).

All except one vegetation type at Warramboo were considered to be of *moderate* conservation significance. The *Acacia synchronicia* shrublands on stony plains vegetation type (AsyAbAaTw), which supports Priority Flora, was considered to be of high conservation value.

Flora

Species richness of Warramboo

A total of 72 taxa of native vascular flora were recorded from Warramboo. As for Mesa A, habitats with more favourable conditions (e.g. flowlines with deeper soils) typically had more species than habitats with less favourable conditions (e.g. hill crests with shallow soils).

Similar to Mesa A, the Warramboo area is relatively species poor in comparison to areas in the Pannawonica locality and areas further east in the Hamersley Range.

Dominant species

The dominant families recorded from Warramboo were the Poaceae (grass family), Mimosaceae (wattle family), Caesalpiniaceae (cassia family), Malvaceae (hibiscus family) and Papilionaceae (pea family). These families are typically predominant in the vegetation of the Pilbara, and usually have most representatives on flora lists from this region, due to their prominence in the Eremaean flora.

Families under-represented in the flora at Warramboo compared to areas further east include the Goodeniaceae (fan-flowers).

Flora of conservation significance

No DRF was recorded from Warramboo. Two species of Priority 3 Flora were recorded, both of which have been previously recorded from the locality and at Mesa A:

- *Abutilon trudgenii* ms. (Priority 3): see description in Mesa A section above and Figure 12.
- *Sida* sp. Wittenoom (WR Barker 1962) (Priority 3): see description in Mesa A section above and Figure 12.

Some of the species at Warramboo were identified as being of conservation interest because they are poorly known and/or could not be identified to species level for reasons other than poor condition of specimens. These species included:

- The taxon *Indigofera monophylla* contains numerous distinct entities in the Pilbara. The specimens from the current study area have not been identified fully at the time of writing. It is possible that they may include taxa with restricted distributions, however further collections and consideration would be required to determine this.
- Malvaceae species (*Abutilon, Hibiscus* and *Sida*): The Malvaceae family has a high species diversity in the Pilbara bioregion, with a large number of undescribed taxa. The undescribed *Sida* taxon recorded from Warramboo - *Sida* aff. *cardiophylla* (site 1215) – has been recorded in other survey areas (particularly at Hope Downs), and is considered poorly collected rather than rare, and not restricted in distribution.

Introduced flora

No weed species were recorded in the Warramboo area during the recent surveys.

Conservation significance of flora

Similar to Mesa A, the combined number of taxa recorded from Warramboo is relatively low compared to areas further east, mainly reflecting low rainfall and subdued topography. The Warramboo area is also relatively species poor compared to other study areas in the Pannawonica locality.

No DRF have been recorded from Warramboo while two Priority 3 Flora species (*Abutilon trudgenii*, and *Sida* sp. Wittenoom) have been recorded. Both of these species have been previously recorded from the local area, are poorly collected rather than rare, and are considered to warrant removal from the Priority listing.

The remaining flora species recorded from Warramboo are largely widespread and typical of the Hamersley Range subregion.

9.1.3 Survey limitations

In addition to those limitations already discussed in the previous sections, the other main limitations of the Biota (2005a, 2006b) surveys include:

- Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically sampled, although some samples were opportunistically collected.
- Although the field work was done at an appropriate time for detecting most ephemeral flora, some species (e.g. annual daisies that would germinate mostly after late winter rains) would not have been present or identifiable at the time of survey. Nonetheless, it is estimated that over 90% of the flora species in the area would have been recorded.
- As some of the sites were only sampled once, additional species might be recorded if the sites were revisited. The species lists should therefore be taken as indicative rather than exhaustive.
- The vegetation units for the study were defined based on interpretation of aerial photography signatures combined with the site data recorded during the field survey. As it was not possible to map areas outside the study area in this way, the distribution of these units outside the study area can only be inferred by their correlation with the Land Systems mapping prepared by the Department of Agriculture. This means that there is a level of uncertainty regarding the assessment of distribution of these vegetation types outside the current study area.
- The PATN floristic analyses conducted for Mesa A and Warramboo are fundamentally limited by the data currently available for the region, which is typically has patchy distribution through the Pilbara and concentrated in development areas.

9.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the proposal may have an impact on vegetation and flora values:

- **Vegetation clearing** for the mine pit area, waste dumps and for establishment of infrastructure such as plant, access tracks and haul roads, will lead to the direct disturbance of vegetation communities and potentially Priority Flora species.
- **Alterations to surface hydrology** may have an impact on those vegetation communities that rely on surface flows.
- **Vehicle movements** could potentially introduce and/or spread weed species.
- **Dust generation** could potentially smother vegetation, thereby retarding growth.

Increased fire frequency/intensity may favour the establishment of weeds and could also prevent the regeneration of native vegetation. However, it is pastoral activities, as opposed to mining activities, that are expected to exacerbate fire regimes in the Pilbara.

Groundwater drawdown in the vicinity of the deep Warramboo aquifer is not expected to have any impact on vegetation. The vegetation at Warramboo is not reliant on this aquifer as a water source as the water table is greater than 15 m below ground surface.

9.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA objectives

The EPA normally applies the following objective to the assessment of proposals that may affect vegetation and flora. The objective is considered relevant to this assessment:

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

The following overriding EPA objective addressing biodiversity is also relevant to this factor:

- *Maintain biological diversity where that represents the different plants, animals and micro-organism, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.*

National Strategy for Conservation of Australian Biodiversity

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

EPA Position Statement No. 2

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

- comparison of development scenarios or options of biodiversity at the species and ecosystems level
- no known species of plant or animal is caused to become extinct as a consequence of the development and the risks to threatened species are considered to be acceptable
- no association or community of indigenous plants or animals ceases to exist as a result of the proposal
- there is a comprehensive, adequate and secure representation of scarce or endangered habitats within the project area and/or in areas which are biologically comparable to the project area, protected in secure reserves
- if the project is large (in the order of 10 ha to 100 ha or more, depending on where in the State) the project area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity are secure and protected
- the on-site and off-site impacts of the project are identified and the proponent demonstrates that these impacts can be managed.

EPA Position Statement No. 3

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

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

EPA Position Statement No. 9

EPA Position Statement No. 9, "*Environmental Offsets*", recognises environmental offsets as one tool that can provide alternative beneficial environmental outcomes in situations where social and economic growth is sought at some detriment to the environment. The Position Statement recognises native vegetation (with some further clarification) as a critical asset. Critical assets represent the most important environmental assets in the State that must be fully protected and conserved. The EPA does not consider it appropriate to validate or endorse the use of environmental offsets where projects are predicted to have significant adverse impacts to critical assets.

EPA Guidance Statement No. 51

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

Significance of vegetation and flora

The assessment framework for assessing the significance of vegetation and flora was described above in Section 9.1.1 and Section 9.1.2 and in Biota (2005a, 2006b) which is contained in Appendix 2.

9.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

9.4.1 Vegetation clearing

In total, approximately 2250 ha of vegetation will be cleared for the development of the Mesa A/ Warramboo mining areas, including associated infrastructure (e.g. camp, plant, mine roads) and excluding the transport corridor and the Warramboo wellfield (Table 17). Clearing requirements for the transport corridor are described separately in Section 18.

Approximately a further 20 ha of vegetation disturbance will be required for the installation of the Warramboo aquifer wellfield (wells, access tracks and associated infrastructure) for use during mine construction and operation (Section 14).

Areas to be disturbed for the proposed wellfield will be surveyed prior to any ground disturbance activities and the results incorporated in the wellfield planning process. Areas containing populations of significant flora and vegetation of high conservation value will be avoided and protected from disturbance as far as practicable.

Robe has designed the project to keep vegetation clearing to only that required for meeting infrastructure and mining requirements for safe and efficient mining operations. Any opportunity to reduce the footprint will be taken into account during detailed design stages.

Table 17 Area of vegetation types in mining areas to be cleared (excluding Warramboo wellfield)

Vegetation types	Approximate area to be cleared (ha)
Stony hills and breakaways	
AatAiAarAbTw	178
AiAarTw	69
ElAarTw	244
ElAatAarTw	1047
ElAatAtuGwTw	23
ElAiAbTw	58
ElAprAatAarTw	3
ElAtuAbTwERIm	30
ElCcAtuAarTw	38
Sub total	**1690**
Stony plains	
AiAaAbTw	106
AatAbTe	2
AsyAbAaTw	56
AsyAbTlo	3
AxTw	15
CcAaAbAsyTeTw	12
CcAsyCAoTla	23
ChCzAtrAaTla	146
Sub total	**363**
Minor creeklines and flowlines	
CcChAatAaTe	25
CcChAtrAbPlTwTe	7
ChAtuGwAatAarTw	20
ChAtuTeTw	4
ChCzAtuAtrTe	1
Sub total	**57**
Clayey Plains	
AxCAoTwTe/h	18
Sand sheet	
CzAtGeTs	3
Not mapped	119
Total	**2250**

The majority of the disturbance requirements (approximately 75% or 1690 ha) will occur in vegetation types of the stony hills and breakaways. The vegetation types of this group are considered to be of *moderate* conservation significance (Biota 2005a, 2006b).

All vegetation types, except one, in areas proposed for disturbance are considered likely to be more widely represented in the western section of the Hamersley sub-region. The exception being the vegetation of the sand sheets (S1: CzAtGeTs). This vegetation type is likely to be restricted in distribution in both the local area and region and is consequently considered to be of *very high* conservation significance. Robe's original designs had key infrastructure (waste dumps, plant and load-out) located in the area of the main sand sheet as this was the most efficient location in terms of capital and operational costs. Robe, in consultation with Biota and DEC (Nature Conservation Division), recognised the significance of the sand sheet vegetation during the project planning stages and revised designs such that no infrastructure will be placed on the main sand sheet. Approximately 3 ha of the sand sheet vegetation (2% of the sand sheet occurrence within the project area) falls inside the proposed mining area and will be disturbed. Much of this 3 ha is located on top of Mesa A and has been previously disturbed. The remaining undisturbed areas of sand sheet vegetation (approximately 145 ha) will be protected from all disturbance. Protection measures will include demarcation of the main sandsheet, appropriate signage and drainage design. The loss of 3 ha of the sand sheet will therefore not affect the conservation status of this vegetation community.

Around 12% (266 ha) of the disturbance will occur in vegetation types considered to be of *high* conservation significance (as ranked by Biota 2006b). They include vegetation types from the stony plains, creeklines and clayey plains vegetation groups (AsyAbAaTw, AxTw, CcAsyCAoTla, ChCzAtrAaTla, CcChAtrAbPlTwTe, ChCzAtuAtrTe, AxCAoTwTe/h). These vegetation types are considered to be of *high* conservation significance as they typically support Priority Flora or habitat-specific flora species, however, they are likely to be more widely distributed in the Pannawonica locality[7]. There is limited publicly available data to compare the findings of vegetation surveys with (Biota 2006g). However, aerial photography shows that clayey habitat extends outside the study area over a further 175 ha southeast of Mesa A, 60 ha west of the Deepdale Road and 155 ha east of the Deepdale Road (Biota 2006g). There are also some areas of clayey habitat along the southern transport corridor. It is very likely that the vegetation types of high conservation significance associated with this habitat within the study area are also represented in these areas outside it. Therefore, while some areas have been classified as high conservation significance, they are also likely to be more widely distributed in the Pannawonnica locality than existing data perhaps indicates (Biota 2006g).

The vegetation types of high conservation significance were considered as part of the project planning, however as they are distributed throughout both the proposed northern and southern corridors, it is impossible to avoid all disturbance to them. As only one transport corridor will be selected, the other proposed corridors could be used to provide an indication of the wider distribution of the vegetation types (including vegetation of high conservation significance) outside the transport corridor that is selected. The transport corridors that are not selected will be conserved and this will mean that the

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[7] It is impossible to know how much of these vegetation types are reserved, as there is no equivalent definition/mapping of vegetation in the conservation estate. There are three conservation reserves in the locality, only two of which are formally gazetted:

- Millstream-Chichester National Park is located approximately 110 km northeast
- Karijini National Park is located approximately 220 km southeast
- Cane River Conservation Park is located approximately 50 km southwest.

conservation status of vegetation of high conservation significance is not expected to be greatly affected.

Taking into consideration the likely regional distribution of most vegetation types occurring in the project area and the relatively small area of disturbance of the sand sheet vegetation and other vegetation types of conservation significance, the development would be expected to have only a local impact on the vegetation types present and unlikely to have regional implications.

Two species of Priority 3 Flora will be directly affected by the mine development; *Abutilon trudgenii* ms. and *Sida* sp. Wittenoom. Both species are known from other sites in the Pannawonica and wider Pilbara region and are considered to warrant removal from the Priority species listing. The loss of flora from disturbance to the project area is not expected to affect the conservation status of these two Priority Flora species. Robe will ensure significant populations of Priority Flora are protected from disturbance as far as practicable.

Other flora species recorded in the project area are relatively common and widespread in the Pilbara bioregion.

9.4.2 Alteration of surface drainage flows

The proposed Mesa A pit does not intersect any creeks or rivers. The Warramboo pit intersects a number of minor creeks that will be diverted around the perimeter of the pit and into the downstream catchment (Section 13), therefore, flow volumes downstream will be maintained. This will in turn maintain the downstream vegetation composition along the natural drainage courses.

Disruption to sheet flows will also occur due to the construction of levees and cut-off drains which will direct water around the mine pits; the levees and drains will result in a concentration of sheet flows into defined drainage courses (Section 13). There are no known vegetation types within the study area that would be expected to be sustained by sheet flow, however ponding of sheet flow could lead to vegetation death (Biota 2006b). Robe will design levees and drains so as to ensure natural drainage flows are maintained wherever possible and to avoid ponding of water.

9.4.3 Weeds

Mesa A and Warramboo are currently relatively weed free. Movement of vehicles has the potential to introduce weeds and/or spread existing populations of weeds within the project area as does the presence of cattle. Implementation of a weed hygiene and control program will reduce the potential for the introduction and spread of weeds. As an extension of this weed program, Robe will implement a weed control program along Robe River within the operational area to target stands of Parkinsonia and other priority weeds.

9.4.4 Dust

Dust may have physical effects on plants such as blockage and damage to stomata, shading, abrasion of leaf surface or cuticle and cumulative effects (e.g. drought stress on already stressed species). Vegetation located close to roads and other sources of dust is more likely to be subject to such impacts. Areas of clay substrate have the potential to generate large amounts of dust from even light vehicle movement. As a result of Mesa A/Warramboo project, areas along new roads not currently affected by dust will be temporarily affected. Robe will minimise the number of tracks utilised by Robe vehicles to reduce adverse impacts resulting from dust and erosion.

9.5 PROPOSED MANAGEMENT ACTIONS

Vegetation and flora issues at Mesa A/ Warramboo will be addressed by the following proposed management actions:

- undertake DRF and Priority Flora surveys of areas proposed for disturbance which have not already been surveyed prior to ground disturbance activities in those areas
- prepare and implement separate Construction Environmental Management and Environmental Management Plans which include flora and vegetation management actions to:
  - minimise clearing
  - avoid disturbance to significant populations of Priority Flora as far as practicable
  - avoid disturbance to significant populations of DRF should they be present or apply for appropriate permits if disturbance cannot be avoided
  - avoid disturbance to TECs should they be present
- prepare and implement separate Construction Environmental Management and Environmental Management Plans which include fire management actions in all operational and adjacent areas
- prepare and implement separate Construction Environmental Management and Environmental Management Plans which include weed management actions in all operational and adjacent areas. Weed management actions include:
  - identify and map the extent and distribution of target weed species occurring within the project area
  - establish and maintain a weed inventory recording the location of weed species within the project area
  - site inspections to record new observations of weed infestations
  - staff inductions to include information on identification, reporting of weeds and procedures to prevent the spread of weeds
  - weed hygiene measures for vehicles and machinery entering and leaving the project area
  - minimise site disturbance by avoiding unnecessary clearing of vegetation during construction
  - implement a weed control program for targeted weed species e.g. target stands of Parkinsonia and other priority weeds along Robe River within the operational area
- ensure no direct disturbance to the sand sheet with the exception of approximately 3 ha which lies within the mining area
- prevent access to the main sand sheet area adjacent to Mesa A by demarcating the area and installing signage
- indicating the main sand sheet area as an 'environmentally sensitive area' on the Pilbara Iron GIS system, with no disturbance allowed
- implement drainage measures to divert potentially sediment contaminated run-off away from the main sand sheet area
- monitor the condition of the vegetation on the sand sheet

- support research of an unresolved floristic taxonomic issue in a selected Pilbara flora species[8].

9.6 PREDICTED OUTCOME

The Mesa A/Warramboo mine development will result in the progressive removal and eventual rehabilitation of approximately 2250 ha of native vegetation over the life of the project (excluding transport corridor). There is an increased risk of the spread of weeds, however this will be mitigated through Robe's weed control and hygiene procedures.

The project is not expected to have any significant effect on regional flora and vegetation values due to the wide distribution of most vegetation types and flora species found in the project footprint and the control measures that will be implemented to minimise impacts on flora and vegetation values. No recorded TECs or DRF populations will be affected by mining. Consistent with EPA objectives, the abundance, species diversity, geographic distribution and productivity of flora at species and ecosystem levels will be maintained thereby conserving regional biological diversity. The botanical studies undertaken by Robe have ensured that highly significant floristic areas will be substantially avoided and the implementation of vegetation protection measures will further ensure impacts are mitigated.

[8] Specimens of apparently undescribed taxa will be submitted to the WA Herbarium and/or relevant specialist taxonomist to allow further research.

10. TERRESTRIAL FAUNA

10.1 DESCRIPTION OF FACTOR

The range of habitats found over the project area are known to support a range of fauna species, including several that are endemic to the region and/or listed for protection under State and Federal conservation legislation.

Recently, fauna surveys were undertaken at Mesa A and Warramboo by Biota which were generally consistent with EPA Position Statement No. 3 "*Terrestrial Biological Surveys as an Element of Biodiversity Protection*" (EPA 2002b) and Guidance Statement No. 56 "*Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*" (EPA 2003a, Biota 2005b and Biota 2006c).

The following description of the fauna of Mesa A and Warramboo is adapted from Biota (2005b and 2006c), unless otherwise stated. The Biota reports are contained in Appendix 2.

10.1.1 Mesa A

Fauna habitat

Biota (2005b) identified three primary habitat types at Mesa A, which were largely based on vegetation structure (from Biota 2005a) and landform, and undertook fauna sampling within each (Figure 11). These habitats were:

- stony hills and plains (site MEA01, MEA06, MEA11, MEA21, MEA23)
- sand dunes and sand sheets (site MEA14)
- creeklines and floodplains (site MEA05).

The majority of the vegetation types at Mesa A did not appear to be restricted in distribution (Biota 2005b), suggesting that the fauna habitats are likewise probably more broadly distributed. The notable exception was vegetation type S1: CzAtGeTs, which corresponds to the sand sheet habitat (site MEA14). Biota (2005b) considered this habitat to be of *very high* conservation significance to fauna, as it is considered likely to be restricted in distribution in both the local area and region, and supports a distinctive assemblage (e.g. the Delicate Mouse *Pseudomys delicatulus*, Spinifex Hopping Mouse *Notomys alexis*, and burrowing skinks such as the coastal form of *Lerista muelleri*).

An additional fauna habitat of importance is the edge of Mesa A, and in particular the northern gorge on the eastern escarpment of Mesa A (site MEA06). The edges of the mesas are characterised by the presence of caves and overhangs. Similarly caves and rocky substrates in the northern gorge on the eastern escarpment of Mesa A yielded the Ghost Bat *Macroderma gigas* (Priority 4), evidence of the Northern Quoll *Dasyurus hallucatus* and the as yet undescribed and poorly collected skink *Eremiascincus* sp. nov.

Fauna

Birds

A total of 292 birds representing 29 species were recorded at Mesa A. The most species rich site was MEA14 (19 species; 94 individuals), which corresponded to the sand sheet habitat. The site poorest in species was MEA23 (five species; 11 individuals), which corresponded to a habitat of *Acacia* over *Triodia*. *Triodia* (spinifex) flats with little overstorey typically have the lowest species diversity of any habitat. It should be noted, however, that spinifex flats do contain a few specialised species that rarely occur in other habitats.

The most abundant species at Mesa A were *Emblema pictum* (Painted Finch; 85 individuals) and *Melopsittacus undulatus* (Budgerigar; 56 individuals).

Regional endemism and restricted taxa

The Striated Grasswren *Amytornis striatus whitei* was the only bird species recorded in the Mesa A fauna survey that is considered endemic to the Pilbara bioregion. It is widespread and common in the bioregion in suitable habitat, which usually consists of *Triodia* growing on scree slopes, mesa tops and, particularly, the edges of hilltops (Johnstone and Storr 2004). The Striated Grasswren appears to favour areas where there are some patches of bare, exposed rocks and it occurs primarily on banded ironstone (Dr Mike Craig, Biota, pers. obs. 2005, cited in Biota 2005b).

The only other regional near endemic that may occur in the project area is the Black-tailed Treecreeper *Climacteris melanura wellsi,* which was not recorded during the Mesa A survey. This species typically occurs in eucalypt woodland, either along minor watercourses or in more open woodlands on scree slopes and mesa tops.

Species of conservation significance

No birds of conservation significance were recorded during the Mesa A survey; however three species of conservation significance could potentially occur in the area (Section 10.1.3).

Mammals

Ground mammals

Six species of ground mammal were recorded in surveys of Mesa A. These species were: *Tachyglossus aculeatus* (Short-beaked Echidna), *Ningaui timealeyi* (Pilbara Ningaui), *Dasyurus hallucatus* (Northern Quoll), *Macropus robustus erubescens* (Euro), *Pseudomys delicatulus* (Delicate Mouse) and *Canis lupus dingo* (Dingo). All species were native, with the exception of the Dingo (Biota 2005b).

Regional endemism and restricted taxa

N. timealeyi was the only mammal species recorded in the Mesa A survey that is considered a near endemic to the Pilbara bioregion. It is widespread and common across a range of substrate types vegetated with *Triodia* species.

Other regional endemics or near endemics that may occur in the project areas but were not recorded during the survey of Mesa A include *Dasykaluta rosamondae* (Little Red Kaluta), *Planigale* sp. and *Petrogale rothschildi* (Rothschild's Rock Wallaby). *D. rosamondae* exhibits a distribution that closely mirrors *N. timealeyi* and is found across a wide range of substrates dominated by *Triodia* spp. (Biota 2005b). *Planigale* sp. is believed to be restricted to the Pilbara bioregion (Ms Norah Cooper, WA Museum, pers. comm. 2005, cited in Biota 2005b). Within Western Australia, the genus Planigale has undergone recent revision, resulting in the recognition of two new species in the Pilbara bioregion (Norah Cooper, WA Museum, pers. comm. 2005, cited in Biota 2006c). The two newly erected species may be separable on the basis of habitat type, with one frequenting heavy soils such as self-mulching clays in the Chichester Range and weakly gilgaied soils and the second showing a preference for scree slopes , major creeks, stony plains and adjacent habitats. *Petrogale rothschildi* favours large boulder screes, boulder tors and breakaways with caves and overhangs.

Species of conservation significance

The Northern Quoll (*Dasyurus hallucatus*) is listed as endangered under the EPBC Act. This species is listed as endangered as it has recently undergone a considerable contraction of its range across Queensland and the Northern Territory (due to the effects of grazing, fires and Cane Toads); however this contraction does not appear to have occurred in the Kimberley region of Western Australia. The status of this species in the Pilbara is less clear and poorly understood. The taxon is not listed by DEC (Nature Conservation Division) under the *Wildlife Conservation (Specially Protected Fauna) Notice 2005*, nor is it listed as a Priority species (Biota 2006c).

Surveys of the Robe Valley suggest that the area supported a large population of Northern Quolls (Ecologia 1991), although targeted searches trapped just one individual (Biota 2006c). This species was trapped on the scarp of Mesa B. A skull from this species was also recovered from a small cave at Mesa A (Biota 2005b).

Bats

Four species of bat were recorded during an echolocation study at Mesa A (site MEA06). These species were *Vespadelus finlaysoni* (Finlayson's Cave Bat); *Chaerephon jobensis* (Northern Free-tail Bat); *Chalinolobus gouldii* (Gould's Wattled Bat) and *Scotorepens greyii* (Little Broad-nosed Bat). *V. finlaysoni* typically roosts in caves and other subterranean structures and the other three species generally roost in trees (Churchill 1998).

An additional species of bat, *Macroderma gigas* (Ghost Bat) was sighted leaving a cave at Mesa A (site MEA06).

Species of conservation significance

One Priority 4 listed species, *Macroderma gigas* (Ghost Bat), was sighted leaving a cave at Mesa A.

Biota (2005b) note that *Rhinonicteris aurantius* (Orange Leaf-nosed Bat) may occur within caves located in the Mesa A area. This is a Schedule 1 species and is federally listed as vulnerable.

Reptiles

Twenty six species of herpetofauna (121 individuals) were recorded during surveys of Mesa A. The reptiles comprised six geckos (Gekkonidae); three legless lizards (Pygopodidae); three dragons (Agamidae); eleven skinks (Scincidae); one goanna (Varanidae); and two front-fanged snakes (Elapidae).

The most abundant group were the Scincidae, which accounted for approximately 67% of all herpetofauna recorded in the Mesa A survey. The most common species was *Lerista bipes*, with 47 specimens recorded from one site (MEA14). The most speciose site was MEA14 with 17 species (78 individuals) recorded. The site poorest in species was MEA21 with one species (1 individual) recorded.

The absence of frog records during the Mesa A survey is likely to be indicative of the lack of any rain during the survey period.

Regional endemism and restricted taxa

Acanthophis wellsi (Pilbara Death Adder) was recorded during the Mesa A survey, and is endemic to the Pilbara. A number of other species that are endemic or nearly endemic to the Pilbara may occur in the project area: *Delma elegans* (recorded from Warramboo in March 2005), *Diplodactylus savagei* (recorded in March 2005 from Warramboo, in October 2004 at Brockman 4, and in 1991 at Mesa J (Ecologia 1991)), *Nephrurus wheeleri cinctus* (recorded in March 2005 from Warramboo), *Notoscincus butleri* (recorded in March 2005 from Bungaroo Creek), *Diplodactylus wombeyi* (recorded in October 2004 at Brockman 4), *Lerista flammicauda* (recorded by Ecologia at Mesa J in 1991) and *Varanus aff gilleni* (recorded in March 2005 from Bungaroo Creek and in 1991 from Mesa J (Ecologia 1991)).

Unresolved species complexes

Several reptiles collected were representatives of unresolved taxa with uncertain conservation significance. The most significant of these is *Eremiascincus* sp. nov., of which one individual was collected at site MEA06 (Figure 13). This individual is the first adult specimen collected, and represents a new taxon which is yet to be described. Only two other individuals from this taxa have previously been recorded. All three specimens have been found in rocky gorges, a habitat not typical of the two described species, *E. richardsonii* and *E. fasciolatus,* both of which favour sandy areas.

Robe commissioned genetic analysis of the *Eremiascincus* sp. nov specimens. The analysis showed that the specimen collected at Mesa A is genetically and/or morphologically related to four other specimens in the area bounded by a triangle between Newman, Onslow and Roebourne (Doughty and Donnellan 2005).

Given the apparently wider distribution of this taxon and habitat preference (rocky gorges), it may be undersampled rather than rare.

Photo: Greg Harold (Biota 2005b)

Figure 13 *Eremiascincus* sp. nov. collected during the Mesa A fauna survey

Species of conservation significance

No Schedule or Priority listed herpetofauna species were recorded during the Mesa A survey. Three species of conservation significance potentially occur within the area (Section 10.1.3).

Invertebrates

Two taxa of short-range endemic invertebrates were recorded during surveys of Mesa A. These were:

- one species of terrestrial mollusc, *Rhagada convicta*, collected from Mesa A (site MEA01)
- one mygalomorph spider from Mesa A (site MEA01), however this specimen is awaiting identification from the Western Australian Museum.

Eight families of araneomorph spiders were recorded from Mesa A; seven at site MEA01; one at site MEA03; and three at site MEA14. Specimens were identified to morphotypes and are awaiting confirmation from the Western Australian Museum. Twenty-four scorpionids were collected from Mesa A; twenty-three at site MEA01 and one at site MEA03.

Introduced fauna

One introduced species, *Canis lupus dingo* (Dingo) (Biota 2005b), was recorded at Mesa A (sites MEA01 & MEA14).

10.1.2 Warramboo

Fauna habitat

Biota (2006c) identified three primary habitat types at Warramboo, and undertook fauna sampling within each (Figure 11). These habitats were:

- stoney plain (site WA01)
- low stoney hillside (sites WA03, WA04)
- narrow drainage line (site WA02).

An area of fauna habitat considered to be of conservation significance at Warramboo includes the vegetation and soils of creeklines through stony plains, which may support short-range endemic invertebrates.

Fauna

Birds

A total of 180 birds representing 20 species were recorded at Warramboo. The most abundant species were *Lichenostomus virescens* (Singing Honeyeater; 55 individuals) and *Melopsittacus undulatus* (Budgerigar; 25 individuals).

In general, sites that were dominated by *Triodia* species and lacking an overstorey were relatively species poor. This was particularly evident at Warramboo, where all sites were characterised by relatively low species richness.

Regional endemism and restricted taxa

The Black-tailed Treecreeper *Climacteris melanura wellsi* is considered to be near endemic to the Pilbara. This species was not recorded in surveys of Warramboo, however may be expected to occur in habitats found within the area. The species is typically found in eucalypt woodlands along watercourses, scree slopes or mesa tops.

Species of conservation significance

Five bird species of conservation significance could potentially occur in the Warramboo area (Section 10.1.3).

Mammals

Ground mammals

Two species of ground mammal were recorded during the survey of Warramboo: *Dasykaluta rosamondae* (Little Red Kaluta) and *Ningaui timealeyi* (Pilbara Ningaui).

Regional endemism and restricted taxa

The two species recorded in surveys of Warramboo are considered to be nearly endemic to the Pilbara bioregion. *Ningaui timealeyi* is widespread and common in the region, across a range of substrate types vegetated with *Triodia* species. The distribution of *D. rosamondae* closely follows that of *N. timealeyi* and similarly, it is found across a range of substrates dominated by *Triodia* spp.

Petrogale rothschildi is the sole near-endemic that was not recorded during the survey of Warramboo, although it has been documented in the region during previous studies at Mesa J approximately 38 km to the south-east (Ecologia 1991) and at Bungaroo Creek approximately 55 km to the south-east (Biota 2006c). This species favours large boulder screes, boulder tors and breakaways with caves and overhangs.

Bats

Bat surveys were not undertaken at Warramboo.

Reptiles

Thirty species of herpetofauna were recorded during surveys of Warramboo. The reptiles comprised one tree frog (Hylidae); six geckos (Gekkonidae); three legless lizards (Pygopodidae); two dragons (Agamidae); three goanna (Varanidae); eleven skinks (Scincidae); one blind snake (Typhlopidae); one python (Boidae) and one front-fanged snake (Elapidae).

The most abundant group were the Scincidae, with 62 records, accounting for 45% of all herpetofauna records for the survey. The most speciose site was WA02 with 18 species recorded. All other sites recorded over 10 species.

Regional endemism and restricted taxa

Three herpetofauna species considered to be endemic or near endemic to the Pilbara bioregion were recorded during the surveys of Warramboo. These species were *Diplodactylus savagei*, *Delma elegans* and *Ramphotyphlops pilbarensis*.

Unresolved species complexes

A number of specimens collected during the survey of Warramboo represent taxa in which the taxonomic status of different populations are currently uncertain and may be under review. Consequently, the distributions and conservation significance of these groups are difficult to ascertain. These taxa are as follows:

- The *Diplodactylus stenodactylus* species complex is currently under review, with possibly six new species occurring in the Pilbara bioregion (Mr Laurie Smith, WA Museum, pers. comm. 2004, cited in Biota 2006c). The taxonomic and conservation status of the specimens obtained during the survey of Warramboo are uncertain.
- *Diplodactylus savagei* exhibits a range of morphologies within its distribution and may represent a species complex.
- *Glaphyromorphus isolepis* is believed to be a species complex.
- *Menetia greyii* is a known species complex and the conservation status of specimens collected during the Warramboo survey is unclear.

Invertebrates

The Warramboo fauna survey yielded mygalomorph taxa from three families; *Aname* "sp. Pannawonica 1" (Nemesiidae), *Missulena* "sp. Pannawonica 1" (Actinopodidae), and five specimens whose genera are yet to be confirmed (Barychelidae).

Introduced fauna

No introduced species were recorded in fauna surveys at Warramboo.

10.1.3 Conservation significance of fauna

Several species that have been recorded from or potentially occur in the Mesa A/Warramboo area are declared as rare, threatened or vulnerable in State and/or Commonwealth legislation (Table 18).

Table 18 Species of State and Federal conservation significance recorded or likely to occur in the Mesa A/Warramboo area

Species	State level	Federal level	Distribution	Likely presence
Dasyurus hallucatus (Northern Quoll)	Not listed	Endangered	Endemic to Australia, where it occurs in the Hamersley Ranges, Kimberley, north-west Australia, NT and Queensland	Likely to occur along the length of the Robe River and adjacent mesas where there is suitable habitat
Rhinonicteris aurantius (Orange Leaf-nosed Bat)	Schedule 1	Vulnerable	Endemic to Australia, where it occurs in the Pilbara region of WA, through the Kimberley and in NW Queensland	Possibly occurs in caves where water is nearby in the Mesa A area
Pezoporus occidentalis (Night Parrot)*	Schedule 1	Endangered	Records sparsely distributed across inland Australia, with concentrations in western Queensland and the eastern Pilbara	Unlikely to occur in the project area
Liasis olivaceus barroni (Pilbara Olive Python)	Schedule 1	Vulnerable	Endemic to Pilbara	Highly likely to occur

Species	State level	Federal level	Distribution	Likely presence
Tringa glareola (Wood Sandpiper)	Schedule 3	Migratory	Non-breeding migrant from the northern hemisphere	Highly likely to visit area
Falco peregrinus (Peregrine Falcon)	Schedule 4	-	Cosmopolitan distribution. The only subspecies in Australia (*macropus*) is widespread throughout Australia	Likely to occur in Mesa A area as suitable prey species such as parrots, are common
Ramphotyphlops ganei	Priority 1	-	Poorly collected species, known to occur in the Pilbara region	Likely to occur
Antipodogomphus hodgkini (Pilbara Dragonfly)	Priority 2	-	Holotype collected from Millstream Spring, Millstream Station (Watson 1969). Limited published information available for this species.	Not enough is known about the species to comment further on distribution or ecology of this species
Nososticta pilbara (Pilbara Damselfly)	Priority 2	-	Holotype collected from Millstream Spring, Millstream Station (Watson 1969). Limited published information available for this species.	Not enough is known about the species to comment further on distribution or ecology of this species
Sminthopsis longicaudata (Long-tailed Dunnart)	Priority 4	-	Inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region to the Central North Territory and South Australia	Likely to be present
Macroderma gigas (Ghost Bat)	Priority 4	-	Fragmented distribution	Species sighted at Mesa A
Leggadina lakedownensis (Lakeland Downs Mouse)	Priority 4	-	Distribution in Western Australia included the Pilbara and Kimberley regions	Unlikely to occur
Pseudomys chapmani (Western Pebble-mound Mouse)	Priority 4	-	Common to very common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion	No active mounds were recorded during the survey of Mesa A/Warramboo. An active mound was recorded from the transport corridor survey
Neochmia ruficauda clarescens (Star Finch – western)	Priority 4	-	This subspecies occurs in the Pilbara region and has a southern distribution limit of Shark Bay	Unlikely to be a permanent resident in the Mesa A or Warramboo areas. Species was recorded along watercourses and minor drainage lines of the transport corridor
Leiopotherapon aheneus (Fortescue Grunter)	Priority 4	-	Endemic to Pilbara	Highly unlikely to occur in the project area outside the Robe River
Notoscincus butleri	Priority 4	-	Endemic to Western Australia and restricted to the arid northwest of the Pilbara bioregion	Possibly occurs in the Mesa A/Warramboo area. Species recorded in proposed transport corridor

10.1.4 Survey limitations

There are several limitations of the fauna surveys for Mesa A/Warramboo, being:

- Sampling of the Mesa A and Warramboo study areas comprised a single survey phase. It is likely that additional fauna species would be recorded if the sites were revisited at other times of the year.

- The habitats targeted for bat sampling at Mesa A were watercourses and caves where bats might congregate and be easily encountered. The survey methods were biased towards those species that frequent such habitats and which can be readily identified using the Anabat system. This meant that some species could have been missed.
- Terrestrial invertebrate sampling at Mesa A and Warramboo was targeted at specific groups, and was otherwise largely opportunistic. Given the relocation of the WA Museum, it was not possible to complete identifications of all collected invertebrates (Biota 2005b). Identifications beyond morphotype were restricted to those invertebrates considered to be of particular interest, such as short range endemics.

10.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the proposal that may affect fauna values include:

- **Vegetation clearing** for mine pit, waste dumps and associated infrastructure such as plant, access roads and workshops, will directly disturb terrestrial fauna habitat and may result in the deaths of of individual terrestrial fauna.
- **Alterations to surface hydrology** flows may affect fauna habitats that rely on surface water flows.
- **Vehicle movements** in mining areas and on mine access roads could potentially result in the deaths of individual fauna, particularly less mobile species.

Minor potential impacts include noise emissions from the mining operations, which may cause habitats close to mining operations to be unsuitable for fauna foraging and habitat, however this is not anticipated to be a significant impact. Dust generated during the mining and ore handling process, and introduction of weed species may also have minor impacts on fauna in the Mesa A/Warramboo areas.

10.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA objective

The EPA normally applies the following objective in its assessment of proposals that may affect fauna. This objective is considered relevant to this proposal.

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

EPA Position Statement No. 3

EPA Position Statement No. 3, "*Terrestrial Biological Surveys as an Element of Biodiversity Protection*", discusses the principles that the EPA would apply when assessing proposals that may have an impact on biodiversity values in Western Australia. The Position Statement intends to provide the following outcomes:

- promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and therefore the need to develop and implement best practice in terrestrial biological surveys

- enable greater certainty for proponents in the environmental impact assessment (EIA) process by defining the principles the EPA will use when assessing proposals which may have an impact on biodiversity values.

EPA Guidance Statement No. 56

As described in the EPA Position Statement No. 3, the EPA determined that a series of guidance statements were warranted to provide an easy-to-use decision-making guide to the level of biological survey required. EPA Guidance Statement No. 56 "*Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*" (EPA 2003a), provides guidance on standards and protocols for terrestrial fauna surveys, particularly those undertaken for the environmental impact assessment of proposals.

State protection

In a legislative context, the preservation and conservation of fauna is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950*
- *Conservation and Land Management Act 1984.*

In Western Australia, rare or endangered species are protected by the *Wildlife Conservation (Specially Protected Fauna) Notice 2005*, under the *Wildlife Protection Act 1950*. Schedules 1 and 4 in this notice are relevant to this assessment, providing a listing of those species protected by this Notice.

The DEC (Nature Conservation Division) Priority Fauna List also nominates conservation species from priority one to five. It is expected that the potential impacts from a proposal on these priority listed species should be managed so that the species do not meet the International Union for Conservation of Nature and Natural Resources (ICUN) criteria for threatened species.

Commonwealth protection

The Commonwealth EPBC Act protects species listed under Schedule 1 of the Act. In 1974, Australia signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, an official list of endangered species was prepared and is regularly updated. This listing is administered through the EPBC Act. The current list differs from the various State lists, however some species are common to both.

International agreements

Australia is party to the Japan-Australia (JAMBA) and China-Australia (CAMBA) Migratory Bird Agreements. Most of the birds listed in these agreements are associated with saline wetlands or coastal shorelines and have little relevance to the proposed area. However, some migratory birds not associated with water are also listed on these international treaties.

10.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

10.4.1 Vegetation clearing

Native fauna relies heavily on native vegetation to provide food, shelter and breeding sites. The loss or degradation of native vegetation may reduce the capacity of the habitat to support the range of species it does in an undisturbed state.

Vegetation will be progressively removed from sections of the project area, firstly during the construction of mining infrastructure, and secondly during the mining process. Approximately 2250 ha of vegetation will be cleared for the development of the Mesa A/Warramboo mining areas, including associated infrastructure (e.g. camp, plant, mine roads) and excluding the transport corridor route.

Approximately a further 20 ha of clearing will be required for construction of the Warramboo aquifer wellfield for use during mine construction and operation.

The majority of the vegetation types at Mesa A/Warramboo do not appear to be restricted in distribution (Biota 2005a, 2006b), suggesting that the fauna habitats are likewise probably more widely distributed. The notable exception is vegetation type S1:CzAtGeTs, which corresponds to the sand sheet habitat located adjacent to Mesa A. This vegetation type is considered likely to be restricted in distribution in both the local area and region, and supports species restricted to the deep sands of this particular habitat (e.g. *Pseudomys delicatulus, Notomys alexis,* and burrowing skinks such as *Lerista muelleri* (of the type that occurs on coastal sands)). This area represents an eastern intrusion of habitats considered to be more characteristic of coastal land systems and supports numerous fauna species not found elsewhere in the study area. Although the habitat was not found to support any rare or otherwise significant taxa (albeit from a single sampling event), this habitat is considered to be of *very high* conservation significance to fauna.

Approximately 3 ha of the sand sheet vegetation will be disturbed, or approximately 2% of the sand sheet occurrence in the project area. The remaining undisturbed areas of sand sheet vegetation (approximately 145 ha) will be protected from all disturbance. Protection measures will include demarcation of the main sandsheet area, appropriate signage and drainage design.

Additional fauna habitats of importance are the edges of Mesa A, and in particular the northern gorge on the eastern escarpment of Mesa A (site MEA06). The edges of the mesas are characterised by the presence of caves and overhangs, which are important habitats for cave dwelling bat species. The northern gorge on the eastern escarpment of Mesa A supports the Priority 4 listed *Macroderma gigas* (Ghost Bat), which may also occur in caves along the edges of the other mesas. The gorge also supports the as yet undescribed and poorly collected skink *Eremiascincus* sp. nov.. Evidence of the presence of the Northern Quoll was also collected from this gorge.

The escarpment of Mesa A is to be retained, except for a small area (approximately 50 m wide) on the middle of the eastern escarpment, to allow for the passage of haul trucks from the mine to the plant area and transport corridor. The escarpment will be within an exclusion zone which will be protected from mining activities.

The remainder of the habitat types of Mesa A are considered to be of *moderate* conservation significance.

An area of fauna habitat considered to be of conservation significance at Warramboo includes the vegetation and soils of creeklines through stony plains, which may also support short-range endemic invertebrates. This type of fauna habitat also occurs along the northern rail transport corridor, and is therefore not restricted to Warramboo.

The remainder of the habitat types of Warramboo are considered to be of *moderate* conservation significance.

10.4.2 Alteration to surface drainage flows

The proposed Mesa A pit does not intersect any creeks or rivers. The Warramboo pit intersects a number of minor creeks that will be diverted around the perimeter of the pit and into the downstream catchment. This will maintain the downstream flows therefore the vegetation composition along the natural drainage courses, and should not significantly alter fauna habitats downstream.

Disruption to sheet flows will also occur due to the construction of levees and cut-off drains which will direct water around the mine pits. The levees and drains will result in a concentration of sheet flows into defined drainage courses. There are no known habitats within the study area that would be expected to be sustained by sheet flow. Conversely, ponding of sheet flow could lead to vegetation death and potential drowning of terrestrial snail communities; however swale drains adjacent to major roads appear to support healthy terrestrial snail populations (Biota 2006c). Robe will design levees and drains so as to ensure natural drainage flows are maintained wherever possible and to avoid ponding of water.

10.4.3 Vehicle and equipment movement

The site preparation process and vehicle movements around the mine site have the potential to kill some individuals that are disturbed and intercepted by heavy machinery. Less mobile species, such as reptiles, are most likely to be affected. Individuals from two species of conservation significance, *Liasis olivaceus barroni* (Pilbara Olive Python) and the blind snake *Ramphotyphlops ganei*, may be accidentally killed during the construction of the mine and infrastructure. Biota (2005b) notes that the conservation status and distribution of these species are unlikely to be affected by this degree of impact[9].

10.4.4 Impacts on fauna of conservation significance

The likelihood of impacts occurring on selected species of conservation significance are discussed below:

- *Dasyurus hallucatus* (Northern Quoll): habitat loss may lead to the deaths of some individuals, however the effect of this on the abundance of the species is difficult to establish given the natural variations recorded for this species. Not enough is known of the foraging behaviour of this species within the Pilbara to be able to determine exactly what consequences will arise from the development of the Mesa A orebody and associated transport corridor in terms of permanent habitat loss. The escarpment of Mesa A will be retained and there will be limited impact on the Robe River; the Northern Quoll appears to be associated with both key features in the riparian-rocky slope continuum habitat. A reduction in geographic spread would appear very unlikely

[9] The conservation status of this species is difficult to ascertain from limited number of records (Biota 2005b).

given that this species is known from all surrounding areas. It is considered unlikely that the proposal will increase the conservation status of this species in Western Australia (based on the IUCN criteria for a Vulnerable classification).

- *Rhinonicteris aurantius* (Orange Leaf-nosed Bat): mining at Mesa A will potentially lead to loss of foraging habitat and roosting sites. However, given that the escarpment of Mesa A is to be retained, the project is unlikely to affect the conservation status of the species.
- *Liasis olivaceus barroni* (Pilbara Olive Python): clearing will potentially lead to habitat loss and the possible deaths of some individuals associated with construction of the mine and infrastructure. However, the conservation status and distribution of the species is unlikely to be affected by the project.
- *Tringa glareola* (Wood Sandpiper): clearing will cause some limited loss of ephemeral habitat. The conservation status and distribution of this species is unlikely to be affected by the project.
- *Falco peregrinus* (Peregrine Falcon): clearing may cause loss of potential nesting and foraging habitat. The conservation status of the species is unlikely to be affected.
- *Ramphotyphlops ganei*: potential habitat loss and the possible deaths of some individuals associated with construction of the mine and infrastructure. The conservation status of this species is difficult to ascertain from limited number of records, however given the scale of the proposal to available habitat the conservation status and distribution is unlikely to be affected.
- *Sminthopsis longicaudata* (Long-tailed Dunnart): clearing will cause potential loss of habitat. The conservation status and distribution is unlikely to be affected by the proposal.
- *Macroderma gigas* (Ghost Bat): mining at Mesa A will potentially lead to loss of foraging habitat and roosting sites. However, given that the escarpment of Mesa A is to be retained, the project is unlikely to affect the conservation status of the species.
- *Neochmia ruficauda clarescens* (Star Finch – Western): the proposed development would be expected to have little effect on the species, given that it is unlikely to occur in the project area permanently. However, it is important to protect creekline vegetation from cattle grazing, frequent burning and to ensure that hydrological disruption to these areas is minimised, as the species may utilise watercourses and minor drainage lines when these hold water.
- *Notoscincus butleri*: clearing will cause potential loss of habitat. The conservation status of this species is unlikely to be affected by the proposed development, either at a bioregion or subregion level.

Other species of conservation significance that potentially occur within the project area are also considered unlikely to be significantly affected by the proposal development.

10.5 PROPOSED MANAGEMENT ACTIONS

Fauna issues at Mesa A/ Warramboo will be addressed by the following management actions:

- ensure no direct disturbance to the sand sheet with the exception of approximately 3 ha which lies within the mining area
- demarcate and install signage on the main sand sheet area adjacent to Mesa A

- retain the Mesa A escarpment and maintain at least a 50 m mining exclusion zone around the Mesa A escarpment (including the three identified gullies), except for the area where the escarpment will be breached to allow access from the pit to the plant area
- prepare and implement an Environmental Management Plan which includes feral animal control, where appropriate
- provide funding and support for ongoing fauna surveys and research to increase knowledge of the faunal ecology of the region, including further research into the Northern Quoll populations of the Robe River locality
- ensure vegetation clearing is kept to the minimum necessary for safe construction and operation of the project, particularly in areas adjacent to habitat of higher conservation significance
- design levees and drains so as to ensure natural drainage flows are maintained wherever possible and to avoid ponding of water
- implement standard dust suppression measures across the project area during construction and operation to mitigate effects on surrounding vegetation and fauna habitat
- undertake progressive rehabilitation.

10.6 PREDICTED OUTCOME

The Mesa A/Warramboo mine development (excluding transport corridors) will result in the progressive loss of approximately 2250 ha of fauna habitat over the life of the project and as a result will potentially affect the local abundance of fauna populations. Negligible amounts of fauna habitats of high conservation significance will be affected by the proposal, and there is unlikely to be significant impacts on fauna which are of conservation significance at a regional, state, national or international level.

Areas of vegetation disturbance will be progressively rehabilitated to restore the original fauna habitat values.

The fauna studies undertaken in the Mesa A/Warramboo project area have ensured that highly significant habitats will be avoided where possible. Robe's commitment to retain the majority of the escarpment of Mesa A, the northern gorge on the eastern escarpment and the majority of the unique sand sheet habitat at Mesa A will reduce the impacts on sensitive fauna in the region. Ongoing fauna surveys and associated research will contribute to increased knowledge of the faunal ecology of the region.

The localised impacts on the abundance of fauna populations will be mitigated by Robe's management actions. The proposal is consistent with EPA objectives, as the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels will be maintained.

11. SUBTERRANEAN FAUNA

The technical background for the assessment of potential impact on subterranean fauna has been provided by Biota Environmental Sciences (Biota 2006f).

11.1 DESCRIPTION OF FACTOR

Subterranean fauna are animals that inhabit underground habitats, and comprise stygofauna and troglofauna. Stygofauna are obligate groundwater-dwelling aquatic fauna that inhabit a range of groundwater systems. Troglofauna are obligate terrestrial fauna that inhabit air chambers in underground caves or small humid air-filled voids.

Research work by the Western Australian Museum has shown that the Pilbara and Yilgarn regions of Western Australia contain diverse stygofaunal communities that inhabit calcrete and alluvial aquifers (Humphreys 1999). Subterranean fauna are also found in palaeodrainage channels in inland deserts of Western Australia (Watt and Humphreys 2001). In the arid zone, troglofauna are generally considered to be relictual rainforest litter fauna, having arisen from tropical fauna lineages that descended into subterranean environments during the aridification of Australia (during the late Miocene; Humphreys 1993).

Western Australian stygofauna and troglofauna exhibit high levels of endemism (EPA 2003b). Many species have restricted ranges, which is a characteristic of subterranean fauna worldwide (Strayer 1994). For example, short-range endemism (*sensu* Harvey 2002) is common in troglofauna, with some species only known from single cave systems (e.g. the millipede *Stygiochiropus peculiaris* from Cameron's Cave at Cape Range; Humphreys and Shear 1993).

Western Australian stygofauna and troglofauna have significant conservation significance, as they appear to be linked to the time when Australia was part of Gondwanaland (Humphreys 1999). Some species of stygofauna have extremely localised patterns of distribution, and this has been linked to the lack of connectivity between aquifers (Watt and Humphreys 2001).

Most subterranean fauna in Western Australia are invertebrates, the most common stygofauna, being crustaceans (EPA 2003b).

11.1.1 Stygofauna

Sampling program

Sampling for subterranean fauna in the project area was first completed by Biota (2004) and focussed on stygofauna sampling at Mesa A as part of exploration stage environmental surveys. No stygofauna were collected from any of the 13 boreholes sampled. This is probably due to the geology of the deposit which lacks an alluvial or calcrete aquifer.

Although no stygofauna were collected, the first records of troglofauna from the mainland Pilbara were opportunistically recovered from the plankton haul nets during stygofauna sampling. Further subterranean fauna investigations therefore focussed on troglofauna at Mesa A, and are discussed below (Section 11.1.2).

Sampling at Warramboo, Tod Bore and Dinner Camp areas was undertaken in October 2005 by Biota (2006d). The Tod Bore and Dinner Camp areas are located south west of Warramboo. The majority of the 23 bores sampled within the Warramboo, Tod Bore and Dinner Camp areas were exploration drill holes installed between 1982 and 2004 (Figure 14). The sampling program followed similar methodology to that applied to other stygofauna sampling work recently completed in the region. The approach adopted was consistent with that outlined in EPA Guidance Statement No. 54 (EPA 2003b).

Sampling results

During the 2005 sampling at Warramboo, Tod Bore and Dinner Camp, samples were obtained from 21 of the 23 bores selected; one bore was no longer present and one was dry at the time of sampling.

Stygofauna were recorded from only a single bore, MEARC3167 (Figure 14), within the Tod Bore area; where 20 oligochaetes were collected. More detailed identification of these specimens has not been completed at this time. The majority of the oligochaetes specimens collected in recent Pilbara work appear to be relatively widespread at the species level (Biota 2006d).

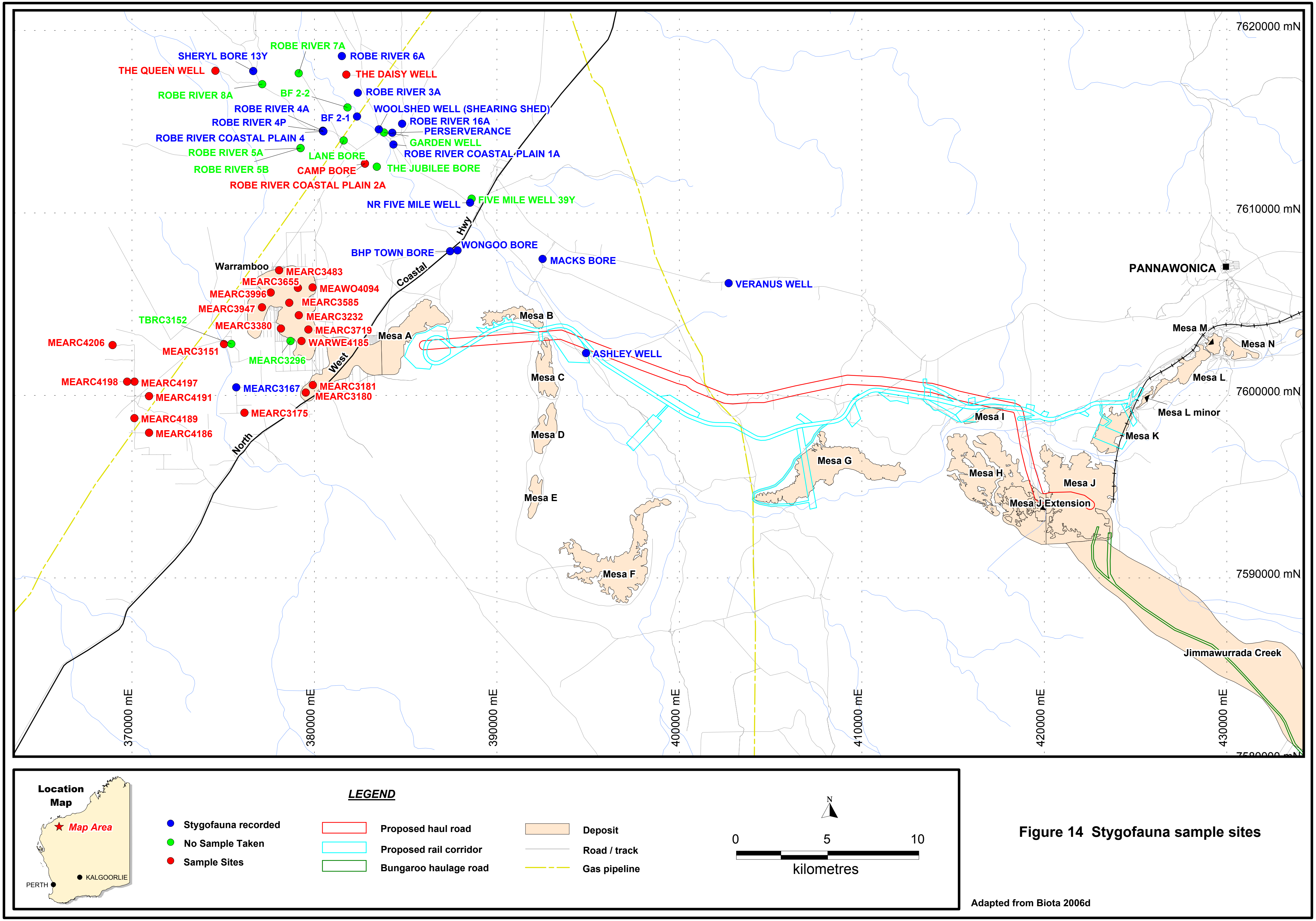


Figure 14 Stygofauna sample sites

Adapted from Biota 2006d

11.1.2 Troglofauna

Sampling program

The initial subterranean fauna sampling in December 2003 recovered four troglobitic taxa from two of the sampled bores at Mesa A, which was recognised as an outcome of considerable significance (Biota 2004). Troglofauna had never before been documented from mesa formations on the mainland Pilbara region and had previously only been recorded in Western Australia from karstic limestone systems (at Cape Range, Barrow Island and in the Kimberley; Harvey 1988, Biota 2002, Humphreys 2001). Very little previous work in terms of comprehensive surveys and sampling programs has been documented on troglofauna. The specimens from the 2003 survey were the first documented record of such a fauna occurring in a pisolitic mesa formation. Biota (2004) suggested that the humid, dark, fractured and vuggy environment indicated by drill logs from Mesa A were analogous to the habitats occupied by troglobites in karstic limestone formations.

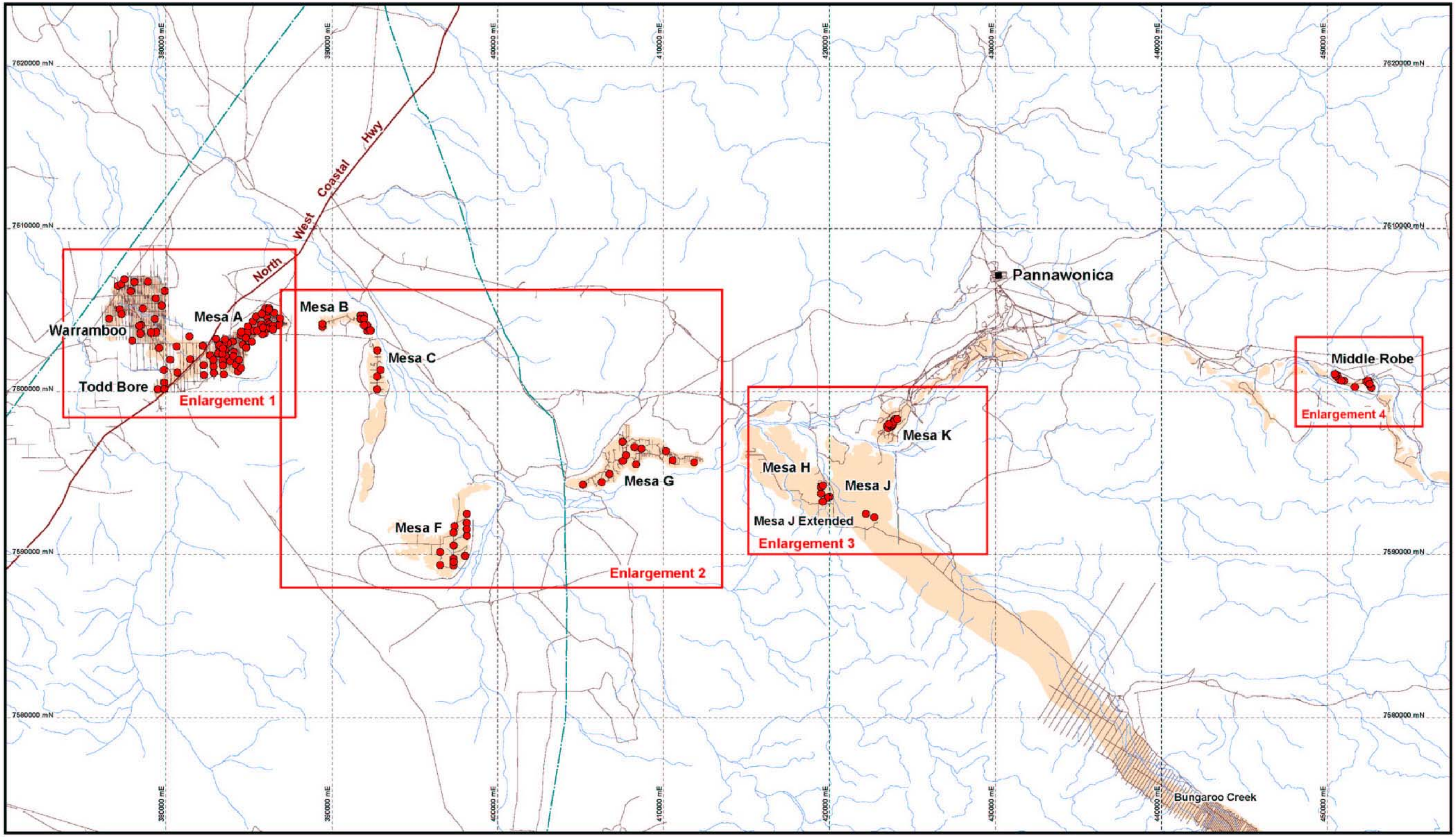
Further sampling was undertaken at Mesa A from November 2004 to January 2005, and this confirmed the presence of troglofauna at Mesa A. Following this, Biota (2006f) undertook a wider intensive fauna sampling to determine the significance of the Mesa A troglofauna within the Robe River region. The overall approach and methods used by Biota were consistent with EPA Guidance Statement No. 54 (EPA 2003b) and methods previously developed by the WA Museum on Cape Range. The sampling program was aimed at assessing the distribution of troglobitic taxa primarily within Mesa A against similar reference sites (i.e. pisolitic mesas) in the Robe valley. An intensive sampling program was undertaken in three phases at Mesa A, with sampling also undertaken at Mesas B, C, F, G, H, J and K, Middle Robe, Warramboo and Tod Bore (Figure 15; Table 19).

Table 19 Intensive troglofauna sampling program

Project area	Landform	Area (ha)	Status of area	Total sampling (over three phases)	
				Boreholes	Litter traps
Mesa A	Mesa	573	Exploration area; proposed for mining	74	235
Mesa B	Mesa	173	Exploration area	11	30
Mesa C	Mesa	227	Exploration area	4	13
Mesa F	Mesa	935	Exploration area	13	47
Mesa G	Mesa	989	Exploration area	17	61
Mesa H	Undulating low hills	1,749	Exploration area	6	14
Mesa J	Mesa	1,429	Current mining area	2	8
Mesa K	Mesa	306	Historical mining area	12	41
Middle Robe	Mesa	89	Historical mining area	15	57
Tod Bore	Undulating low hills	-	Exploration area	3	11
Warramboo	Undulating low hills	1,979	Exploration area; proposed for mining	29	80
Total	**-**	**-**	**-**	**186**	**597**

Adapted from Biota (2006f)

A further sampling program was initiated during early June 2006 and is currently in progress. This program included downhole video camera investigation in exploration boreholes within an area of Mesa A proposed for a mining exclusion zone, prior to traps being set. A supplementary report with the results of the 2006 troglofauna sampling program will be made available for public comment.



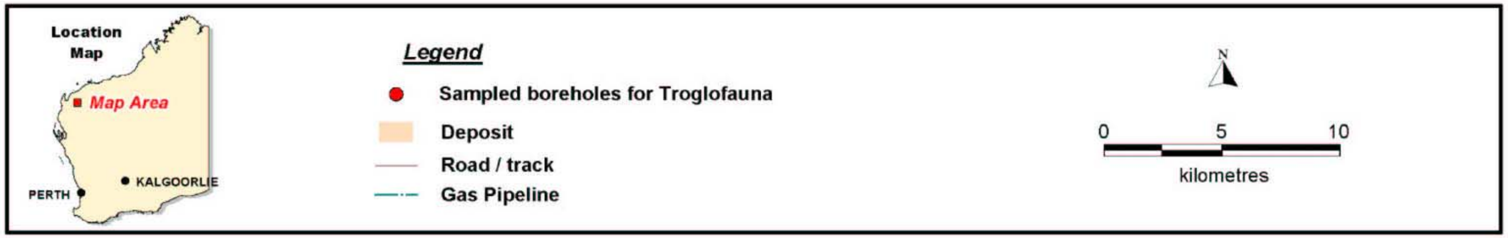


Figure 15 Location of troglofauna sampling sites within the Robe River valley

Adapted from Biota 2006f

Sampling results

A total of 3,892 invertebrate specimens, representing 23 orders, were recorded during the troglofauna surveys (Biota 2006f). Eight of the 23 orders contained specimens that were troglobitic, and of the 197 specimens in these orders, a total of 159 were troglobitic (Table 20).

Troglofauna were recorded at depths ranging from 4 – 40 m. While there are some uncertainties with sampling effects, this probably indicates that they occur within both the high grade pisolite ore and also within the subgrade pisolite ore which exists below the main orebody (Biota 2006f). Mining of the subgrade ore is not part of this mining proposal.

The troglobitic groups recorded (Schizomida, Pseudoscorpionida, Araneae, Scolopendrida, Polydesmida, Diplura, Thysanura and Blattodea), are representative of the key orders in the subterranean fauna of Barrow Island (Humphreys 2001) and Cape Range (Biota 2002). Photographs of troglofauna specimens collected during the sampling program are shown in Figure 16.

Specimens from several other taxonomic orders were subject to a more detailed identification and analysis on the basis that they include troglobitic taxa in other locations (Opilionida, Hymenoptera, Hemiptera), and/or their edaphobitic (deep soil and litter) ecology and distribution could lead to the potential for short-range distributions (Acarina, Collembola) (Biota 2006f). Upon analysis, these specimens were determined not to be troglobitic.

The remainder of the specimens were not analysed further as most clearly represented epigean (surface) forms that are at low risk of species-level spatial restriction (Biota 2006f). This includes all collected representatives of the Oligochaeta, Scorpionida, Scutigerida, Polyxenida, Isoptera, Embioptera, Coleoptera and Diptera (Appendix 2).

Of the troglofauna recorded in the study, the schizomids were the numerically dominant group, accounting for 58% of the troglobitic specimens recorded (Biota 2006f). The highest number of troglobitic specimens (55) was recorded at Mesa A, followed by Mesa B (34) and Mesa G (28) (Table 20). However it should be noted that Mesa A was by far the most extensively sampled site, with 235 litter traps, compared to 30 and 61 respectively at Mesa B and G (Table 19).

Table 20 Order, site location and number of troglobitic specimens recorded

Specimen	**Site**											**Total n***
Order	Mesa A	Mesa B	Mesa C	Mesa F	Mesa G	Mesa H	Mesa J	Mesa K	Middle Robe	Warra-mboo	Tod Bore	
Schizomida	39	24	5		22			12	9	4		115
Pseudoscorpionida	2	7								1		10
Araneae					1							1
Polydesmida			1									1
Scolopendrida	2	1			2							5
Diplura	5	1	1	1	1					1		10
Thysanura	7	1							1	1		11
Blattodea					2				4			6
												159
Total number of specimens per site	**55**	**34**	**7**	**1**	**28**	**0**	**0**	**12**	**14**	**7**	**0**	

*n = number of individuals/specimens

(a) troglobitic schizomid *Draculoides* sp. 'Mesa A' (female)

(b) troglobitic pseudoscorpion *Ideoblothrus* sp. nov.

(c) troglobitic thysanuran *Trinemura* sp. nov. (Mesa A)

(d) troglogitic cockroach Blattellidae sp. 2 (Mesa G)

(Photos: Biota 2006f)

Figure 16 Examples of troglofauna specimens collected during sampling program

The 2006 sampling results were not available at the time of submission of this PER, however, preliminary downhole video footage was collected.

Preliminary results from the downhole video investigation indicate the apparent presence of troglofauna in boreholes within the proposed mining exclusion zone. These records cannot be definitively determined without the collection of specimens themselves, meaning that confirmation of these records must await the completion of the current sampling work (anticipated for end July 2006). A supplementary report with the results of the 2006 troglofauna sampling program will be made available for public comment.

Interpretation of sampling results

Biota (2006f) assessed the relationship between troglofauna distribution and habitat variables, including tectonic units and regional geology, geomorphology and biogeography, depth below mesa surface, effect of rainfall, and mesa size, structure and troglofauna occurrence. This assessment included DNA sequencing and phylogenetic analysis of schizomid specimens from five mesas within the Robe River catchment, which was undertaken by Berry (2005). The main findings, discussed in detail in Appendix 2, are as follows.

1. Berry (2005) concluded that gene flow between schizomid populations on different mesas within the Robe River catchment is almost non-existent, and that schizomid populations in mesas appear to have been separated for several million years. This is consistent with the general timeframes identified for regional aridification and the erosion and uplift processes which began separating the mesa landforms from each other around 10-15 million years ago (Biota 2006f).
2. An exception to the above was the degree of genetic divergence between schizomids from mesas B and C. These schizomid populations showed little genetic divergence, indicating ongoing geneflow or recent isolation (Berry 2005). This is supported by geomorphological evidence that suggests the isolation between mesas B and C would have been more recent (Biota 2006f).
3. In general, little genetic diversity was detected within each mesa schizomid population, suggesting that gene flow and dispersal are ongoing within the individual mesa scale (Berry 2005). An exception to this was mesa G, where moderate genetic structuring was detected (Berry 2005).
4. Troglobitic groups did not show any consistent pattern of vertical distribution in bores sampled (Biota 2006f).
5. Although data were limited, standardised yields from troglofauna sampling show a marked response to rainfall events experienced mid-year (Biota 2006f). This is presumably due to increased activity in the fauna under wet conditions, including moving into strata which may have been drier at other times of the year (Biota 2006f).
6. The presence of a true mesa landform appears to affect the likelihood of troglofauna occurrence. Mesa H and Todd Bore, which lacked mesa geomorphology, yielded no troglofauna. Also, despite the second greatest sampling effort, Warramboo yielded the second poorest standardised number of taxa. This supports the view that the structure and hydrogeology of the mesa landform is important in providing suitable humid habitats for troglofauna (Biota 2006f).
7. There appeared to be no significant relationship between mesa size and frequency of recording troglofauna (Biota 2006f).
8. The linkage between groupings based on DNA sequence data was not entirely consistent with the spatial distribution of the sites on regional tectonic units (Biota 2006f). Biota (2006f) concluded that additional sample sites and the sequencing of further specimens may clarify this, but it is likely that other biogeographic factors have overlain any influence arising from site tectonic origin, contributing to the genetic structuring observed.

Conservation significance

The troglofauna documented by Biota (2006f) represents a previously unrecorded component of the subterranean fauna of Western Australia. Other, similar subterranean fauna communities occur on Cape Range and Barrow Island, both of which are within the conservation estate. Some of the troglobitic species occurring at Cape Range, and on Barrow Island, are now formally listed as Threatened Fauna (Table 21).

Many of the troglofauna species listed in Table 21 have only been described in recent years. Most of these species have been listed on the basis that they have restricted spatial distributions and only occur in particular habitat types.

Table 21 Troglobitic species currently listed as Threatened Fauna under State legislation

Scientific name	Common name
Schedule 1 (Rare and endangered Fauna)	
Draculoides bramstokeri	-
Speleostrophus nesiotes	-
Stygiochiropus isolatus	-
Stygiochiropus peculiaris	Camerons Cave Millipede
Stygiochiropus sympatricus	-
Bamazomus subsolanus	Eastern Cape Range Bamazomus
Bamazomus vespertinus	Western Cape Range Bamazomus
Draculoides bramstokeri	Barrow Island Draculoides
Draculoides brooksi	Northern Cape Range Draculoides
Draculoides julianneae	Western Cape Range Draculoides
Hyella sp. (BES#1154, 2525, 2546)	Camerons Cave Pseudoscorpion
Priority 2 Species (Taxa with few, poorly known populations on conservation lands)	
Nocticola flabella	Cape Range Blind Cockroach
Draculoides vinei	Cape Range Draculoides

(Source: Biota 2006f)

These listed species include the same genera (particularly the Schizomid genus *Draculoides*) and several of the orders represented amongst the fauna collected from Mesa A (including Polydesmida and Pseudoscorpionida).

With the available data, most of the troglobitic taxa documented by Biota's 2005 study would probably be considered 'data deficient' in terms of a definitive determination of conservation status. The new *Draculoides* species detailed in the study are perhaps the exception to this, given their relatively good sample size and that genetic studies and detailed morphological work have been completed (Biota 2006f). A precautionary approach should therefore be adopted in considering the conservation significance of the other less thoroughly studied and well collected troglobitic taxa. The distribution and phylogeography[10] of the schizmoids can be used as a guide to the likely distribution of taxa in the other core troglobitic groups (Pseudoscorpionida, Scolopendrida, Polydesmida, Thysanura and Blattodea).

The troglofauna recorded has the following attributes of relevance to assessing the conservation significance of the species and fauna assemblages:

- species with very short range distributions based on available data; each species currently appears to be restricted to its individual mesa (or possibly immediately adjacent mesas in the case of mesas B and C);
- relictual fauna representative of very old lineages; the lineages from which the contemporary troglofauna arose was present in subterranean habitats since the late Miocene (at least the last 10 million years);
- higher tiers of biodiversity involved; the species present are the only known representatives of orders and families in the Pilbara bioregion; and

[10] Phylogeography is the study of patterns of genetic differentiation across landscapes.

- it is probable that other, currently uncollected species occur in the mesas which also have restricted distributions (Biota 2006f).

With these attributes, there is potential for the troglobitic species occurring in the mesas to be assigned a similar conservation status to troglobitic species found endemic to Cape Range (Biota 2006f). The individual mesas may also be considered localised centres of biodiversity for this component of the regional biota as the troglobitic communities have a high degree of endemism (Biota 2006f).

11.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the proposal have the potential to have an impact on subterranean fauna values:

- **Groundwater drawdown** from groundwater abstraction may lower the water table sufficiently to dry the zone in which some stygofauna species live.
- **Direct habitat removal** through mining, including removal of topsoil, overburden and ore will result in habitat loss and the deaths of some individuals of subterranean fauna species.
- **Changes to surface hydrology**, particularly in regards to sealing of recharge areas and increased surface water runoff, leading to a reduction in habitat suitability.
- **Changes to the subterranean microclimate,** particularly a reduction in humidity levels, could lead to changes in troglofauna use of retained habitat.
- **Surface and ground water contamination** through spills of hydrocarbons or wastewater has the potential to degrade the subterranean environment.
- **Reduction in organic inputs** through clearing of vegetation beyond the mine footprint may lead to a reduction in the availability of inputs to the foundation trophic levels.
- **Vibration** from blasting activities has the potential to cause collapses of strata and mesocaverns within the remnant mesa formation.

11.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA objective

The EPA normally applies the following objective in its assessment of proposals that may affect fauna. This objective is considered relevant to this proposal.

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

EPA Guidance Statement No. 54

EPA Guidance Statement No. 54, '*Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia*' (EPA 2003b), provides guidance on standards and protocols for subterranean fauna surveys, particularly those undertaken for the environmental impact assessment of proposals.

EPA Position Statement No. 3

EPA Position Statement No. 3, '*Terrestrial Biological Surveys as an Element of Biodiversity Protection*' (EPA 2002a), discusses the principles that the EPA would apply when assessing proposals that may have an impact on biodiversity values in Western Australia. The Position Statement intends to provide the following outcomes:

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

State protection

In a legislative context, the preservation and conservation of fauna is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950*
- *Conservation and Land Management Act 1984.*

In Western Australia, rare or endangered species are protected by the *Wildlife Conservation (Specially Protected Fauna) Notice 2003*, under the *Wildlife Protection Act 1950*. Schedules 1 and 4 in this notice are relevant to this assessment, providing a listing of those species protected by this Notice.

The DEC (Nature Conservation Division) Priority Fauna List also nominates conservation species from priority one to five. It is expected that the potential impacts from a proposal on these priority listed species should be managed so that the species do not meet the International Union for Conservation of Nature and Natural Resources criteria for threatened species.

Commonwealth protection

Relevant commonwealth legislation is the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In 1974, Australia signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora. As a result, an official list of endangered species was prepared and is regularly updated. This listing is administered through the EPBC Act. The current list differs from the various State lists, however some species are common to both.

11.4 Assessment of Potential Impact, Mitigation and Residual Risk

11.4.1 Groundwater drawdown

The available data suggest that there appears to be very little in the way of a stygal community present at Warramboo. The bores sampled have been installed for a considerable period, so it therefore appears unlikely that any issue relating to the period elapsed since bore installation are affecting the result. No stygofauna were recorded from the Warramboo deposit or the area that would be affected by groundwater abstraction.

The only stygofauna recorded to date from this locality were oligochaetes from a single site at Tod Bore (to the south of Warramboo), which are typically widespread at the species level. The results to date therefore suggest that there is little impediment to sourcing water from the Warramboo area. This will be confirmed by an additional stygofauna sampling phase at Warramboo to be conducted during 2006.

11.4.2 Habitat removal

Direct habitat removal will be the most direct impact on the troglofauna of Mesa A. The Robe pisolite to be mined for the project is also the core habitat for the troglobitic species occurring within Mesa A. Given that most of the subterranean species in question are slow-moving and occur in microhabitats that have been relatively stable for an extended period, those troglofauna populations located in the mine area will most likely be lost. Some additional habitat loss is anticipated along the proposed transport corridor at Mesa F (for the southern transport corridor option only) and at Mesa B. The impact of the transport corridor encroaching on potential troglofauna habitat is expected to be minimal at Mesa B, however is discussed in more detail in Section 20.

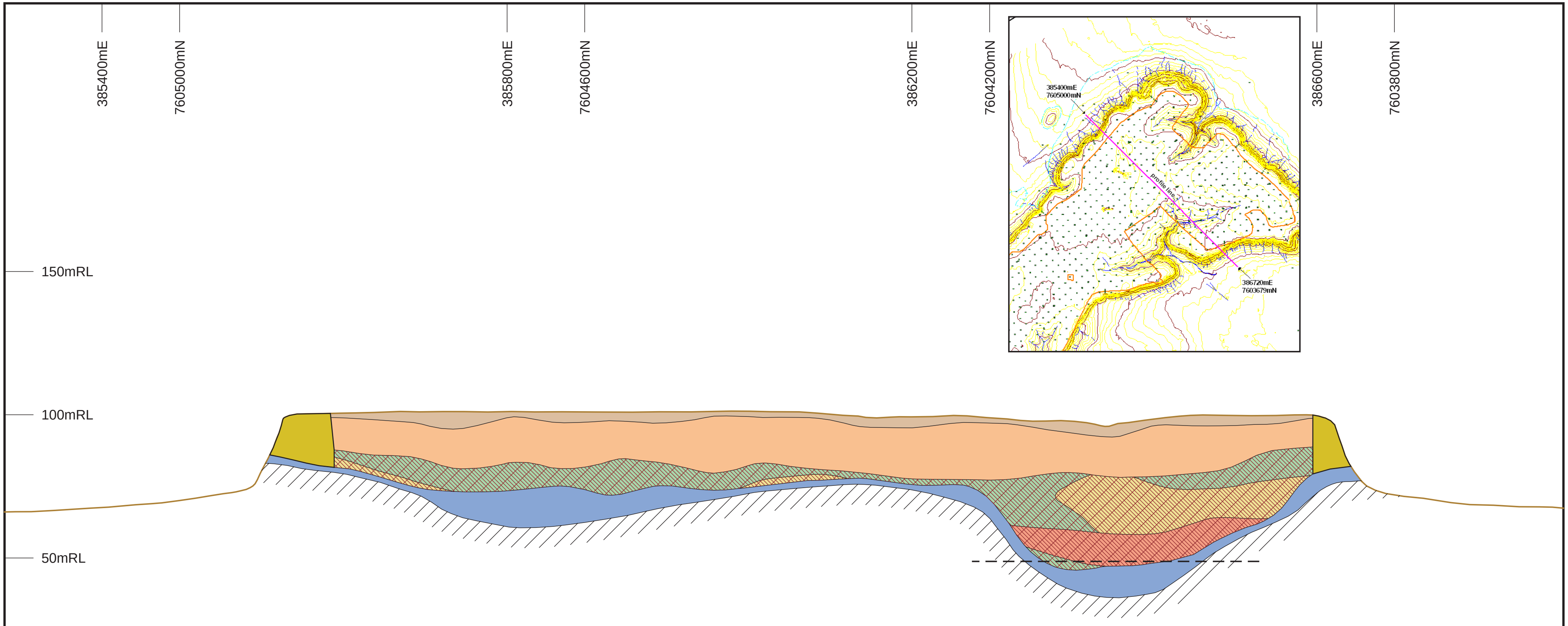
At present there appears to be no evidence that any troglobitic taxa are restricted specifically to the proposed pit area itself, as opposed to the balance of Mesa A. Although some genetic structuring is present, the evidence from the schizomid fauna suggests that a single interbreeding population occurs across the Mesa A (Biota 2006f). The development of the Mesa A pit area could then proceed without the immediate extinction of any of the troglofauna species occurring within Mesa A provided an adequate portion of the remainder of Mesa A is set aside and not developed.

The effect of habitat removal on troglofauna at Warramboo is not considered to be significant, as despite a high sampling effort, only a limited number of troglofauna were recorded. Biota (2006f) concluded that the poor yield of troglofauna from Warramboo is likely to be due to the lack of mesa geomorphology, which provides suitable structure and hydrogeology for troglofauna species.

A key consideration that arises from the direct impact of mining is the viability of the remaining populations of troglofauna species endemic to Mesa A. The viability of the remaining habitat is likely to be a function of the extent, configuration and intactness of the portions of the mesa formation left undisturbed by mining activities.

Direct impacts to troglofauna are addressed through Robe's commitment to maintain a habitat retention zone, which comprises an exclusion zone around the perimeter of the mesa, including the gully area (Figure 8). This includes a significant portion of high grade ore which will be excluded from mining, and also includes all of the sub-grade[11] pisolite which exists below the high grade orebody (not currently part of this proposal) (Figure 17).

[11] Subgrade pisolite: exists below the high grade pisolite at Mesa A. This pisolite is benificiable ore (requires wet processing) comprising a mix of pisolite and clay, containing a higher density of cavities and vughs than the high grade pisolite. Minor subgrade ore exists within the high-grade ore zone, however this generally refers to lower grade ore rather than benificiable ore.



- Hardcap / Weathered pisolite +/- Quaternary alluvium
- Pisolite high grade ore (ROM) — ~48% of orebody
- Basal pisolite
- Subgrade pisolite (mixed pisolite +/- clay) — ~52% of orebody (not part of feasibility scope)
- Basement
- Water table
- Proposed troglofauna mining exclusion zone

0 250 500m

Horizontal Scale

Pilbara Iron
A member of the Rio Tinto Group

Figure 17
Mesa A
Schematic geological cross section with potential Troglofauna Habitat

PDE-0020595 v1.0

Robe has committed to retaining a minimum of 15 x 10^6 m^3 of the Mesa A resource in the form of a mining exclusion zone to protect the viability of the troglofauna population, and in addition, approximately half of the mesa which is comprised of subgrade pisolite remains as additional potential troglofauna habitat. Robe will conduct further work to confirm that the volume of Mesa A retained will support a viable troglofauna population.

Of critical importance to the viability of the troglofauna population will be the volume of retained habitat within Mesa A. It should be recognised that the troglofauna taxa within Mesa A utilise a three-dimensional habitat space; presumably moving in horizontal and vertical directions as fracturing, cavities and interstitial connections allow. In this proposal, whilst the surface area expression of the mining exclusion zone alone may not appear extensive, it is the volume of this zone, combined with the volume of the subgrade zone which is of critical importance. Robe plans to disturb less than 50% of the known and potential troglofauna habitat within the Mesa A resource.

The current understanding of the ecology of these subterranean ecosystems is limited. However, some guidance can be obtained from the following findings:

- the size of other, smaller mesas known to contain similar troglobitic assemblages; for example, Mesa B contained a similar abundance and diversity of troglofauna as Mesa A, however is approximately a third of the size (Biota 2006f)
- the size and configuration of habitat remnants in other areas subject to historical mining disturbance that still support troglofauna; for example Mesa K and Mesa 2402E (located in the Middle Robe area) have been largely disturbed by historical mining activities and still support troglofauna species (Biota 2006f)
- data from other sites where mining activity has encroached into troglofauna habitat; for example troglofauna have been recorded at the Exmouth Limestone mine at Cape Range less than 50 m from the pit wall over three years after the commencement of mining (Biota 2002; Biota 2004).

A summary of the status, areas and volumes of Mesas A, B, K and 2402E (located in Middle Robe) is shown in Table 22.

Table 22 Summary of status and area of extent of each study area

Project area	Status	Estimated area (ha)	Estimated volume (m^3)
Mesa A	Resource area proposed for mining		
	• area/volume of mesa pisolite (potential troglofauna habitat)	573	126 x 10^6
	• volume of high grade resource (ROM) 270 Mt	-	65 x 10^6
	• volume of ROM proposed for mining	-	58 x 10^6
	• volume of pisolite proposed as mining exclusion zone (potential troglofauna habitat: includes high grade ore and subgrade within the perimeter and gully areas)	-	15 x 10^6
	• volume of subgrade pisolite (potential troglofauna habitat)	-	61 x 10^6
Mesa B	Exploration area		
	• total area of deposit on mesa	173	-
	• volume	-	8.7 × 10^6
Mesa K	Historical mining area		

Project area	Status	Estimated area (ha)	Estimated volume (m^3)
	• total area of deposit on mesa	306	-
	• area of mesa mined to a maximum of 40 m below original surface	169	-
	• area of deposit on mesa not mined	137	-
	• remaining volume	-	7.2×10^6
Mesa 2402E (located in Middle Robe)	Historical mining area		
	• total area of deposit on mesa	89	-
	• area of mesa mined to a maximum of 22 m below original surface	68	-
	• area of mesa not mined	21	-
	• remaining volume	-	1.6×10^6

Historical mining at Mesa 2402E and Mesa K removed parts of these mesas. Sampling and identification conducted by Biota (2006f) has shown that following mining these mesas continue to support troglofauna in the areas which have not been mined.

Historical mining and creation of waste dumps/stockpiles occurred over an area of approximately 169 ha on Mesa K. Mining was to a maximum of 40 m below the original mesa surface, with much of the mining being to a depth of less than approximately 20 m below the original mesa surface. The original height of Mesa K was between approximately 25 m and 40 m above ground level. Historical mining has therefore left an area of deposit of approximately 137 ha on the mesa which is partially disturbed (tracks) but has not been mined or been subject to significant surface alteration. Troglofauna from one order (Schizomida) were recorded from drill holes in this partially disturbed area (Biota 2006f). The remaining volume of core troglofauna habitat (sub-grade and high grade pisolite) in Mesa K is estimated to be 7.2×10^6 m^3 (Table 22).

Historical mining occurred over an area of approximately 68 ha on Mesa 2402E. Mining was to a maximum of 22 m below the original mesa surface with much of the mining being to a depth of approximately 15 m below the original mesa surface. The original height of Mesa 2402E was between approximately 60 m and 80 m above ground level. Historical mining on Mesa 2402E has therefore left an area of approximately 21 ha on the mesa which is partially disturbed but has not been mined or been subject to significant surface alteration. Troglofauna from three orders (Schizomida, Thysanura and Blattodea) were recorded from drill holes in this partially disturbed area (Biota 2006f). The remaining volume of core troglofauna habitat in Mesa 2402E is estimated to be 1.6×10^6 m^3 (Table 22).

The only drill holes remaining at Mesas K and 2402E are in small sections of the orebodies which have not been mined. Sampling for troglofauna on these mesas was therefore limited to these areas. Results confirm the existence of troglofauna within the remnant, isolated sections of the orebody which have not been mined, however it is not yet known whether troglofauna exist exclusively in these areas or whether troglofauna also utilise the remaining lower part of the mesa (which contains 1 – 4 m thickness of the orebody) in the mined areas.

The volume pisolite orebody which has not been mined at Mesa 2402E and which has been shown to support troglofauna (1.6×10^6 m^3) is nearly 10 times less volume of troglofauna habitat than just the proposed mining exclusion zone at Mesa A (approximately 15×10^6 m^3). This is not including the additional volume of the subgrade zone (61×10^6 m^3) proposed for troglofauna habitat retention.

Sampling of troglofauna in the proposed mining exclusion zone has been constrained by the lack of drill holes in the area since the area has been largely excluded from exploration drilling for Aboriginal Heritage reasons. Until recently, it had only been possible to conduct troglofauna sampling in four drill holes in the proposed mining exclusion zone and in three drill holes located less than 10 m outside the proposed mining exclusion zone. Trapping was conducted in these drill holes during Phase 3 (from the end of July to the start of September 2005). Troglofauna were recorded in only one of the drill holes in the mining exclusion zone, however, troglofauna were also recorded in two of the three drill holes which lie within 10 m of the edge of the proposed mining exclusion zone. The specimens recorded were from the troglobitic groups Diplura and Pseudoscorpionida. The lack of troglofauna recorded in the proposed mining exclusion zone is thought to be due to the relatively low sampling effort in this zone.

Aboriginal Heritage approval was only recently granted to establish drill holes in the mining exclusion zone for the purposes of troglofauna. A new sampling program was initiated in June 2006 and is currently in progress. Results were not available at the time of the PER submission, however preliminary results from downhole video investigation indicate the apparent presence of troglofauna in boreholes within the proposed mining exclusion zone area. The confirmation of these records, however, must await the completion of the current sampling work (anticipated for end of July 2006). Robe currently does not have a contingency plan should troglofauna not be found within the mining exclusion zone from this sampling program. However, the evidence available to date suggests that troglofauna occur within the subgrade pisolite below the main orebody which is proposed as part of the troglofauna habitat retention zone.

A draft Troglobitic Fauna Management Plan has been prepared to address the management of the risks of indirect impacts to troglofauna, ongoing sampling and ongoing research activities (Appendix 2).

The Troglobitic Fauna Management Plan also addresses reconstruction of troglofauna habitat. Robe will implement subterranean habitat reconstruction in sections of the pit where mining is complete. This backfilling will be undertaken in an effort to provide re-constructed habitat similar in physical and chemical composition to the existing mesa. The long-term objectives of this habitat reconstruction are to provide:

- a stable structure that will not collapse, erode or infill with sediment during post-closure storm events
- a reconstructed portion of Mesa A that has internal cavities and microclimate as close as possible to pre-existing conditions with the available materials
- a reconstructed habitat that adjoins that retained portion of Mesa A to allow for potential troglofauna re-colonisation into the back-filled area.

To achieve this, Robe will implement a programme prior to mining at Mesa A, which will continue to be refined and implemented during operations and post-closure. This will include:

- habitat characterisation – describe existing subterranean habitats at Mesa A
- material characterisation – establish the physical framework and chemical properties of the pre-mining material to be used for backfill
- physical reconstruction – trial habitat reconstruction will be used to develop specifications for actual profile reconstruction at Mesa A once mining is complete in the backfill area
- monitoring – trial reconstruction areas and actual backfill areas will be monitored for humidity levels, physical stability and other parameters.

11.4.3 Changes to surface hydrology

Humidity levels within the mesas are ultimately sustained by periodic surface water input and recharge during rainfall events. Alteration to surface hydrology, particularly in regards to sealing of recharge areas, could therefore affect underlying subterranean habitats. Increases in surface erosion could also lead to sedimentation of interstices and the filling (and thereby degradation or loss) of microhabitat space utilised by troglofauna within the mesa (James 1993). This is probably only likely within the upper few metres of the areas directly below mining.

To address some of these issues, project infrastructure, access roads and other ground disturbance will avoid the mining exclusion zone portion of Mesa A set aside as troglofauna habitat (except for access tracks and drill holes required for troglofauna monitoring/sampling purposes). Any access roads that follow the margins of these retained areas will have sediment traps installed as part of drainage treatments to prevent any sediment mobilised during storm events entering subterranean habitats.

Exclusion of infrastructure and ground disturbances as described above will aim to retain the natural surface hydrology of the area as much as possible and thereby minimise changes in humidity of the remaining habitat. Drainage management in areas adjacent to the mining exclusion zone will reduce the risk of sediments entering the area, and thereby help maintain the quality of the area retained as troglofauna habitat.

11.4.4 Changes to subterranean microclimate

Reduction in the key microclimate parameters, particularly humidity levels, could lead to changes in troglofauna use of the retained habitat. Troglofauna have been shown to be far more sensitive to water loss than their surface analogues. Hadley *et al.* (1981) found that troglobitic lycosid spiders lost significantly more water than comparable surface-dwelling species. Humphreys (1991) also demonstrated that troglofauna communities tend to contract in distribution into deeper habitats as humidity levels fall in more superficial areas. These physiological and ecological responses signal sensitivities in this fauna to drying of strata and reductions in subterranean relative humidity levels (Biota 2006f).

A potential impact mechanism relating to this is presented by the exposure of openings in the mine pit wall leading to deeper fractured strata in adjoining mesa habitat. The likelihood of this causing humidity reductions or other microclimate change in subterranean habitat in the mining exclusion zone will reduce with increasing distance from the pit wall. Recent evaluation of the hydrogeology of the Mesa has indicated that there is no direct relation of troglofauna sampled to the watertable within the Mesa, which would incicate that the troglofauna habitat is related to the insitu moisture content of the pisolite. The subgrade pisolite is also above the watertable, however tends to have slightly higher moisture content than the high grade pisolite due to clays within this zone retaining moisture.

Robe will conduct biophysical (e.g. humidity) monitoring to ensure that a suitable subterranean microclimate for troglofauna is maintained in the habitat retention zone at Mesa A. Biophysical monitoring will also be conducted in similar habitats on a nearby analogue site (probably Mesa B) to enable any regional changes in mesa humidity levels to be identified from changes specific to Mesa A. Criteria will be developed to trigger management actions in the event that localised reductions in humidity are recorded. Examples of management actions which may be considered include trials of down-hole trickle irrigation to offset drying effects from the pit wall exposure or larger scale re-injection of groundwater into the base of the mesa if wider scale declines in relative humidity levels are recorded.

The area to be retained as troglofauna habitat should be sufficient to maintain a suitable subterranean microclimate for troglofauna species; monitoring of the subterranean microclimate will be undertaken to ensure that any changes to the microclimate are detected and managed.

11.4.5 Surface and groundwater contamination

The potential exists for the subterranean environment to be degraded by spills of hydrocarbons or wastewater if not appropriately managed. This can affect troglofauna populations with susceptible species dying out.

Diesel and other hydrocarbons will be used on a routine basis during mining, presenting both operational (e.g. refuelling) and storage risks.

These risks however are relatively straight forward to manage through established project design, infrastructure and operational procedures. Hydrocarbon storage for the project will be situated off the mining exclusion zone and will meet relevant Australian Standards. All servicing will be carried out at dedicated facilities off the mesa remnants, and no refuelling of plant or equipment will be conducted in the mining exclusion zone.

In addition, hydrocarbon storage areas will be located at ground level below the mesa formation which will greatly reduce the risk of surface and groundwater contamination in the habitat retention zone. There is therefore little risk of troglofauna being affected by hydrocarbon contamination.

11.4.6 Changes in organic inputs

Troglofauna are dependent on organic carbon as an input to the foundation trophic levels (Humphreys 1991 and Humphreys 1993). All organic carbon inputs into troglobitic ecosystems ultimately stem from surface sources. Clearing of vegetation beyond the mine footprint therefore has the potential to reduce nutrient influx to the underlying mesa remnants, leading to a reduction in inputs to the foundation trophic levels in the subterranean ecosystem.

The management of organic carbon inputs will be addressed through the implementation of Robe’s Ground Disturbance Authorisation Procedure which includes identification of all areas proposed for clearing in a geographic information system, conducting relevant surveys and providing written authorisation to allow clearing to commence. Vegetation clearing will be prohibited within the mining exclusion zone (except where required to allow installation of access tracks and drill holes for troglofauna monitoring/sampling purposes). In relation to the subgrade material, backfilling will be implemented during the mining process, including revegetation of these sections.

These controls will prevent organic carbon source material from being removed from areas retained as troglofauna habitat.

11.4.7 Vibration

Blasting activities during mining have the potential to cause collapses of strata and other features such as mesocaverns in the remnant mesa formation (Biota 2006f). This is a difficult impact to quantify, however Robe will undertake a geophysical analysis to identify the extent to which vibration may be extending into the adjoining mining exclusion zone and the underlying subgrade ore.

11.5 PROPOSED MANAGEMENT ACTIONS

Subterranean fauna issues for the project will be addressed by the following proposed management actions:

- conduct an additional round of stygofauna sampling at Warramboo
- establish a habitat retention zone at Mesa A, which includes any area that troglofauna studies find are essential for the viability of the troglofauna species at Mesa A
- finalise and implement the Troglobitic Fauna Management Plan including actions to:
    - investigate the distribution of troglofauna populations in potential habitat retention zones at Mesa A
    - mitigate indirect impacts to troglofauna habitat by prohibiting clearing (except for access tracks and drill holes required for troglofauna sampling purposes) within the mining exclusion zone and hydrocarbon storage in the areas retained as troglofauna habitat
    - undertake monitoring of biophysical parameters throughout the life of the mine
    - undertake ongoing troglofauna sampling throughout the life of the mine
    - undertake geophysical assessment to identify the extent to which vibration may be extending into the adjoining retained mesa habitat
    - undertake backfilling in sections of the pit where mining has been completed in such a way as to create re-constructed habitat which is similar in physical and chemical composition to the existing mesa, including revegetation
    - develop criteria to trigger management actions which may include consideration of down-hole trickle irrigation or larger scale groundwater re-injection
- undertake a longer term research program addressing the troglofauna of the Robe valley mesas, including:
    - investigation of the characteristics of relevant subterranean habitat
    - investigations into the ecology and ecosystem processes for troglobitic communities
    - additional sampling of troglofauna
    - further genetic and morphological identification.
- provide funding to assist with establishment of facilities for DNA analysis.

11.6 PREDICTED OUTCOME

The proposed development is unlikely to have a significant impact on stygofauna in the Warramboo area as sampling recorded little stygofauna in the area. An additional round of stygofauna sampling will be conducted to confirm the results. The effect of habitat removal on troglofauna at Warramboo is not considered to be significant, as despite a high sampling effort, only a limited number of troglofauna were recorded.

The proposed development will result in the loss of some troglofauna habitat at Mesa A. Data gathered indicates that remnant areas without significant surface disturbance on previously mined mesas continue to support troglofauna following mining activities. The proposed troglofauna habitat retention zone at Mesa A will ensure the retention of a significant portion of the troglofauna habitat. Robe will conduct further work to confirm that the volume of Mesa A retained will support a viable troglofauna population.

The draft Troglobitic Fauna Management Plan (Appendix 2) addresses the management of the risks of indirect impacts to troglofauna, ongoing sampling and ongoing research activities, and reconstruction of subterranean habitat.

The proposed funding for research into troglofauna and the establishment of facilities for DNA analysis will assist with furthering knowledge of troglofauna in the Pilbara region and developing appropriate management actions for any future proposed developments in the region.

12. LANDSCAPE AND GEODIVERSITY

12.1 DESCRIPTION OF FACTOR

A Landscape and Geodiversity Assessment for the project area was undertaken by John Cleary Planning (2005). Results of the assessment are in Appendix 2 and are discussed below. The following text has been adapted from John Cleary Planning (2005).

The proposed mine site lies within the Ashburton Plain Landscape Character Type, close to the Gascoyne Ranges and Hamersley Ranges Landscape Character Types, and is within the Pilbara Bioregion (Thackway & Creswell 1995). The Ashburton Plain Landscape Character Type has extensive sand plain with low rocky hills in the east, including near the area of the mine.

The proposed mine is at the western extremity of a series of pisolite, mesa formations associated with the Robe River. These mesas punctuate a landform of plains and low angle talus slopes that generally fall away to the Ashburton Plain in the west. Further inland, to the east-south-east, the land rises substantially in elevation, into the Hamersley Ranges, where more robust formations create more rugged and highly dissected landforms, including prominent highpoints, ridges and cliffs.

The area is used for pastoral activities, although these activities are often not evident to people using the area. The region is very sparsely populated, with occasional homesteads and outstations, mining operations, roadhouses and towns such as Pannawonica and Onslow. The North West Coastal Highway is the main travel route through the region. Main link roads extend from it to Onslow and Pannawonica. Other roads are generally unformed pastoral access roads.

Panoramic, high distance views over the surrounding country are generally available throughout the area, due to the open nature of the landforms and sparse vegetation. Views become confined close to, and between, mesa formations, in gullies and near the riverine vegetation.

12.1.1 Landscape and geodiversity assessment

Geodiversity refers to the range of geological, geomorphological, and soil features, systems and processes that exist in an area. Geodiversity values of the Mesa A/Warramboo project area were assessed in terms of:

- **Intrinsic values** – value without human-related rating.
- **Ecological values** – value as part of ecosystems.
- **Scientific values** – values in demonstrating particular aspects of geological and geomorphic process.

Landscape values include a range of human related values that stem from the relationships between people and places. Landscape values of the Mesa A/Warramboo project area were assessed in terms of:

- **Landscape character** – the nature of places, classified into types or units.
- **Landscape significance** – the most valued landscape features.
    - **Aesthetic** – features that contribute most to the enjoyment of people through sensory paths.

   - **Social** – features that most represent the associations between the community and a place, including for cultural/spiritual reasons.
   - **Historic** – features that most demonstrate the degree of connection between a feature and past important people or events.
- **Views** – the extent of views from a location.
- **Access** – the nature of access to a location.
- **Wilderness quality** – the level of disturbance.
- **Recreation and tourism value** – the degree to which a feature contributes to recreation and tourism.

12.1.2 Geodiversity values

Intrinsic values

In relation to geodiversity, intrinsic value refers to the existence of a range of geological, geomorphmological, and soil features, systems and processes that occur in an area. Intrinsic geodiversity values of Mesa A are shown in Figure 18 and are identified as:

- a partial mesa of Robe Pisolite of low to moderate height with a relatively flat top and one side merging seamlessly with the plain to the south-west
- three well-separated, distinct, deeply incised gullies (two of which had vegetation and an obvious surface water body following heavy rainfall)
- a variable escarpment, varying from scree slopes with minor outcroppings and talus, to prominent buttresses and walls
- at a detailed scale the mesa had walls or buttresses with a group of pigeon hole formations
- at a detailed scale the mesa had an escarpment with a group of large caves.

The partial mesa formation of Mesa A is not common in the Robe River/Deepdale formations.

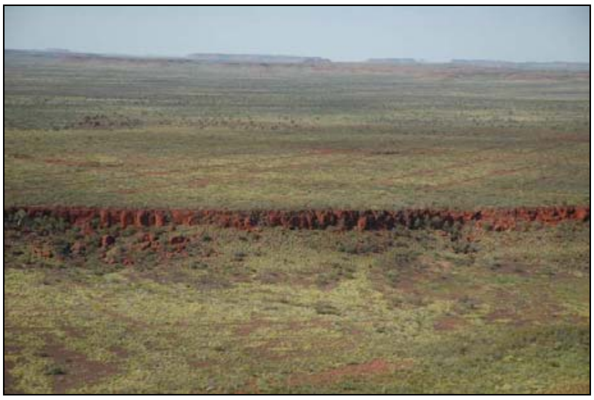
Ecological values

The flora survey undertaken for the area identified one vegetation type of *very high* conservation significance, being S1: CzAtGeTs vegetation of the sand sheet adjacent to Mesa A, which is considered likely to be restricted in distribution in both the local area and region, and supports species restricted to the deep sands of this particular habitat (Biota 2005a, Biota 2005b).

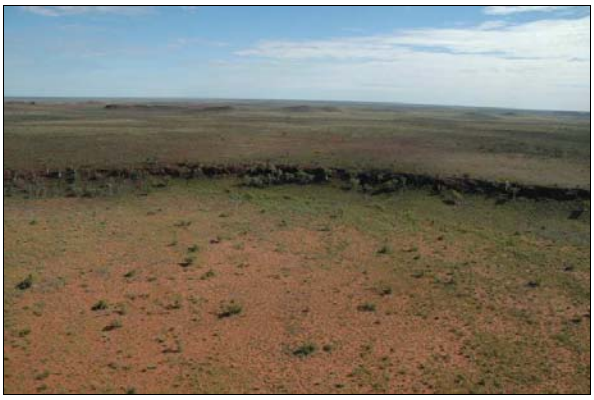
The same flora survey also identifies two Priority 3 Flora Species:

- *Abutilon trudgenii,* which was found on the mesa plateaus, particularly on clayey to stony plains, and is thought to be widespread
- *Sida sp.*, which was also found on the mesa plateau (Biota 2005a).

No Declared Rare Flora were found in the area of Mesa A, nor would be expected to occur (Biota 2005a).

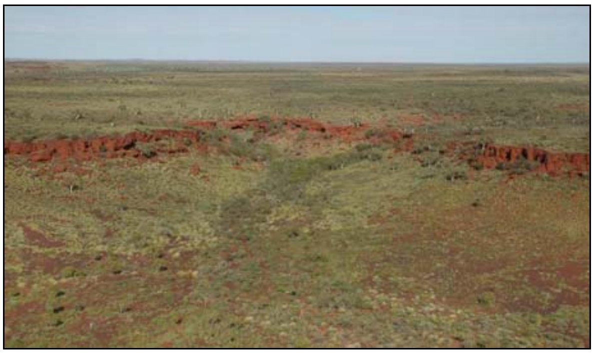


(a) Looking across the northern end of Mesa A showing the western escarpment and the flat mesa top



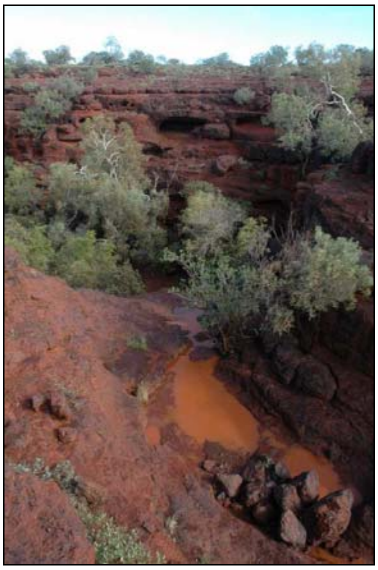
(b) Looking across the middle of Mesa A showing the eastern escarpment and the sand sheet in the foreground

(c) Looking across the northern gully on the eastern escarpment of Mesa A showing its enclosed nature and the sharp abutting of the gully walls and the mesa top



(d) Looking across the northern gully of Mesa A

(e) The walls of the gully in the northern side of Mesa A with dense and varied vegetation



(f) Stream, waterfall and walls of the gully in the north of the eastern side of Mesa A

(Source: John Cleary Planning 2005)

Figure 18 Photographs of Mesa A

Scientific values

With respect to the deposits of the Robe River, the distinctive topographic variations among the mesas A to N without doubt reflect a combination of variations in channel development and depositional environment. For example, the well defined escarpments and high grade ores at Mesa J and Mesa A originated in sharply defined channels, whereas the more undulating landscape and lower grade ores of Mesa G are likely to have their origin in a more braided channel environment. The layered nature of some mesas, such as Mesa B, suggests more complex variations through time in the evolution of the channel at that point.

Thus, all the Robe River pisolite mesas have scientific value for what they can, as palaeo-channel deposits, reveal about the evolution of the area (and the origin of the ores). Mesa A demonstrates a particular variation in this evolution but is not unique in this regard.

An examination of the heritage registers of the Heritage Council of Western Australia, the Australian Heritage Commission and the National Trust did not reveal any previous records of sites of significance in the Robe River valley.

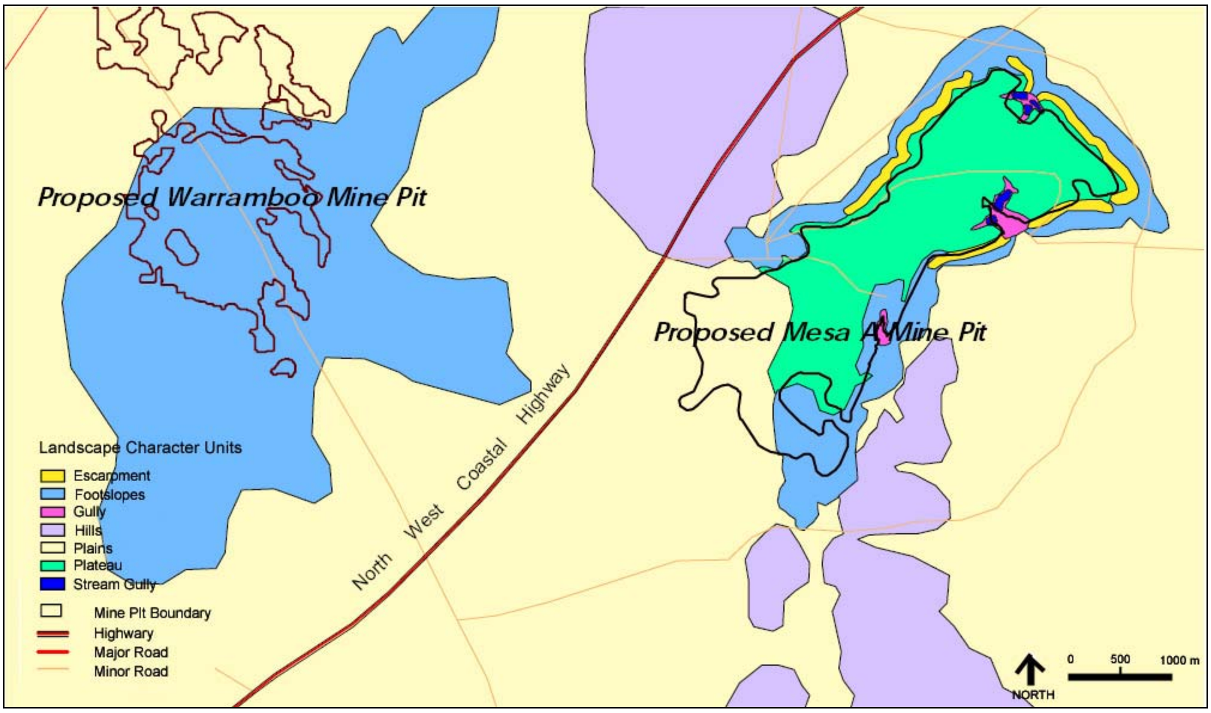
12.1.3 Landscape values

Landscape character

Seven character units have been identified based on the characteristics of Mesa A, Warramboo and adjacent areas (Figure 19). These units are:

- *Plains unit*, which includes the relatively flat land near and between the hills and mesas.
- *Plateau unit*, which includes the flat mesa top where the proximity to the escarpment is apparent.
- *Escarpment unit*, which includes the eastern, northern and western sides of Mesa A where there are obvious escarpments.
- *Escarpment gully unit*, which includes the two gullies on the eastern side of Mesa A and the gully on the northern side.
- *Stream gully unit*, which includes the confined gullies where the streambed is dominant.
- *Footslopes unit*, which includes the slopes leading up from the plain to the escarpment or mesa top except where there is a rocky escarpment.
- *Hills unit*, which includes the small and medium-sized hills on the western side of Mesa A (i.e. either side of the highway) and mesas to the south east of Mesa A.

With the exception of stream gully unit, these character units are well represented in the study area. Some of these units, such as the gully units and the escarpment unit are also relevant to aesthetic significance.



Source: John Cleary Planning (2005)

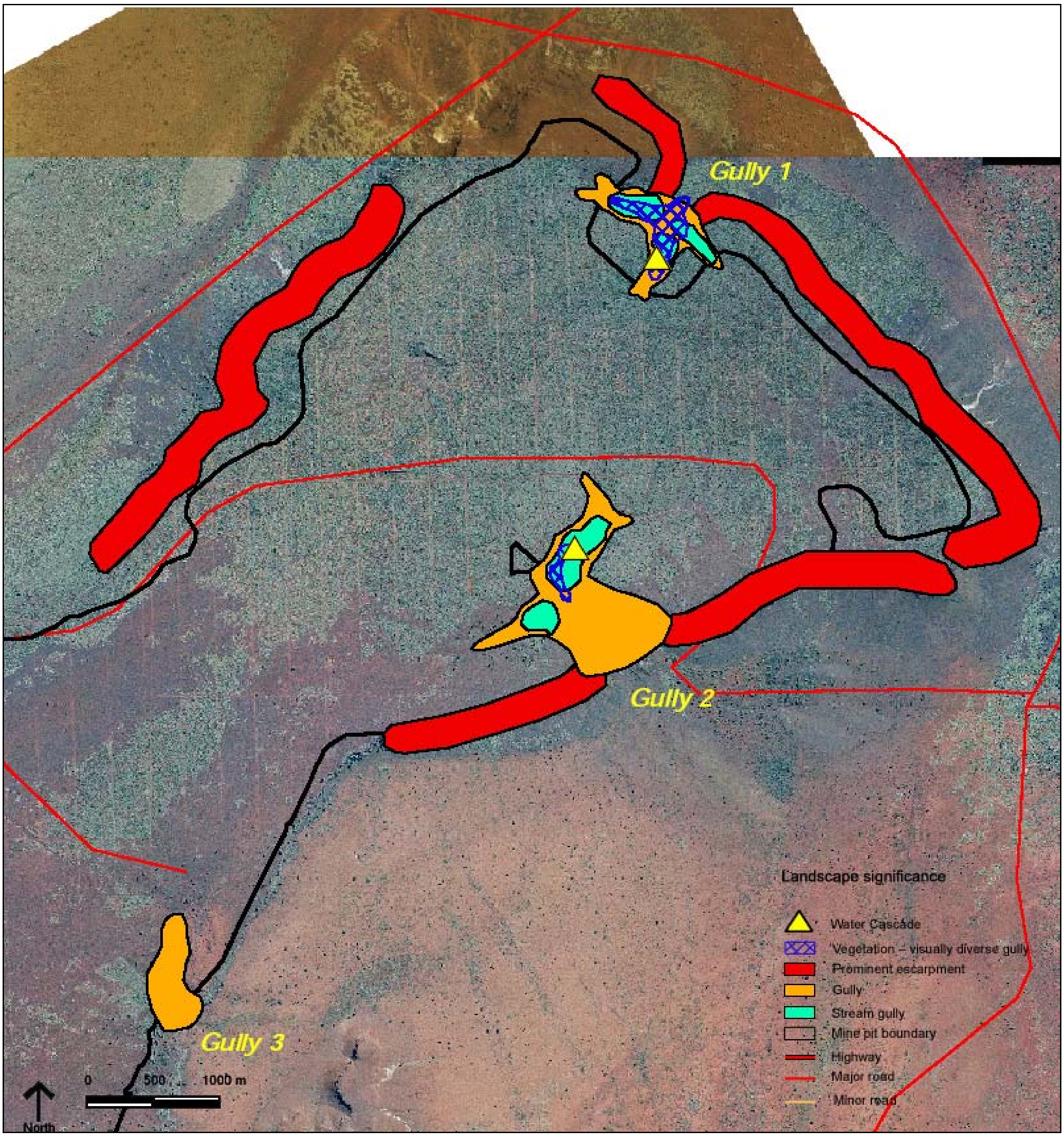
Figure 19 Landscape character units for Mesa A/Warramboo

Landscape significance

Aesthetic

Aesthetically significant features of Mesa A are shown in Figure 20, include:

- the most prominent sections of the escarpment
- the three main gullies in the escarpment of Mesa A
- diverse stands of vegetation including the stream-related vegetation
- the stream gullies and their settings, extending to the mesa plateau.



Source: John Cleary Planning (2005)

Figure 20 Features of landscape significance at Mesa A

Social

Indigenous people attach special value to parts of the mesa, including much of the escarpment (Section 16).

Historic

Assessment of the historical significance of the area concluded the following:

1. There are no specific recorded sites of historic significance related to the early European exploration of the area.
2. The Robe River mining operations in general are significant in the development of the Western Australian iron ore mining industry.
3. Mesa F has moderate significance due to it being the location of the first recorded identification of iron ore in the Hamersley Iron Province by A. Gibb Maitland in 1906.
4. Mesa A has no specific historic significance.

Views

The generally flat terrain around Mesa A, particularly along the North West Coastal Highway means that the potential for good, long distance views is high. In some areas close to Mesa A, low hills and outcrops restrict views to the foreground (0 – 300 m) and close middleground (300 m – 1000m). The vegetation, particularly trees, tends to be very sparse (except where there are watercourses), which also allows expansive views (notwithstanding landform).

There are good views to both the Mesa A and Warramboo areas from most locations on the highway as it traverses the area. The most critical views are those from the highway. These views to the mine operations are likely to improve when the proposed highway realignment and overpass are constructed.

The terrain at Warramboo falls away to the north-north-west, dropping approximately 25 m over the pit areas. This aspect generally restricts the area potentially affected by the mine pits to areas to the north of the pit area (i.e. most of the pit area slopes away from key views). The waste dumps have the potential to affect views from a wider area, including areas to the south and near the highway.

The terrain at Mesa A rises gently from the plain in the south, by approximately 10 m over the pit area, and then drops abruptly at the mesa escarpment in the north, falling approximately 40 m to the plain. The escarpment defines the mesa on the western, northern and eastern sides. A well-defined valley that stems from the south and a series of hills lie to the west of the mesa and a series of small mesas lie to the south-south-east. The general aspect of the landform, together with the nature of the adjacent landforms, restricts views of the mine pit from locations in the north and west, provided the escarpment is retained. If the mesa escarpment is breached, the breach would be highly visual (given the exposed nature of the escarpment) and would open up views to the pit and increase the area that is potentially visually affected. Views of the mine pit may be possible from locations in the south due to the inclined nature of the mesa and the lack of an escarpment on this side of the mesa.

Access

The North West Coastal Highway is the main travel route through the region, which carries a mix of local, industrial, and tourist traffic. Pannawonica Road is a main link road extending from the North West Coastal Highway to the town of Pannawonica. Pannawonica Road carries traffic largely related to the mine operations in the area. Other roads in the area are generally unformed pastoral access roads, many also used for mining exploration.

Travel routes within the region were classified into four sensitivity levels (high sensitivity to very low sensitivity) based on the type of use[12]. North West Coastal Highway and Pannawonica Road have been classified as having Level 1 sensitivity level (high sensitivity). Other roads in the area have been classified as having Level 4 sensitivity level (very low sensitivity).

Distance zones provide an indication of an area's spatial relationship to community use, and are an important variable in determining the visual magnitude of features. Distance zones were identified for the Mesa A/Warramboo project as follows: the Mesa A ore body is approximately 500 m (close middleground) from the North West Coastal Highway (Level 1 travel route); and the Warramboo ore body is approximately 2400 m from the highway (middleground). The haul road will cross the highway (*via* underpass) and other mine operations such as bunds or waste dumps will also be in the same distance zones as indicated above. Pannawonica Road is approximately 7 km (background) from Mesa A.

Wilderness quality

Wilderness quality is an indication of the naturalness of an area, and is based on remoteness and biophysical naturalness. Remoteness is generally based on the distance from access routes, settlement areas and disturbed areas. Biophysical naturalness can be determined in a simple form by using land use mapping, remnant vegetation mapping and field surveys.

The wilderness quality of the project area was considered to be low-moderate, based on the following:

- vegetation appeared to be in good condition
- the main disturbance was the mining exploration tracks, drilling sites and related works
- the sites are close to other roads including the North West Coastal Highway.

Recreation and tourism values

There are no known recreation and tourism activities in the vicinity of the proposed mine. Mesa A provides a feature that contrasts with the scenery otherwise experienced by travellers on the North West Coastal Highway, and in this regard it contributes to the tourism experience in a very small way.

The proposed mine may attract interest from travellers, as it is the closest Pilbara iron ore mine to the North West Coastal Highway.

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[12] John Cleary Planning (2005) notes that sensitivity levels of travel routes and use areas are an indication of the importance of those routes to the experience of people and are established on the volume of people using the area and understanding of their preferences. High sensitivity travels routes include national and state highways, designated tourist roads, major recreational sites and places with recognised or assessed scenic or historic values of national or state importance. Very low sensitivity travel routes include roads receiving local non-recreational use and industrial areas.

Cumulative effects

The proposed mine is the only development of this nature west of Mesa J. At a regional level, the low density of similar development and the large extent of remaining, unaffected, similar values suggest that cumulative effect will be low.

12.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the proposal that may affect landscape and geodiversity include:

- **Mining and backfill,** including removing topsoil, overburden and ore during mining will create a void in the landscape.
- **Placement of drainage structures (e.g. bunds)** will place new raised landforms on the landscape.
- **Placement of waste dumps** will place new raised landforms on the landscape.
- **Placement of other mining infrastructure** will temporarily alter the appearance of the natural environment.

12.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA Objectives

The EPA normally applies the following objectives to the assessment of proposals that may affect land. These objectives are considered relevant to this assessment:

- *To maintain the integrity, ecological functions and environmental values of the soil and landform.*
- *To maintain and protect any significant landscape and geoheritage values, and maintain the integrity, ecological functions and environmental values of the soil and landform.*

12.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

12.4.1 Mining and backfill

Mining of Mesa A will occur below the mesa surface and behind the escarpment face (where it exists). Thus the main alteration to the landscape will be to produce an open void behind the escarpment and an open depression on the southern end of Mesa A where the surface of the mesa is currently at the same level as the surrounding ground surface. Mining of the Warramboo deposit will occur below the level of the surrounding land, thus the main alteration to the landform will be to produce an open depression where the mine pits will be located.

Preliminary mine designs indicate that mining will commence in the central area of Mesa A, moving north-east and south-west, with several pit faces being active at any one time. Vertical batters will be to heights of approximately 10 m with bench widths to broadly match the geometry of the deposit. The maximum depth of the Mesa A pit will be 50 m, with an average depth of approximately 20-25 m. Mining at Warramboo will also be conducted in a single open cut pit, however the pit will have a maximum depth of 20 m. Mining will commence in the south of the pit and move progressively north throughout the life of the mine.

Robe is committed to retaining the Mesa A escarpment (except for a 50 m cut to connect the pit to the plant area). Retention of the escarpment will reduce the visual impact of the mining on the landscape and will greatly reduce the impact on the visual amenity of the area, as it will shield most of the mine pit from view. Views of the mine pit may be possible from locations in the south due to the inclined nature of the mesa and the lack of an escarpment on this side of the mesa. Waste dumps will be positioned in this area to provide a visual barrier from the North West Coastal Highway (Figure 8; Section 12.4.3).

The terrain at Warramboo falls away to the north-north-west, dropping approximately 25 m over the pit area. This aspect generally restricts the area that is potentially visually affected by the mine pits.

The Mesa A and Warramboo pits will be progressively backfilled and rehabilitated. Backfilling the mine pits will help reduce the visual impact of the pits on the landscape. Rehabilitation of the Mesa A/Warramboo area will be undertaken in accordance with the procedures described in Robe's Rehabilitation Handbook (2004).

Exclusion of mining from part of the Mesa A escarpment will also enable retention of the three gully systems, and therefore protect the significant landscape and geodiversity features of these areas (e.g. gully, stream gully). Mining will also be excluded from the majority of the sand sheet habitat, which is classed as having *very high* conservation value, and therefore the geodiversity value of this habitat will be protected.

The wilderness quality of the area will be reduced by the project, due to the extensive physical changes to Mesa A and Warramboo. However, extensive areas of relatively high wilderness quality occur in many other areas in the region.

12.4.2 Drainage structures

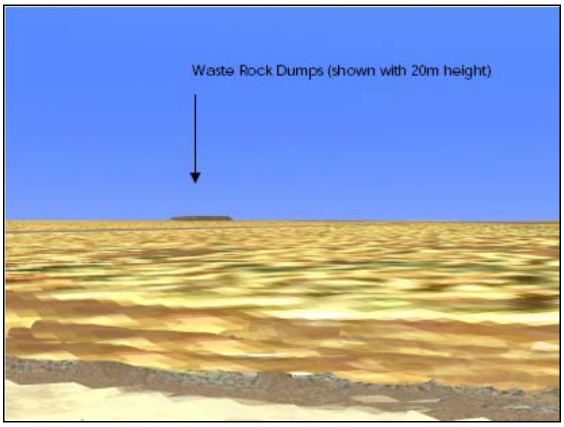
Diversion bunds and drains will be constructed to the south-east and south of the Warramboo pit and the south-west of the Mesa A pit (Figure 8). These structures will be designed and constructed to protect mining areas from being inundated as a result of flooding, as well as to divert minor watercourses flowing into the Mesa A/Warramboo area.

Diversion bunds will be constructed from overburden sourced from the start up pit and revegetated as part of the rehabilitation of the disturbed areas during construction. Diversion drains will be formed and revegetated to resemble natural drainage lines of the area. Changes to landscape character will be minimised by shaping drainage structures to be as natural looking as possible and rehabilitating them to blend in with the natural landscape as far as practicable.

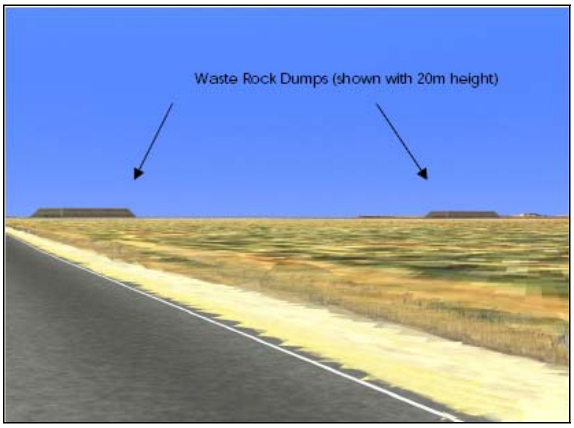
12.4.3 Waste dumps

During the first three years of mining at Mesa A sub-grade ore and waste rock will be placed in above ground waste dumps. Waste dumps will be located immediately to the west and south west of the Mesa A pit. Waste dumps at Warramboo will be located immediately west and south-west of the Warramboo pit. Waste dumps will be constructed to a maximum height of 10 m and will be visible from the North West Coastal Highway (Figure 21). The western waste dump at Mesa A will be positioned to restrict public access to the site and to provide a visual barrier from the North West Coastal Highway. The outer toes of these waste dumps will be established early in the mine life and rehabilitation will commence within three years of the commencement of mining to reduce visual impact.

All waste dumps will be constructed in accordance with the Robe's Waste Dump Design Guidelines, which include minimisation of dump height and shaping of dumps to blend in with the surrounding natural topography. Surface waste dumps will be progressively rehabilitated. These measures will minimise changes in landscape character resulting from the waste dumps.



(a) Simulated view from the North West Coastal Highway, near the southern end of the proposed highway re-alignment, looking towards Warramboo



(b) Simulated view from the North West Coastal Highway, near the southern end of the proposed highway re-alignment, looking towards Mesa A

Note: The height of waste rock dumps will be limited to 10 m, rather than 20 m as shown above.

Source: John Cleary Planning (2005)

Figure 21 Simulated views of waste rock dumps from North West Coastal Highway

12.4.4 Mining infrastructure

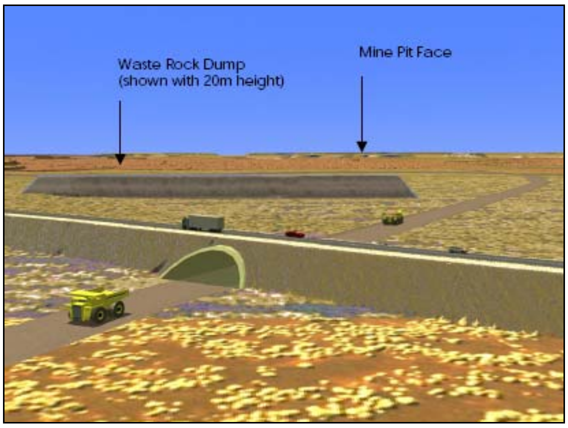
Mining infrastructure at the Mesa A/Warramboo mine site will include the following:

- haul road between Mesa A and Warramboo, including overpass and bypass area
- water pipeline and access track
- heavy vehicle refuelling facility
- power generation plant
- bulk fuel storage facility
- waste oil and bulk lubricant storage facility
- workshops and offices
- diversion bunds
- mine construction camp
- road or rail infrastructure from Mesa A to Mesa J
- mine equipment wash down facilities
- sewage plant
- contaminated water treatment plant.

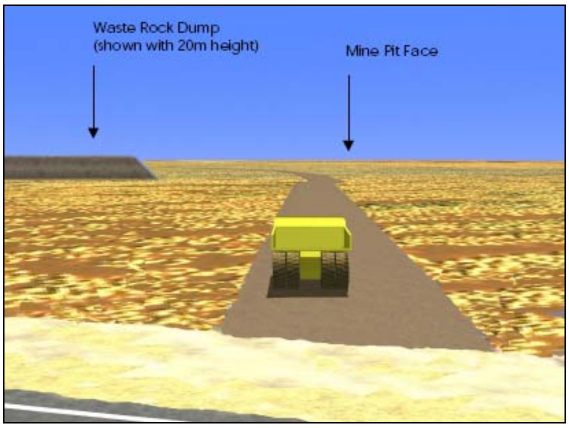
Some of this infrastructure will be visible from the North West Coastal Highway and Pannawonica Road. The most visible infrastructure from the North West Coastal Highway will be the haul road between Mesa A and Warramboo, including overpass and bypass area (Figure 22). The overpass will increase views to adjacent areas, including the mine areas, and will allow for the pit faces on the north and east sides of Mesa A to be seen. Changes to landscape character near the North West Coastal Highway will be mitigated by limiting works in the area to essential access roads and infrastructure, and setting back fencing from the highway as far as practicable.

The Mesa A plantsite will be located immediately east of the eastern Mesa A escarpment. The plantsite will therefore be shielded from view by the Mesa A escarpment thus reducing the visual impact from the North West Coastal Highway. Minimal mining infrastructure will be located at Warramboo.

If lighting is required in areas visible from the North West Coastal Highway, shielded or directional lighting (rather than omni-directional lighting) will be used where possible.



(c) Simulated view from near the proposed North West Coastal Highway overpass, looking towards Mesa A, showing the highway overpass



(d) Simulated view from the proposed North West Coastal Highway overpass, looking towards Mesa A, showing haul road between Mesa A and Warramboo

Note: The height of waste rock dumps will be limited to 10 m, rather than 20 m as shown above.

Source: John Cleary Planning (2005)

Figure 22 Simulated views of mining infrastructure in the vicinity of Mesa A/Warramboo

12.5 PROPOSED MANAGEMENT ACTIONS

Landscape and geodiversity issues will be addressed by the following proposed management actions:

- maintain a 50 m mining exclusion zone around the Mesa A escarpment (including the three identified gullies), except for the area where the escarpment will be breached to allow access from the pit to the plant area
- position the western waste rock dump at Mesa A to restrict public access to the site and provide a visual barrier from the North West Coastal Highway
- restrict waste dump height to a maximum of 10 m
- form and revegetate diversion drains to resemble natural drainage lines of the area

- undertake progressive backfill and rehabilitation of mine pits
- commence rehabilitation of waste dumps by the third year of mine operation
- if lighting is required in areas visible from the North West Coastal Highway, shielded or directional lighting (rather than omni-directional lighting) will be used where possible.

12.6 PREDICTED OUTCOME

Landscape and geodiveristy values of the project area will be affected by the proposal, however the effects will be mitigated, as far as practicable, by range of management measures. The most significant management measure is the retention of the Mesa A escarpment, including a 50 m mining exclusion zone. This will significantly reduce the visual impact of the mine on the surrounding landscape and will protect a number of significant landscape and geodiversity features and is therefore consistent with the EPA objective for this factor.

13. SURFACE WATER AND WATER QUALITY

13.1 DESCRIPTION OF FACTOR

The Robe River drainage catchment is the major river system in the region. The Robe River catchment drains generally from east to west through the high relief areas of the Hamersley Ranges onto the more gently sloping areas in the coastal plain, before discharging into the ocean. The majority of the proposed mine infrastructure is located in the Robe River drainage catchment, however, the proposed Warramboo Pit is located in the Warramboo drainage catchment (Aquaterra 2005a).

There are many tributaries that discharge into the Robe River from within the proposed development area. Significant waterways in or near the mining area are the Robe River and the Warramboo Creek

Warramboo Creek, with a catchment area of approximately 1000 km2, has its headwaters approximately 30 km south of the development area and discharges into the poorly defined scrubland in the coastal plain. It is likely that during large floods, the downstream Warramboo Creek in the coastal plain becomes part of the Robe River Floodplain (Aquaterra 2005a).

As for most parts of the Pilbara, the normal condition for creeks is dry. Runoff is ephemeral, occurring only after significant and intense rainfall events. The Robe River is an intermittent river, which carries a significant underflow in its alluvial bed. The river underflow maintains permanent pools in the river channel, and these pools play an important role in the river ecosystem, by supporting a diverse range of aquatic fauna and acting as refuges during periods of drought.

13.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the proposal may have an impact on surface water and water quality:

- **Drainage management** will alter flow paths with construction of diversion channels and mine pit and infrastructure.
- **Disposal of stormwater** has the potential to affect water quality through contamination by sediments and hydrocarbons.
- **Changed landform after closure** will alter natural surface water flows.

13.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Stormwater management, surface water discharges and activities that emit to the environment are managed under a license issued under the *Environmental Protection Act 1986*.

EPA objectives

The EPA normally applies the following objectives in its assessment of proposals that may affect surface water and water quality. These objectives are considered relevant to this proposal.

- *The EPA objective for the management of watercourses is to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.*
- *The EPA objective for surface water quality is to ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.*

Water resource strategies and guidelines

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

In 2000 the Water and Rivers Commission (WRC) and Department of Minerals and Energy (DME, now DoIR) developed a series of Water Quality Protection Guidelines for mining and mineral processing. These guidelines address a range of issues including installation of minesite groundwater monitoring wells, minesite water quality monitoring and minesite stormwater.

ANZECC/ARMCANZ Guidelines

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

ANZECC and ARMCANZ have also released a set of water quality guidelines for the protection of marine and freshwater ecosystems (ANZECC/ARMCANZ 2000). The ANZECC/ARMCANZ guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, broken down into five geographical regions across Australia and New Zealand. The guidelines and their application to mining are discussed in Batley *et al.* (2003).

13.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

13.4.1 Drainage management

The proposed Mesa A pit does not intersect any creeks or rivers. One creek flows past the eastern edge of the proposed Mesa A pit footprint, however this will not be affected by the proposal.

The proposed Warramboo pit has an upstream catchment of approximately 10 km^2. A number of minor creeks are intersected by the pit footprint and will need to be diverted. Diversion bunds and channels will be engineered to direct flow from these creeks around the perimeter of the pit and into the downstream catchment. The volume of flow and streamflow flow regime downstream will therefore not be affected. All diversion structures and drains will be stabilised to minimise erosion and associated water quality impacts.

Mine flood protection levees, diversion drains and bunds will be designed and constructed to protect the mining areas from being inundated as a result of flooding (Figure 23).

Sheet flow across the proposed pit and mine infrastructure areas will be concentrated by the proposed diversion channels, or alongside flood bunds or raised pads. This will result in a localised increase in flow velocities with the potential to increase soil erosion. Sediment traps or basins will be installed, where appropriate to manage these impacts.

Waste dumps will be designed to incorporate water management features to minimise the potential for sediment-laden surface water runoff (Section 17.3.2).

Drainage will be designed in accordance with Robe's Sediment and Drainage Control Design Criteria.

13.4.2 Disposal of stormwater

There is the potential for accumulation of water in mining pits following rainfall events. Based on experience at Mesa J and older mining areas, the water collected within the pits dissipates quickly through the pit floor. The multiple bench system used for mining will enable mining to continue at a higher bench level while lower levels drain naturally. However, in the event that water needs to be pumped out of a pit following heavy rain, the water will be directed to a settling pond and will then be recycled to the dust suppression circuit as far as practicable. If any water requires discharge from the Mesa A / Warramboo operations, it will be directed to a settling pond and will then be directed into a local drainage line.

The proposed waste dumps have the potential to discharge sediment laden water to the environment. Waste dumps will be designed in accordance with Robe's Waste Dump Design Guidelines to manage these impacts (Section 17.3.2).

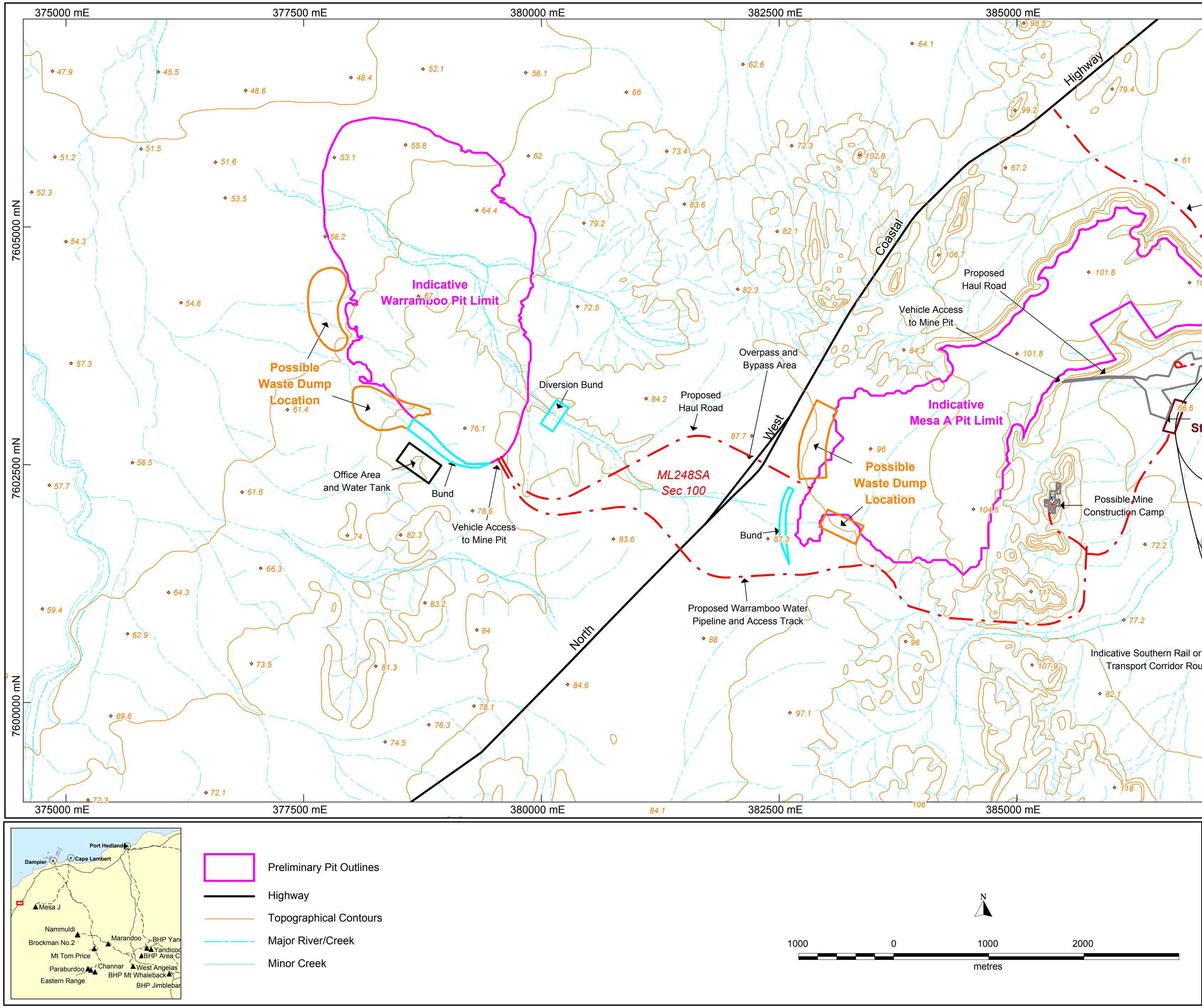
The washdown facility and workshop have the potential for uncontrolled release of water contaminated with hydrocarbons. Hydrocarbons will be stored in accordance with AS1940. The workshop and washdown facility will comprise hardstanding with contained drainage and a dedicated water decontamination plant to remove oily wastes and sediment. Clean water will be used for reticulation of gardens and oily waste will be contained and disposed of through a licenced contractor. Water management measures will ensure protection of downstream runoff water quality.

13.4.3 Post-closure landform

The Mesa A and Warramboo pits will be progressively backfilled and rehabilitated. Selective backfilling will be conducted so as to avoid sterilisation of the resource. The pits will be partially backfilled and landscaped to blend in with the surrounding topography as far as practicable.

The final landforms will be designed to be self draining, and diversion bunds will remain in place to prevent flooding of the pit. Closure is discussed further in Section 17. Drainage control structures will be constructed as part of the final landform to prevent scouring and heavy sediment loads in runoff.

Rehabilitation of the backfilled pits will be in accordance with the procedures outlined in Section 17.3.



Pilbara Iron

Figure 23 Mesa A/Warramboo landforms and drainage of mine

Author: FB	Date: January 2006
Drawn: CB/GC	Revised:
Dwg No.: 113949v8_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

13.5 PROPOSED MANAGEMENT ACTIONS

Surface water issues in relation to the Mesa A/Warramboo project will be addressed by the following proposed management actions:

- stabilise diversion structures and drains to minimise erosion and associated water quality impacts
- design waste dumps to incorporate water management features to minimise the potential for sediment-laden surface water runoff
- design flow diversion at Warramboo such that flow is directed back into the same catchment further downstream
- install sediment traps/basins where appropriate to reduce sediment loads from the mine area
- install settling pond to allow sediment in stormwater to be reduced prior to re-use/discharge
- undertake progressive backfill of pits at Mesa A and Warramboo
- design final landforms to be self-draining.

13.6 PREDICTED OUTCOME

Consistent with the EPA objective for surface water, the alterations to surface flows should not have an adverse impact on identified beneficial or environmental uses of the water as they will be managed under the Environmental Management Plan. The general integrity, functions and environmental values of the Robe River system will be maintained through regular monitoring and control of discharges.

Minor changes in drainage flows associated with earthworks for the mine will not have a significant impact on the quality or quantity of water in the creeks.

14. GROUNDWATER AND WATER SUPPLY

14.1 DESCRIPTION OF FACTOR

The proposed Mesa A/Warramboo mining operation will a require a water supply of 1.5 GL/yr (48 L/s) for a period of approximately 10 years, whereafter the demand will reduce. Groundwater will be sourced for process water, dust suppression and potable water purposes. A breakdown of water use based on preliminary estimates is as follows:

- maximum requirement for control of ore moisture content: approximately 820 ML/yr
- dust suppression: approximately 420 ML/yr
- plant and vehicle washdowns: approximately 80 ML/yr
- potable water supply: approximately 180 ML/yr.

Aquaterra undertook groundwater investigations to determine potential water supply options for this proposal. The investigations included geological studies, exploration drilling, permeability tests and analysis of historical data from mineral exploration to determine the water supply potential and possible impacts of their abstraction. The following discussion is based on Aquaterra (2005b) unless otherwise stated.

The following aquifers were examined as potential water supply options:

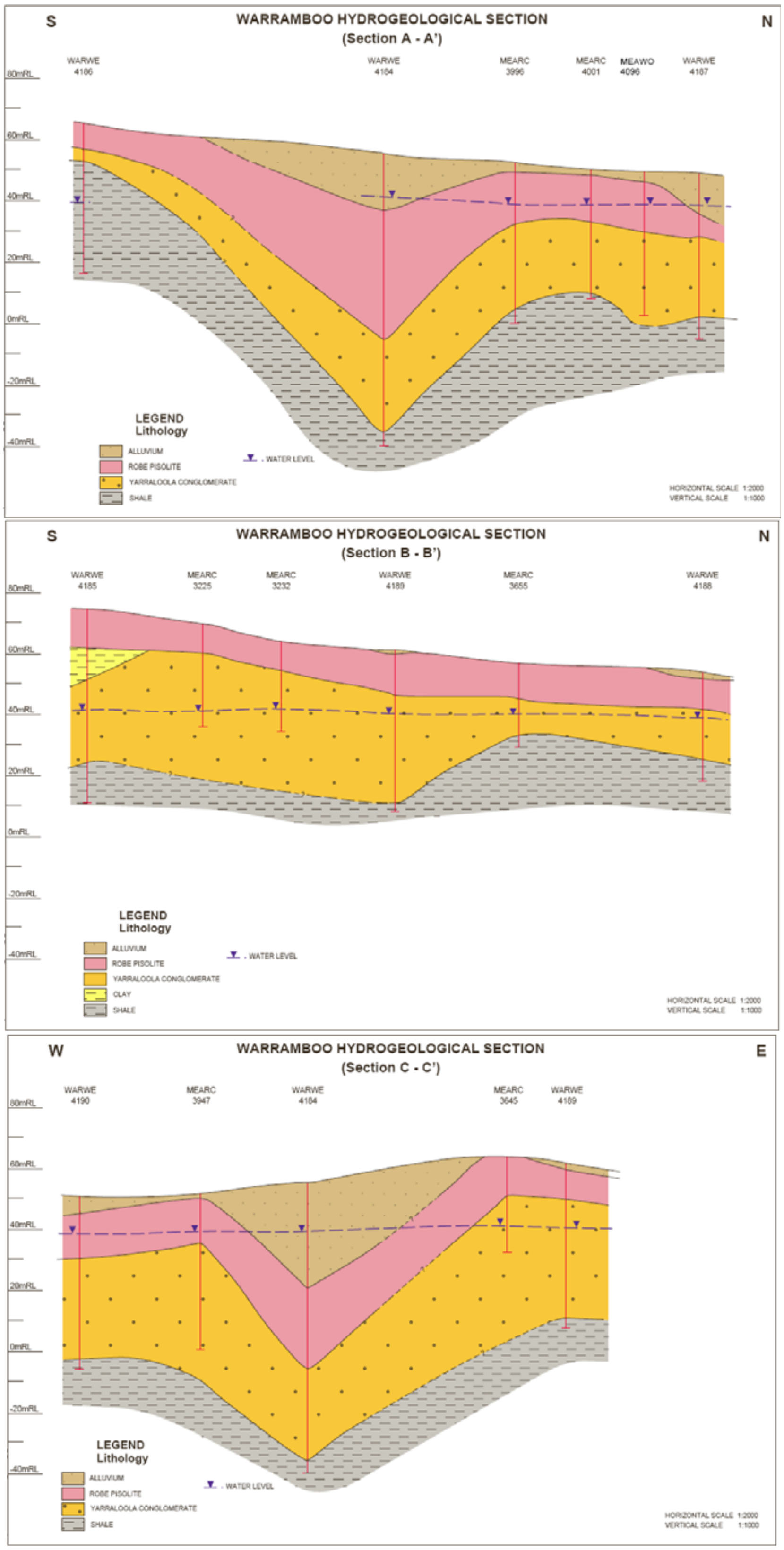
- Mesa A bedrock aquifers: these aquifers are linked to fracturing within the Ashburton Formation bedrock
- Birdrong Sandstone aquifer: the Birdrong aquifer is known to be a high yielding aquifer, however the drilling undertaken suggests the aquifer is located further west of the Warramboo region
- Robe River alluvial aquifer: either upstream or downstream of the Yarraloola Homestead
- Warramboo aquifer: Yarraloola Conglomerate.

The aquifer in the Warramboo area was chosen as the preferred water supply option due to lower set up and operating costs, and lower anticipated impact on the surrounding environment.

14.1.1 Warramboo aquifer

The Warramboo aquifer is located on the eastern margin of the Carnarvon Basin which is a sedimentary basin extending from south of Kalbarri northwards towards the mouth of the Fortescue River. This basin provides a large water resource.

The Yarraloola Conglomerate underlies the Robe Pisolite and the surface alluvium (Figure 24). The cretaceous Yarraloola Conglomerate generally consists of moderately sorted, sub-angular to sub-rounded chert, quartz and banded jaspilite pebbles in white to yellow sandy clay with occasional claystone and sandstone lenses. The conglomerate forms the main aquifer at Warramboo and is unconfined in this area, although appears to become semi-confined to the west.



Source: Aquaterra (2005b)

Figure 24 Warramboo hydrogeological sections

A total of 10 wells were drilled to between 35 and 95 m below ground in 2004 and 2005 to explore the water source potential in the Yarraloola Conglomerate at Warramboo. Drilling results from 2005 are summarised in Table 23. There is also historical data available in this area from previous mineral exploration.

Table 23 Warramboo drilling summary 2005

Bore ID	Easting[1] (GDA94)	Northing[1] (GDA94)	RL[2] (mAHD)	Total depth (m)	Slotted depth interval (m)	Casing type	Airlift yield (L/s)	Water level (mbgl)	Field pH	Field TDS (mg/L)
WARW E4184	377820	7604861	55	95	10-94	155mm PVC C12	4	15.73	8.1	1346
WARW E4185	379287	7602983	74	59	4-52	155mm PVC C12	1	32.11	8.4	852
WARW E4186	377897	7602948	65	48	-	- (not cased)	-	23.72	-	-
WARW E4187	377297	7607089	49	53	3-51	155mm PVC C12	8	9.98	8	1391
WARW E4188	379103	7607140	54	36	6-30	155mm PVC C12	0.8	14.04	8.2	1944
WARW E4189	379614	7605112	62	53	11-53	155mm PVC C12	5.5	21.65	8.1	1313
WARW E4190	376372	7604849	51	56	8-56	155mm PVC C12	6.5	12.79	7.9	1027

Source: Adapted from Aquaterra 2005b

[1] Reading taken from handheld GPS

[2] Elevation taken from adjacent mineral hole (surveyed)

The key results of the drilling investigation were:

- groundwater levels were between 10 m and 30 m below ground level (mostly >15 m below surface) with a low hydraulic gradient to the north west
- airlift yields ranged from between 1 L/s to 8 L/s and transmissivity values were estimated to range between 10 m^2/d and 450 m^2/d
- water quality is mainly fresh with total dissolved solids values averaging 1300 mg/L and a pH of 7-8 (slightly alkaline).

The investigation indicated that the aquifer is permeable enough to deliver suitable production well yields (5 L/s to 10 L/s per bore).

14.2 POTENTIAL SOURCES OF IMPACT

The main aspect of the mining operations that may have an impact on the deep Warramboo groundwater resources is:

- **Groundwater abstraction** leading to a drawdown of the groundwater levels in the area immediately around the wellfields.

Mine operations will be above the water table, with no impact on groundwater expected as mining will be carried out under dry conditions. Current water use in the area is restricted to use for pastoral activities, so the proposed abstraction for mining operations will not adversely affect other users.

14.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA objective

The EPA normally applies the following objective in its assessment of proposals that may affect groundwater. This objective is considered relevant to this proposal.

- *To ensure that alterations to groundwater flows or quality do not have an adverse impact on beneficial or environmental uses of the water and that the integrity, functions, and environmental values of watercourses are maintained.*

Regulatory framework

The abstraction of groundwater is subject to a licence issued by the DoW under the *Rights in Water and Irrigation Act 1914* that specifies the maximum abstraction rate and includes conditions for monitoring.

Stormwater management, surface water discharges and potentially polluting activities are managed under a licence issued under the EP Act.

Water Resource Strategies

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

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

14.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

14.4.1 Proposed abstraction

To supply the 1.5 GL/yr water demand over the ten year project period, it is proposed to pump from a series of wells (~10) in the Warramboo aquifer (Yarraloola Conglomerate). The water quality of the Warramboo aquifer meets the water quality requirements of the mining operations. The wells will be located around the Warramboo mine site. The indicative wellfield layout that was used in the modelling is shown in Figure 25.

Additional pump testing of the Warramboo aquifer is planned to commence in September 2006 to provide more detailed information for the purposes of optimising the wellfield design and for development of a Groundwater Operating Strategy for operation.

14.4.2 Modelling

A groundwater model of the Warramboo aquifer was constructed to evaluate drawdown effects of the water supply abstraction. The analytical groundwater flow model, WinFlow Version 1.07 was used. WinFlow was judged suitable for this PER level of assessment as groundwater levels are mostly >15 m below ground and no groundwater dependent vegetation expected in the area that would require detailed risk assessment. The model parameters, calibration and methods are described in full in Aquaterra (2005b) and summarised in Table 24.

The conceptual model was derived using the permeability analysis and lithology information from the drilling. Recharge to the aquifer was assumed to be 1% of the annual rainfall to the area, which is 366 mm/yr. The model was calibrated to observed water levels from mineral exploration holes and monitoring bores.

The preliminary modelling shows that the Warramboo aquifer is capable of providing a sustainable water source for the proposed mining operation. The modelling is conservative as it assumes a blanket recharge of 1% of annual rainfall across the area and does not incorporate complex mechanisms of recharge owing to the annual variation in rainfall or recharge resulting from ephemeral sheet flow or periodic flooding.

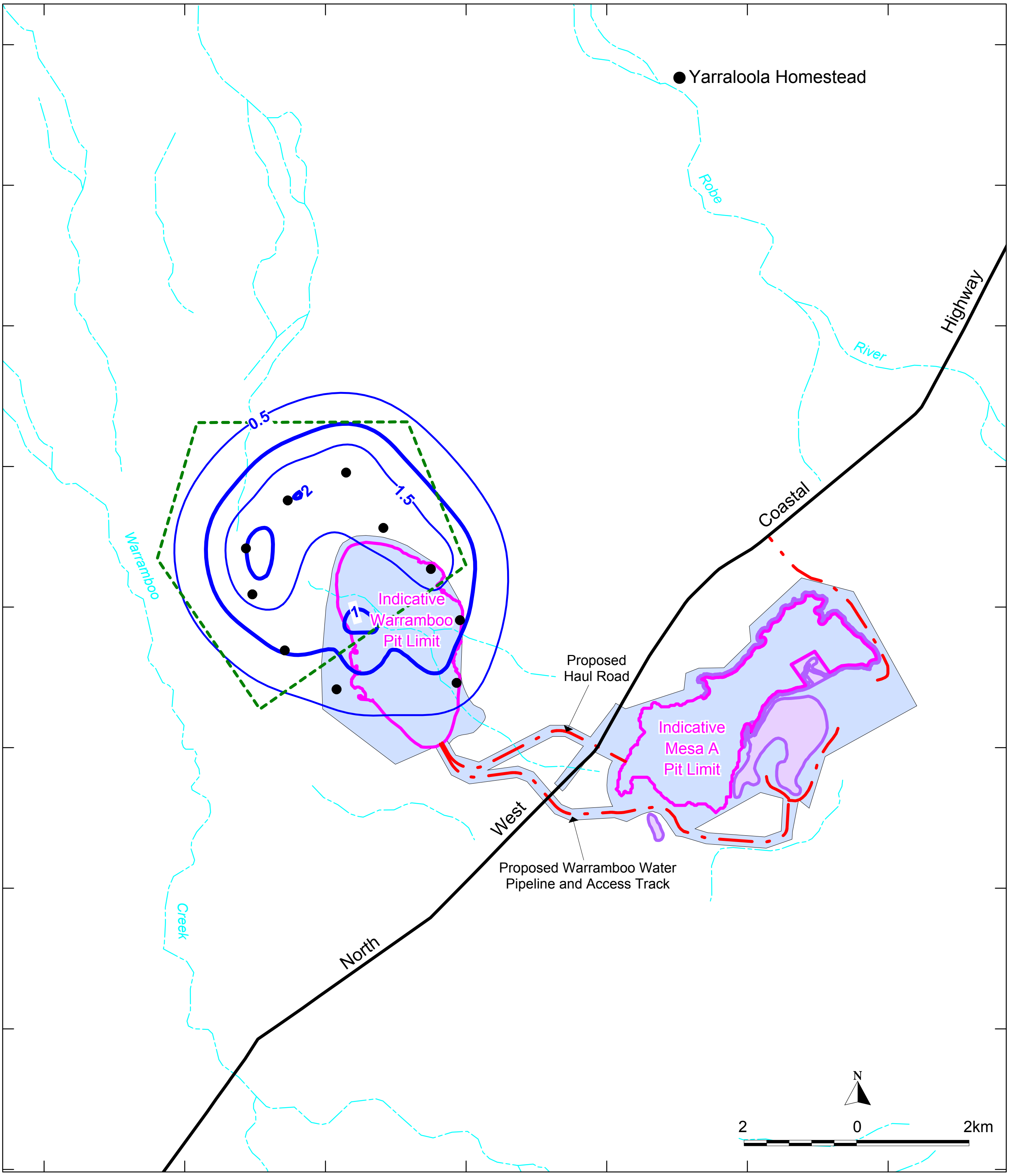
Additional modelling of the Warramboo aquifer will be undertaken upon completion of the detailed pump testing program scheduled for September 2006.

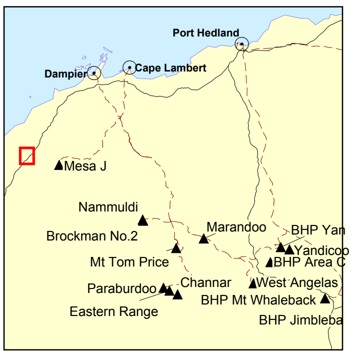
Table 24 Simplified parameters for the Warramboo aquifer model

Parameter	Value
Hydraulic conductivity (m^2/d)	4
Saturated thickness (m)	25
Hydraulic gradient	0.001
Direction of flow	NW
Recharge (m/d)	9.9×10^{-6}
Porosity	0.3
Specific yield	0.1
Time (days)	3650

14.4.3 Predicted drawdowns

The proposed groundwater abstraction from the Warramboo aquifer is expected to result in localised watertable drawdowns, with the greatest changes occurring around the wells pumped at the highest rates. From preliminary modelling, the predicted drawdown after 10 years is expected to be 0.5 m, three kilometres from the centre of the proposed wellfield (Figure 25).





- Proposed Borefield Area
- Predicted Drawdown Contour (m)
- Indicative Bore Location
- Major River/Creek
- Minor River/Creek
- Mine Footprint
- Exclusion Zone

Pilbara Iron
A member of the Rio Tinto Group

Figure 25 Mesa A Warramboo proposed bore locations & drawdown contours

Author: FB	Date: January 2006
Drawn: CB/GC	Revised:
Dwg No.: rp113949v11_rev1	Report No.:
Projection: MGA Zone 50 GDA94	Scale:

As groundwater levels are mostly >15 m deep, the vegetation in the area is unlikely to be groundwater dependent. Therefore the potential impact of the predicted drawdowns on vegetation is expected to be minimal.

Aquaterra (2005b) concluded:

> "*To satisfy the water supply demand of 1.5 GL/yr for a ten year period, abstraction from a series of wells (~10) surrounding the mine site would result in a cone of depression that would extend out approximately 2 km from the edge of the wellfield. The 0.5 m drawdown contour is expected to extend approximately 1.2 km away from the edge of the wellfield, while the 2 m drawdown would be approximately 100 m away from the pumped wells. With water levels being mostly greater than 15 m below surface, impacts on groundwater dependent vegetation are expected to be limited*."

14.4.4 Potential ecosystem response to drawdowns

Studies on vegetation on the Gnangara Mound have shown that groundwater dependence is most closely related to groundwater depth. If groundwater occurs close to the surface it is likely that the ecosystem is highly dependent. In general, the greater the depth to groundwater, the lower the inferred plant dependency on groundwater as a water source and the more tolerant the plant is to groundwater fluctuations due to a corresponding increase in the use of alternative water sources (Froend and Loomes 2004). Quantitative information suggests reduced importance of groundwater to vegetation existing at depths of >10 m and although at depths between 10 – 20 m there is a probability of vegetation groundwater use, it is thought to be negligible in terms of total plant water use. Beyond 20 m the probability is substantially lower (Zenich *et al.* 2002). This research conclusion has been used as a rule of thumb in other parts of Western Australia. Therefore, drawdowns in the Warramboo aquifer, where the depth to watertable is >15 m, are considered unlikely to have any impact on the vegetation that occurs in the area.

Warramboo Creek does not intersect the Warramboo aquifer and is a losing stream that recharges the aquifer when it flows. Therefore, a change in watertable levels would have no impact on the creek or other surface water flows.

The groundwater modelling showed a very limited drawdown of 0.5 – 1.5 m in the immediate vicinity of the production bores. This would be unlikely to cause a decline in riverine vegetation even if strongly phreatophytic communities were present. Based on the contours and vegetation mapping, there are no groundwater dependent vegetation types present in the area that would be affected by groundwater change at Warramboo (Biota 2006g).

14.5 PROPOSED MANAGEMENT ACTIONS

The management of groundwater resources at Mesa A/ Warramboo will be addressed by the following proposed management actions:

- prepare and implement a Water Management Plan for the operation in accordance with any conditions of a licence granted under the *Rights in Water and Irrigation Act 1914*
- prepare and implement a Groundwater Operating Strategy for the operation in accordance with any conditions of a licence granted under the *Rights in Water and Irrigation Act 1914*
- prepare and implement a water balance for the operation.

14.6 PREDICTED OUTCOME

Abstraction from the deep Warramboo aquifer will result in a localised watertable drawdown with a predicted drawdown after 10 years of 0.5 m at 3 km from the centre of the proposed wellfield. However, following completion of mining operations and associated water abstraction, the underlying watertable will return its pre-development levels over time. There is expected to be negligible impact on vegetation as the vegetation of the proposed wellfield area is not likely to be groundwater dependent as groundwater levels are mostly >15 m. The abstraction of groundwater from the Warramboo aquifer is not expected to have an adverse impact on vegetation or surface water flows and the EPA objective for this factor will be met.

15. DUST

15.1 DESCRIPTION OF FACTOR

15.1.1 Definition of dust

In the assessment of environmental impacts, dust is more conventionally referred to as ‘particulates’ or ‘airborne particulates’. Some commonly used definitions describing airborne particulates are:

- Total suspended particulates (TSP): all particles that are suspended in the atmosphere. In practice, this will refer to particles typically up to 30 micrometers (µm) in aerodynamic diameter, but might include particles up to 50 µm in aerodynamic diameter under windy conditions.
- PM_{10}: particulate matter with an equivalent aerodynamic diameter 10 µm or less.
- $PM_{2.5}$: particulate matter with an equivalent aerodynamic diameter 2.5 µm or less.
- Fine particles: all particles less than 2.5 µm in diameter.
- Coarse matter: all particles in the size range from 2.5 to 10 µm.

Airborne particles are generated during mining mainly by mechanical disturbances, such as blasting, earthmoving and road traffic on unsealed surfaces. In dry windy conditions, particles can be lifted from open or disturbed areas, resulting in visible dust emissions. Most airborne particles that originate from these sources are larger than PM_{10} and are more associated with nuisance than public health problems. The larger particles tend to settle back to the ground within a short range (<300 m) from the source.

15.1.2 Generation and dispersion of dust

The generation of airborne dust from mining and ore handling operations will depend on:

- the frequency at which a dust generating activity takes place
- meteorological conditions, such as wind speed
- composition of dust, including particle size distribution, particle density and moisture content
- the condition of the source.

The Mesa A/Warramboo area is an arid environment that is subject to naturally high background dust levels when compared to the south-west of Australia. This is due to dust lift off as a result of the hot dry climate and sparsely vegetated landscapes of the region. This is recognised in the discussion paper on a State-wide Air Quality Environmental Protection Policy (EPA 1999) that notes airborne dust in the Pilbara (and Goldfields) can be a problem as background levels can be close to or higher than the National Environmental Protection Measure (NEPM) standard.

15.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the mining operations that may significantly affect dust emissions include:

- **Physical disturbance of the land surface** during construction of infrastructure and mining (removal of vegetation, blasting, excavations).
- **Haulage and light traffic** on unsealed roads.
- **Crushing and materials handling** at fixed plant sites.
- **Wind episodes** over dry open mine areas, stockpiles and unsealed roads.

15.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA Objective

The EPA normally applies the following objective in its assessment of proposals that may generate dust emissions. This objective is considered relevant to this proposal.

- *To ensure that dust emissions do not adversely affect environmental values or the health, welfare and amenity of people and land users by meeting statutory requirements and acceptable standards.*

National Environmental Protection Measure

In June 1998 a NEPM for Ambient Air Quality was endorsed by the National Environment Protection Council (NEPC). The desired environmental outcome of this Measure is ambient air quality that allows for the adequate protection of human health and well being (NEPC 1998). The measure included standards for air quality, including for particulates as PM_{10}. In 2003, the National Environmental Protection Measure was amended to include advisory reporting standards for particles as $PM_{2.5}$ (NEPC 2003).

The National Environmental Protection Measure standards and goals for particulates are shown in Table 25.

Table 25 National Environmental Protection Measure for ambient air quality

Pollutant	Averaging period	Maximum concentration	Maximum allowable exceedences
Standards and goal for pollutants other than particulates as $PM_{2.5}$			
Particles as PM_{10}	1 day	50 µg/m^3	5 days a year
Advisory reporting standards and goal for particulates as $PM_{2.5}$			
Particles as $PM_{2.5}$	1 day	25 µg/m^3	Goal is to gather sufficient data nationally to facilitate a review of Advisory Reporting Standards
	1 year	8 µg/m^3	

15.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

15.4.1 Dust investigations

A series of tests in respect of dustiness have been carried out by CSIRO using pisolitic material from Mesa J. It has been found that the Mesa A/Warramboo material is similar to that from the upper benches of Mesa J and therefore it has been predicted that conclusions reached for Mesa J during the testwork can be applied directly to Mesa A/Warramboo (Robe 2005c).

Drop tests undertaken by TUNRA (1998) indicated that dustiness of Mesa J fines is related to the moisture content of the material. There is little reduction in the dustiness of the material up to 3% moisture content, although a significant reduction was observed between 3-4%. Dustiness is further reduced, although more gradually by an increase in moisture content up to 6%. Therefore for fines, a moisture content of 3% or above is required to effect a significant reduction in dustiness.

CSIRO (1998) conducted wind tunnel testwork to assess dust emissions generated by strong winds. The study found that at gravimetric water contents of approximately 3% the Mesa J fines has a much lower potential for dust generation than that from the West Angelas operation.

Material handling dust tests (rotating drum tests) using Mesa J ore indicated the moisture content required to suppress the majority of the dust ranged from 4 to 6%. Above this moisture content, negligible dust was generated (Robe 2005c).

Test work on wind erosion potential using a large wind tunnel to test behaviour on flat surfaces and scaled down rail cars indicated that negligible dust is generated for Mesa J fines on flat surfaces. However, this material is susceptible to wind erosion in stockpiles. This is probably due to coarser fines falling to the bottom of the stockpiles exposing sides of the stockpiles which do not have particles greater than 1 mm (Robe 2005c).

Lumps and fines with a high percentage of particles over 2 mm are generally not susceptible to wind erosion, apart from the loss of a little dust from fines that adhere to the surface of the lump when moist (Robe 2005c).

15.4.2 Physical disturbance of land surface

Dust emissions from physical disturbance to the land surface represent one of the biggest potential sources of dust in mining operations. In total approximately 2250 ha of land will be cleared for the Mesa A/Warramboo mine and Robe will minimise clearing requirements as far as practicable to reduce the total exposed area.

Dust may have physical effects on plants such as blockage and damage to stomata, shading, abrasion of leaf surface or cuticle and cumulative effect (e.g. drought stress on already stressed species). Dust also has the potential to cause health impacts, however due to the remoteness of the mine from the town of Pannawonica these impacts will not be significant. At Mesa A/Warramboo the principle risks of dust and drivers for dust control are safety and health of the mine workforce.

Water or other suitable dust suppressants will be applied to minimise dust generation from the active mining area.

15.4.3 Haulage

Water, or other suitable dust suppressants, will be applied to haul roads and other unsealed areas to reduce dust generation from unsealed surfaces. Signage and enforcement of speed limits will be used to reduce dust generation from vehicle travelling on unsealed roads.

15.4.4 Crushing and materials handling

Dust generation during materials handling will be controlled through ore moisture content control and/or other suitable measures. Measures which may be utilised include in-pit irrigation of the broken ore to control the moisture content, deluge of the ore at the load-out point to 'cap' the ore or use of dry fogging (compressed air used in conjunction with water to obtain extremely small water droplet sizes) to suppress dust.

15.4.5 Wind episodes

Wind episodes leading to wind erosion of dust from cleared areas represents a significant potential source of dust from mining operations, particularly under dry climatic conditions and strong wind conditions. Robe will apply water or other suitable dust suppressants to these areas during periods when dust is likely to become a problem. This watering will be in addition to maintaining wetted surfaces within active mining and haul areas.

Robe will also rehabilitate all disturbed areas as soon as practicable following disturbance. Early rehabilitation ensures the total cleared area is minimised and reduces the potential for dust generation during windy conditions.

15.5 PROPOSED MANAGEMENT ACTIONS

The management of dust at Mesa A/ Warramboo will be addressed by the following proposed management actions:

- control dust generation through ore moisture content control or other suitable measures
- apply water or other suitable dust suppressants to reduced dust generation from unsealed areas
- install signage and enforce speed limits to reduce dust generation from roads
- minimise clearing of vegetation
- undertake regular inspections to visually assess dust generation and to ensure the correct functioning of dust suppression equipment
- undertake progressive rehabilitation to minimise total exposed area.

15.6 PREDICTED OUTCOME

The Mesa A/Warramboo operations are relatively remote and are at distance from sensitive premises. Robe will implement dust management actions that will be sufficient to ensure that the proposal will be managed to meet the EPA objective of not adversely affecting environmental values or the health, welfare and amenity of people and land uses. The proposed management actions will also ensure that dust emissions from the operations will meet statutory requirements and acceptable standards.

16. ABORIGINAL HERITAGE

16.1 DESCRIPTION OF FACTOR

Numerous archaeological and ethnographic surveys have been carried out at and in proximity to the Mesa A and Warramboo area over the last three decades; the most recent and relevant being:

- Wood and Westell (2003; 2005): archaeological surveys of Mesa A and Warramboo areas.
- Stevens (2003; 2004a; 2004b; 2005): ethnographic surveys of Mesa A and Warramboo areas.

All surveys were undertaken in cooperation with the Kuruma Marthudunera. It should be noted that the escarpment faces at Mesa A were not assessed in the above mentioned surveys (only cursory examination of rock shelters along the mesa escarpment was undertaken) and the ethnographic surveys related to Robe's exploratory drilling program only (e.g. Kuruma Marthudunera provided comment on drilling disturbance to sites and not mining related disturbances to sites).

The following description of archaeological and ethnographic heritage for Mesa A and Warramboo are from the above mentioned studies, unless otherwise stated.

16.1.1 Archaeological heritage

Mesa A

Over 40 archaeological sites were recorded at Mesa A by Wood and Westell (2003) comprising mostly artefact scatters[13] and several scarred trees[14]. Most artefact scatter sites were small in area and represented by a low density of artefacts. Four artefact scatter sites (Mesa A – 4d, e, f and g; Wood and Westell 2003) were periphery components of a much larger site complex (Wood and Westell 2003). This larger site complex (DIA Site No. 18 517), recorded during previous survey work, contains a wide assemblage of artefacts and is located in association with a deeply incised gully, two rock shelters[15] and a large rock pool. The volume of material present at this larger site is indicative of repeated habitation of this area. The extent and assemblage diversity of this site complex is relatively uncommon in the area.

One scarred tree displayed a small ovoid scar similar to that expected from the manufacture of a shield or dish (Figure 26). The remaining scarred trees displayed evidence of honey procurement and were

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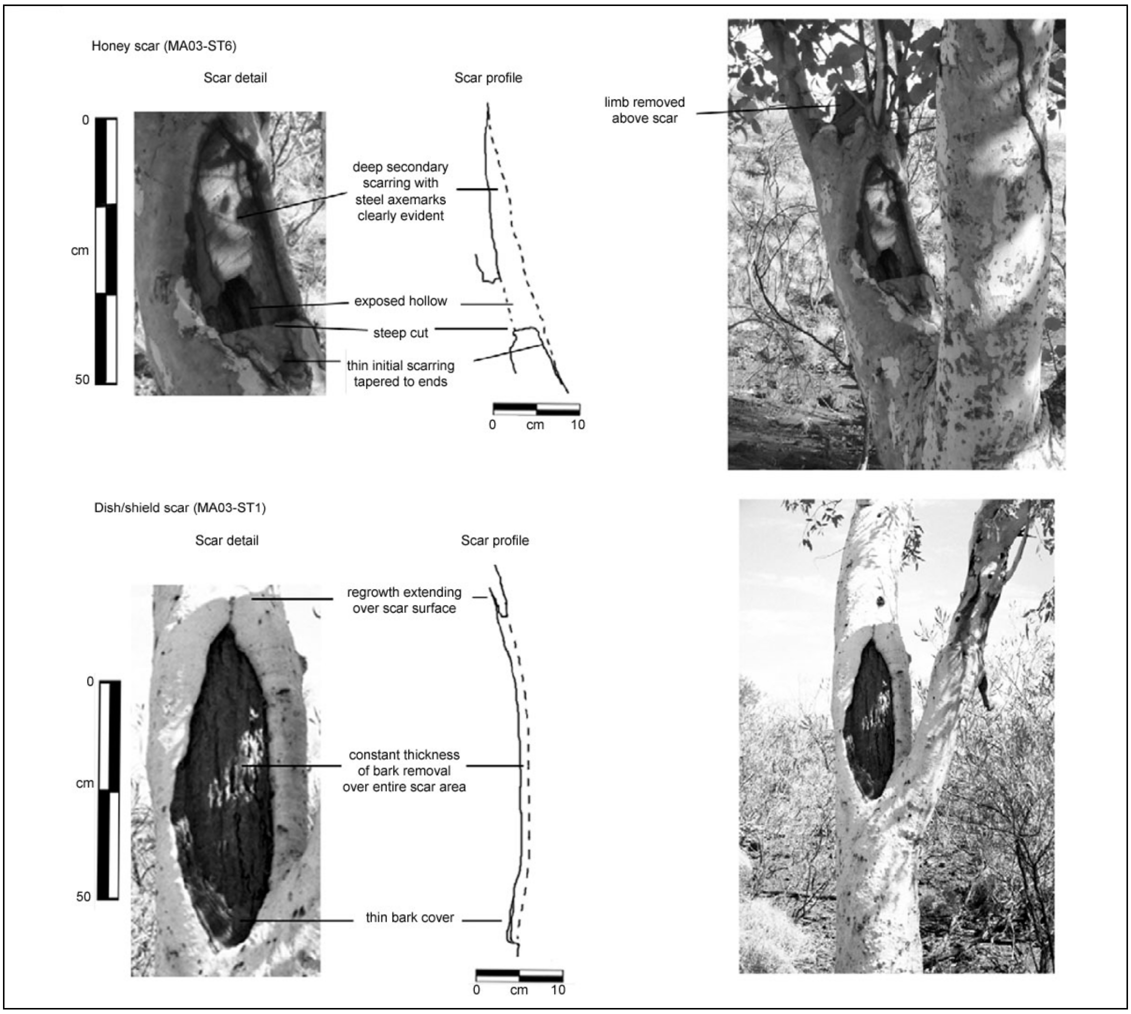
[13] *Artefact scatter* refers to locations where a range of activities has occurred such as the manufacture and maintenance of tools and the processing of foods. These sites will often contain a wider range of lithic materials than quarries and reduction scatters.

[14] *Scarred (modified) tree* refers to a tree with its trunk and limbs modified by the removal of bark and/or wood. Aboriginal people removed wood/bark for material items such as shields and baskets or to access native honey inside hollows in the tree.

[15] *Rock shelter* refers to an overhang, cave or cliff face that contains evidence of human occupation in the form of stone artefacts, charcoal, faunal material or rock art.

likely to have been cut in relatively recent times given that steel axe marks were evident and decaying wood chips were still present around the base of some scarred trees.

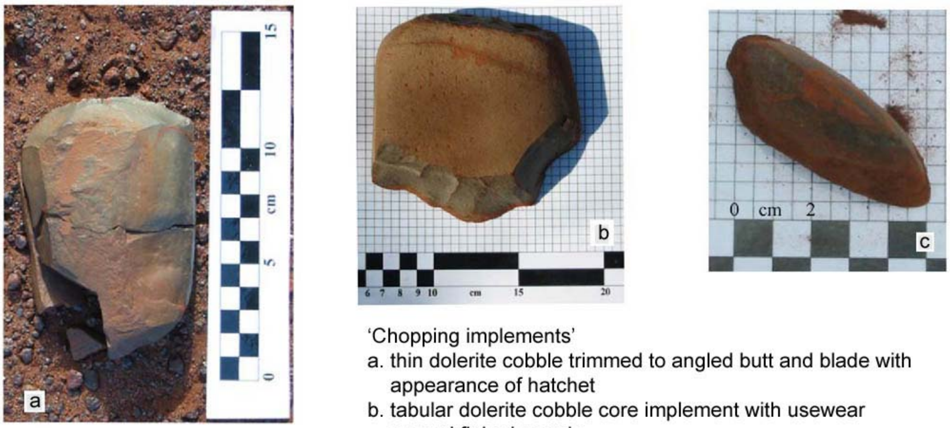


Source: Wood and Westell (2003)

Figure 26 Scarred tree types recorded at Mesa A

Although the escarpment faces of Mesa A were not included in the heritage surveys, numerous rock shelters likely to contain archaeological material are known to be present (these are not included in the count of archaeological sites for Mesa A).

Over 500 isolated artefacts scattered across Mesa A were recorded (Figure 27). Of these, a large number were introduced unmodified rock fragments that occurred in all situations, including the mesa rim, along shallow ephemeral watercourses, gullies and the plateau surface. These artefacts are known as *manuports*, a term given by archaeologists and anthropologists to a natural object that has been moved from its original context by human agency but remains otherwise unmodified. The source of these manuports is most likely to be the alluvial valley floors and the manuports were most likely transported and used for pounding and as grindstones. However, the manuports may have been used for other forms of cultural activity. The manuport phenomenon has been reported upon elsewhere in the Pannawonica region.



'Chopping implements'
a. thin dolerite cobble trimmed to angled butt and blade with appearance of hatchet
b. tabular dolerite cobble core implement with usewear around flaked margin
c. fragment of edge-ground dolerite axe

a b c

Progressive usewear on grindstones
a. amorphous dolerite grindstone with lightly abraded surface
b. shallow groove and pecked surface on large trimmed tabular dolerite block
c. deeply grooved grinding surface on sandstone block (trimmed)

Source: Wood and Westell (2003)

Figure 27 Example of artefacts recorded at Mesa A

In general, access to the Mesa A area would have been conditional on the availability of freshwater, therefore, occupation would have been limited to the summer wet season when rock holes collected water. Furthermore, as there is almost a total lack of shelter across the mesa plateau (the vegetation is dominated by low sparse growth and grasses), there would be an expectation that habitation areas would be located in proximity to accessible rockshelters (e.g. the mesa escarpment).

The majority of sites identified at the Mesa A area were concentrated around the mesa rim and along major creek lines and gullies, although some sites were recorded across the mesa plateau but still in the vicinity of the mesa rim and prominent gullies. The more substantial sites, in terms of extent and assemblage variability, were located in proximity to deeply incised gullies around the mesa rim.

Warramboo

Over 20 sites were recorded at Warramboo by Wood and Westell (2005) comprising mostly artefact scatters with one scarred tree (possibly used for honey procurement) and one rock shelter (subject to a cursory assessment only) identified. Unlike Mesa A, only a small number of manuports were recorded at Warramboo.

Most of the sites recorded at Warramboo represent small, low density scatters of artefacts with typically narrow assemblages; artefact assemblages were dominated by unmodified flakes. There was one artefact scatter site that was quite large in extent, being a semi-continuous deposit that extended 2 km along the length of a main northwest flowing ephemeral creekline (DIA Site No. 18 514).

Most of the sites identified at the Warramboo area were concentrated in and around water courses (e.g. ephemeral creek lines). It should be noted however, that many of the water courses represent insignificant features that are unlikely to have held or collected water for any length of time and it may be that these areas were selected for reasons other than water availability.

Site significance

Wood and Westell (2003; 2005) assessed the site significance of the above described archaeological sites of Mesa A and Warramboo[16]. In general, artefact scatters and scarred trees are common in the Pilbara region and typically such sites are assessed as having a low degree of archaeological significance. Rock shelters tend to have a higher degree of archaeological significance due to the importance of such sites to Aboriginal persons (e.g. of ethnographic significance).

The majority of the sites at Mesa A and Warramboo were assessed as being of low significance (82% of sites for both areas). At Mesa A, four sites were assessed to be of high significance; these four sites being those that represented peripheral components of a larger site complex (Mesa A – 4d, e, f and g; Wood and Westell 2003). The large artefact scatter site located along the main creekline at Warramboo (DIA Site No. 18514), was assessed to be of moderate significance and the significance of the rock shelter recorded at Warramboo was undetermined.

16.1.2 Ethnographic heritage

The consensus view, based on both ethnographic and archaeological material, suggests that the characteristic mesa landforms were utilised on a short term, transient basis. This use is manifest in a relatively lower density and scale of occupation of sites on the mesa plateaus compared with alluvial valley sites, especially those situated nearer the Robe River. As a general rule, Aboriginal people throughout the Pilbara attribute some value to all their sites and would prefer that no sites are disturbed.

Results from the Stevens (2003; 2004a; 2004b; 2005) surveys indicate that most of the artefact scatter sites were considered to hold a low level of ethnographic significance. The exceptions being:

1. A stone axe (*budba*), which was located as an isolated artefact on open ground at Mesa A. Its location was recorded to enable salvage prior to any ground disturbance activities.
2. A large artefact scatter that extends along a main creekline at Warramboo. The density of artefacts was considerably greater than for surrounding sites, indicating the creek was a prime

[16] Site significance is a concept which enables archaeologists to estimate the scientific value of places and sites, which in turn, assists in providing specific recommendations for the management of these places and sites. The scientific or research value of a site will depend upon the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information (Wood and Westell 2003; 2005).

location for subsistence activities. The Kuruma Marthundunera considers the site an important representative site that highlights the significance of major creeks about their country. Although the site is of some importance, the Kuruma Marthundunera did not think the site was so important that they could not permit ground disturbing activities about or upon the site, but would like to have a portion of the site salvaged.

3. An extensive artefact scatter at Mesa A which partially extends to the gully down the escarpment (DIA Site No. 18 517 and associated periphery sites). The larger part of the site, which consists of sparse artefact scatters on the mesa top, was identified as being of low ethnographic significance, however the portion that descends the gully escarpment is potentially more important due to the presence of rock shelters; the escarpment was not assessed in Stevens (2004a).

Trees that were used to extract honey were identified as being of interest to traditional owners, however, these modified (scarred) trees were also considered to hold a low level of ethnographic significance.

Rockshelters, terraces and water holes about the Mesa A escarpment were identified as having a high level of ethnographic significance. Kuruma Marthudunera expressed concern at any possible disturbance to these areas.

Although not recognised as sites *per se*, major water courses in the Pilbara region are widely recognised as being of ethnographic value as they are the foci for camping, ceremonies and other activities. Major water courses in the vicinity of the mining areas are Robe River, Warramboo and Mungarathoona Creeks.

16.2 POTENTIAL SOURCES OF IMPACT

The primary aspect of the mining component of the proposal that has the potential to have an impact on Aboriginal heritage values is:

- **Physical disturbance of the land surface** during construction and operation of the mine and associated infrastructure has the potential to disturb heritage sites and affect ethnographic values.

16.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA Objective

The EPA normally applies the following objective in its assessment of proposals that may affect heritage and culture values. This objective is considered relevant to this proposal.

- *To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.*

State legislation

The Minister for Indigenous Affairs is responsible for the administration of the *Aboriginal Heritage Act 1972*. Under section 17 of the Aboriginal Heritage Act, it is an offence to disturb any Aboriginal site without consent under section 18 of that Act.

The Minister considers recommendations from the Aboriginal Cultural Material Committee and the general interests of the community when making a decision on disturbance to a site and may also impose conditions on the approval.

The Registrar of Aboriginal Sites is responsible for maintaining the Register of Places and Objects. The Department of Indigenous Affairs (DIA) has a database of all recorded sites.

EPA Guidance Statement No 41

EPA Guidance Statement No. 41, "*Assessment of Aboriginal Heritage*", provides guidance on the process for the assessment of Aboriginal heritage as an environmental factor. This guidance statement also details those actions that may be pertinent to the factor of Aboriginal heritage, including:

- consultation with DIA staff and desktop review of sites
- undertaking an Aboriginal heritage and/or archaeological survey in consultation with relevant Aboriginal representatives
- inform relevant Aboriginal people of the proposal and conduct appropriate consultation
- demonstrate that any concerns raised by the Aboriginal people have been considered in the environmental management of the factor and that this is made known to the relevant Aboriginal people.

16.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

16.4.1 Disturbance to land surface

Ground disturbance activities will affect some recorded archaeological sites and subsequently affect any associated ethnographic values. As some sites are located on the periphery of disturbance areas, the extent and nature of the impact will not be known until final planning for mine development is complete. It may be practicable for development to avoid some sites on the periphery.

Most of the archaeological sites that cannot be avoided consist of items of low archaeological and ethnographic significance (e.g. artefact scatters, manuports). These sites will be subject to a section 18 consent under the *Aboriginal Heritage Act 1972* and in most instances artefacts at these sites will be salvaged. For most archaeological sites at Mesa A, Kuruma Marthudunera have indicated they will not object to a section 18 consent, so long as disturbance does not extend into the designated exclusion zone around the mesa escarpment (Section 16.4.2).

Robe will maintain a nominal 50 m mining exclusion zone around the rim of the Mesa A escarpment, except for the area where the escarpment will be breached to allow access from the pit to the plant area. The exclusion zone will protect the rock shelter sites identified to be of greater heritage significance. The location of the haul road that results in the escarpment breach was designed to avoid as much of the sand sheet area as possible and to avoid other environmentally and heritage sensitive areas such as the mesa gullies. However, due to plant infrastructure required and proximity to the North West Coastal Highway this was the most viable option for the location of the haul road. A preliminary survey for caves in this section of the escarpment has been undertaken by a Pilbara Iron archaeologist, and a formal heritage survey will be undertaken prior to any work commencing, to determine whether the mesa breakthough will disturb any heritage sites.

16.4.2 Management measures

In accordance with Rio Tinto's '*Aboriginal Heritage*' Policy and Procedures, Robe will implement the *Ground Disturbance and Authorisation* procedure, which is designed to prevent unauthorised ground disturbance activities. The system will be applied to all areas where disturbance is proposed.

The heritage procedures also require that prior to any ground disturbance activities, Robe will ensure all areas have been surveyed to determine archaeological and ethnographic significance. This will include surveying the section of the Mesa A escarpment where the haul road will be placed. Final project plans will be modified to avoid heritage sites wherever practicable.

As recommended by Kuruma Marthundunera, to protect the rock shelters and other heritage values associated with the mesa escarpment, Robe will maintain a nominal 50 m mining exclusion zone around the rim of the Mesa A escarpment, except where the escarpment will be breached to allow access between the pit and plant areas.

Where a heritage site cannot be avoided, Robe will seek consent to disturb the site(s) from the Minister for Indigenous Affairs through a section 18 application under the *Aboriginal Heritage Act 1972*, in consultation with Kuruma Marthundunera. Robe will undertake disturbance in accordance with the conditions of the section 18 consent and will consult and involve Kuruma Marthundunera in mitigative heritage work prior to disturbance of the site. This will include detailed recording of sites and may involve salvage of artefacts.

16.5 PROPOSED MANAGEMENT ACTIONS

Aboriginal heritage issues at Mesa A/ Warramboo will be addressed by the following proposed management actions:

- undertake Aboriginal archaeological and ethnographic surveys of the Mesa A escarpment and other areas of proposed disturbance not yet surveyed, in consultation with Kuruma Marthundunera
- avoid disturbance to significant heritage sites where practicable
- where avoidance of a site is not practical, seek consent to disturb the site from the Minister for Indigenous Affairs through a section 18 application under the *Aboriginal Heritage Act 1972*, in consultation with Kuruma Marthundunera
- maintain a 50m mining exclusion zone around the Mesa A escarpment (including the three identified gullies), except for the area where the escarpment will be breached to allow access from the pit to the plant area, to protect Aboriginal heritage values of the escarpment.

16.6 PREDICTED OUTCOME

A number of recorded Aboriginal heritage sites will be disturbed by mining. It is likely that most of these sites consist of artefact scatters which have been determined to be of low heritage significance. The proposal will avoid disturbance to most of the Mesa A escarpment, which contains numerous rock shelters which have been identified to be of high heritage significance, through the establishment of a mining exclusion zone. Some heritage sites on the escarpment may be disturbed due to the requirement for a passage through the mesa escarpment.

Robe will continue to consult and work with Kuruma Marthundunera regarding management of Aboriginal heritage sites and values and, consistent with the EPA objective for this factor, will manage Aboriginal heritage sites in accordance with the Aboriginal Heritage Act.

17. REHABILITATION AND CLOSURE

17.1 DESCRIPTION OF FACTOR

Mining and the establishment of associated infrastructure will result in clearing of vegetation and disturbance of soil profiles and landforms. Rehabilitation aims to restore disturbed landforms as rapidly as practical so they are sympathetic to surrounding areas and resemble the local environment as much as possible.

Robe aims to rehabilitate all areas of land that it disturbs while carrying out its operations. Robe's environmental performance in rehabilitation has been widely recognised, and in 1997 the company was awarded a certificate of merit in the Golden Gecko Awards for mine site rehabilitation work. Over the years Robe has participated in a number of studies, in conjunction with universities and research organisations, in order to improve rehabilitation techniques in the Pilbara region. Projects have included trials to maximise Spinifex regrowth, establishment of a native seed farm, and the use of remote sensing data to monitor the performance of rehabilitation areas.

General objectives for mine closure are to prevent or minimise adverse environmental impacts and to create self-sustaining natural ecosystems or an alternative land use based on an agreed set of objectives (ANZMEC & MCA 2000). Closure planning is a dynamic process that requires regular review and development throughout the life of an operation, to take into account changes in legal obligations, corporate requirements, community expectations and changes in technical knowledge (SKM 2005a).

17.2 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

EPA objective

The EPA normally applies the following objective in its assessment of proposals that have a rehabilitation and closure component. This objective is considered relevant to this proposal.

- *To ensure as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.*

State legislation and guidelines

In a legislative context, mine site rehabilitation and closure is governed by the following Western Australia legislation:

- *Environmental Protection Act 1986*
- *Mining Act 1978*
- *Mines Safety and Inspection Act 1994*
- *Conservation and Land Management Act 1984*
- *Rights in Water Irrigation Act 1914*
- *Iron Ore (Robe River) Agreement Act 1964.*

The Department of Industry and Resources (DoIR), formerly known as the Department of Minerals and Energy (DME), is the regulatory agency of mining in Western Australia. It has developed a number of guidelines and environmental notes in relation to mining and rehabilitation, which include:

- Guidelines for Mining in Arid Environments (DME 1996)
- Environmental Notes on Mining, Waste Rock Dumps (DME 2001).

Federal guidelines

The Commonwealth Government, through Environment Australia, have released a series of best-practice guidelines for environmental management in mining. These include:

- Environmental Monitoring and Performance (1995)
- Landform Design for Rehabilitation (1998)
- Rehabilitation and Revegetation (1995).

These guidelines have been produced to assist mining companies in achieving acceptable standards of mine closure and rehabilitation.

17.3 REHABILITATION

17.3.1 Rehabilitation objectives

The management objective for rehabilitation is to rehabilitate all disturbed areas to a standard that achieves a safe and stable landform containing native plant communities that approximate those that existed prior to the commencement of the construction work.

Rehabilitation will be undertaken as described in Robe's Rehabilitation Guidelines (Pilbara Iron 2004).

The above objective of rehabilitation is to produce final landforms that are:

- safe
- stable
- support self-sustaining native vegetation communities
- free draining and non polluting
- visually compatible with surrounding landscape.

To facilitate impartial assessment of the progress of rehabilitation, a preliminary set of rehabilitation performance criteria will be established. Regular monitoring of rehabilitation should identify any need to alter management techniques and determine whether the performance criteria are applicable or require revision. Revision of criteria is based on their capacity to reflect practical goals of rehabilitation and is undertaken in consultation with the DEC (Environmental Management Division) and the DoIR. Rehabilitation performance criteria include post-closure land use objectives, closure objectives, landform stability targets, revegetation targets and ground water protection targets.

17.3.2 Rehabilitation approach

Rehabilitation of disturbed areas has three main components:

1. Ensuring the structural stability of constructed landforms.
2. The provision of surface stability.
3. Revegetation.

The long term success of rehabilitation and closure is dependent on the stability of the final landforms. Stability of landforms is in turn dependent on a number of factors including slope length and angle, soil mantle structure, drainage design and vegetative cover. As vegetation cover may take up to ten years to establish to provide adequate protection to the landform, all landforms are designed to withstand exceedances of average annual rainfall for this period.

Rehabilitation of backfilled mine pit

Waste rock produced will be used to backfill the pit at Mesa A and Warramboo as far as practicable, without sterilising the subgrade resource. Backfilling will be selective and partial due to the limited quantities of backfill material available.

The Mesa A and Warramboo pits will be progressively backfilled and rehabilitated. Rehabilitation of the backfilled pits will be in accordance with the procedures outlined in Section 17.3.3.

Rehabilitation of waste dumps

Grade variation in the ore body will require waste rock to be placed in surface waste dumps during the first few years of operation. The maximum waste dump footprint is expected to be approximately 30 ha at Mesa A and approximately 49 ha at Warramboo.

Dump footprints will be designed based on a maximum waste dump height of 10 m, which will be profiled to an average slope of 18 – 20 degrees. Where waste dumps abut natural landscapes, run off from these landscapes will not be directed onto the waste dumps. The tops of the waste dumps will be sloped towards natural topography and/or towards the centre of the dump. A bund wall will be constructed around the perimeter to prevent surface water running over the edge, and to prevent water pooling against the bund wall. The top profile will be left so that excess water will not have a tendency to flow over the dump edge or pool near the edge.

Dumps at Mesa A will be positioned to restrict public access to the site and to act as a visual barrier from the North West Coastal Highway (Figure 22). The outer toes of dumps will be established early in the mine life and rehabilitation of the waste dumps will commence within three years of commencing mining operations.

Waste dumps will be designed in accordance with Robe's Waste Dump Design Guidelines (Pilbara Iron 2005). The design will incorporate rehabilitation design, to minimise waste rehandling, and optimise the configuration and stability of waste dumps to facilitate successful rehabilitation.

Rehabilitation of decommissioned land

Decommissioning of the mine and associated infrastructure will involve the dismantling and removal of all buildings and structures, equipment and pipelines where no agreement to retain them has been made with stakeholders. All compacted areas will be deep ripped and recontoured in order to restore normal drainage. Decommissioned land will be rehabilitated as soon as practicable, in accordance with the procedures outlined in Section 17.3.3.

17.3.3 Rehabilitation procedures

Rehabilitation of the Mesa A/Warramboo project area will be undertaken in accordance with the procedures described in Robe's Rehabilitation Guidelines.

Robe's rehabilitation process currently involves five phases:

1. Recovery and stockpiling of cleared vegetation and topsoil in advance of mining for use on rehabilitation areas.
2. Battering slopes to an angle ≤20º (angle depends on the nature of the material being shaped).
3. Re-spreading of topsoil and deep ripping of soil surfaces.
4. Seeding using local provenance seed where topsoil is considered to be insufficient.
5. Monitoring establishment of plants and development of ecosystem processes.

Management of topsoil is a critical factor in successful rehabilitation, particularly in arid environments such as the Pilbara. Topsoil is valuable as it has a high nutrient content relative to other sections of the soil profile; has a higher water holding capacity; has suitable structural properties; contains most of the viable seed and vegetative material; and contains mycorrhizal fungi that facilitate plant growth.

Topsoil will be obtained during all site clearing activities and used immediately on restored landforms or stored in low lying stockpiles. The long-term viability of topsoil stockpiles will be maintained through the use of Robe's standard procedures for topsoil management to be applied at initial construction and through mine life.

Battering slopes reduces the risk of erosion and therefore helps create a more stable landform. Deep ripping of soil surfaces reduces the risk of erosion and enhances water harvesting capabilities of the rehabilitated landform. Surface ripping creates a typical bank and trough system (Figure 28). Surface ripping is undertaken prior to seeding, to help control runoff and create favourable microsites for seeds.

Currently seeding rates at Pannawonica are approximately 6.5 – 7.0 kg/ha, which includes 2.0 kg of *Triodia* (Spinifex) seed. Seeds consist of a range of local provenance species, including Acacias (*Acacia ancistrocarpa, A. atkinsiana, A. bivenosa, A. colei, A. inaequilatera , A. orthorcarpa , A. pyrifolia , A. tenuissima , A. trachycarpa , A. tumida , A. victoriae*) *Triodia* (*T. pungens, T. wiseana*), *Cassia* (*C. luerssenii, C. notabilis, C. oligophylla*), *Cymbopogon ambiguus*, *Eucalyptus aspera*, *Grevillea wickhamii*, *Hakea suberea*, *Ipomoea muelleri* and *Petalostylis labicheoides*.

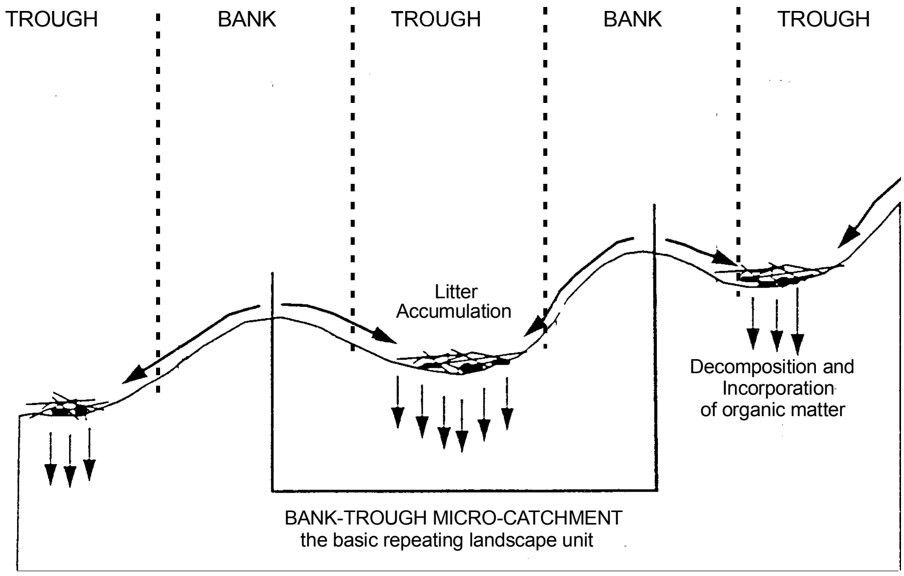


Figure 28 A typical ripped surface with alternating bank and trough landscape zones

17.3.4 Monitoring and performance indicators

Monitoring of mine site rehabilitation will be undertaken to measure the progress of rehabilitation and ensure that objectives and targets are being met. Monitoring programs provide useful feedback for improvement of rehabilitation techniques, and help assess the long term success of rehabilitation. Monitoring also provides vital information to establish realistic and achievable completion criteria.

Robe has been undertaking rehabilitation monitoring since 1999, at previously mined sites in the Robe River area, including mesas K, J and M (Figure 29). Robe's rehabilitation monitoring to date has focused on ecosystem functions, measuring parameters such as vegetation density, vegetation cover and indicators of landscape function including surface stability, infiltration capacity and nutrient cycling capacity. Results of rehabilitation monitoring are reported in Robe's Annual Environmental Report.

Monitoring of revegetation is required to ensure that vegetation communities are approaching the planned land use values for the area. In general, vegetation is monitored to assess whether the revegetation is similar in terms of composition, structure and function to that present in an adjacent control area. Control areas are permanent reference sites selected on the basis of representative landform and vegetation applicable to each of the land systems to be restored. These sites help to account for changes in seasonal or interannual changes in ecosystem state and represent a potential end point for rehabilitated landscapes. A series of transects will be installed on rehabilitated waste dumps, borrow pits, mesas and control sites, to monitor rehabilitation performance at Mesa A/Warramboo.

Erosion monitoring is an example of a performance indicator which Robe uses to determine rehabilitation success. Erosion monitoring is undertaken by measuring stability and sediment loss over time along transects in rehabilitated and control areas. Monitoring the stability of the landform involves counting and measuring rills and gullies along transects. Sediment loss can be monitored and estimated by constructing dams at the base of the waste dump or control, from which loss per unit area can be measured. Other monitoring programs include monitoring of riverine habitats, drainage shadow effects and occurrence of Priority species and special interest plant species.

(a) Rehabilitation monitoring area J4 at Mesa J 1999

(b) Rehabilitation monitoring area J4 at Mesa J 2001

(c) Rehabilitation monitoring area K1 at Mesa K 1994

(d) Rehabilitation monitoring area K1 at Mesa K 2001

Figure 29 Rehabilitation monitoring at Mesa J and Mesa K

17.3.5 Completion criteria

Completion criteria will be developed in consultation with DoIR and DEC (Nature Conservation Division & Environmental Management Division). The criteria will be directed towards the return of vegetation communities and fauna typical of the area. The specific completion criteria may include, but not be limited to, flora and fauna species abundance, diversity, and community composition and habitat characteristics.

17.3.6 Consideration of climate change

Based on current climatic trends, the Central Pilbara region is not expected to experience significant decreases in annual rainfall in the long term, which would more likely adversely affect rehabilitation than increases in rainfall. Unlike the south-west of Western Australia, the Central Pilbara has experienced an increase in average rainfall from between 5 to 50 mm since 1970 (Bureau of Meteorology 2005b). Long term climate change will equally affect rehabilitation areas and natural vegetation and occur at such a rate that a natural progression of species is more suited to the changing conditions.

Robe's rehabilitation strategy incorporates the use of local species which are adapted to the existing environmental conditions, in particular the dry environment and sporadic occurrence of rainfall. It is not considered appropriate to select plant species that may be better adapted to future climates at this stage, at the expense of creating an ecosystem which does not represent local vegetation types.

17.4 CLOSURE

Corporate obligations

As an international mining company, Rio Tinto has established corporate-wide closure planning and closure implementation requirements, some of which may go beyond legislative and statutory requirements. Similarly, and as a separate business entity, Pilbara Iron has established business requirements for its operations. These requirements include policies, standards, guidelines, and operational documentation (e.g. procedures and work instructions).

Industry guidelines

Regulatory agencies and industry bodies have established guidelines (industry best practice) to assist mining companies to achieve acceptable standards of mine closure and rehabilitation.

While there are no legislative requirements to adherence to these guidelines, both Rio Tinto and Pilbara Iron subscribe to the intent and advice of such guidelines. Industry 'best practice' guidelines include the following key documents:

- Strategic Framework for Mine Closure (Australian and New Zealand Minerals and Energy Council (ANZMEC) and Minerals Council of Australia (MCA 2000).
- Mine Closure Guidelines for Mineral Operations in Western Australia (Chamber of Minerals and Energy 2000).
- Enduring Values – The Australian Minerals Industry Framework for Sustainable Development (Minerals Council of Australia 2004).
- Relevant sections of the Best Practice Environmental Management in Mining Series (Environmental Protection Authority 1995, Environment Australia 1998).

The Mesa A/Warramboo Closure Statement has been developed to be consistent with the principles of these industry best practice guidelines.

17.4.1 Closure objectives

Robe is committed to constructively contributing to society's transition to sustainable development. Effective closure planning is required to ensure the areas in which the company operates are left in a condition that minimises adverse impacts on the human and natural environment and that a legacy remains which makes a positive contribution to sustainable development.

Broad-based objectives have been established to guide early stages of rehabilitation and closure planning. Current closure objectives for Robe's mining operations are as follows:

1. Relinquishment to the community of a tidy, safe and uncontaminated site.
2. Construction of landforms that are stable, free-draining, non-polluting and aesthetically compatible with the surrounding landscape.

3. Establishment of sustainable endemic vegetation communities that are consistent with reconstructed landforms, surrounding vegetation and suitable for the support of pastoralism.

17.4.2 Closure planning

The closure planning process is dynamic and will require regular review and further development throughout the life of the operation. This will be necessary to allow for changes to legal obligations, corporate requirements, community expectations, costs and the development of more detailed knowledge relating to technical issues.

While the Mesa A/Warramboo mining operation has an estimated project life of 10 years, planning for closure has begun to ensure closure objectives and obligations are met and that adequate financial provisions are made for closure in accordance with accounting standards. A Closure Statement for Mesa A/Warramboo has been prepared to identify the key aspects of closure that will require further investigation throughout the project and to identify high risk considerations associated with the eventual closure of the proposed operation (SKM 2005a). A copy of the Closure Statement is contained in Appendix 2.

A detailed Closure Study will be developed over the life of the proposed operation. This will include conducting studies or acquiring information from different sources to develop a comprehensive knowledge base, consulting with stakeholders to develop a Closure Strategy, and preparing a documented Closure Management Plan.

The closure planning process will include the review and assessment of available documentation and appropriate consultation to determine the following:

- existing environment
- legal/regulatory requirements relevant to closure
- review of existing and future environmental impacts relevant to closure
- stakeholder expectations for closure.

One of the keys to achieving acceptable closure outcomes, and also reducing the cost of closure without compromising outcomes, is the successful integration of closure concepts into ongoing short and long-term mine planning activities. In this regard, Pilbara Iron has already considered several key aspects of potential closure impacts in the preliminary planning of the proposed operations. The following considerations have been included in the current planning for the project to mitigate potential impacts of closure:

1. Progressive backfilling of the mine voids to improve post mining landform. Backfilling will be partial only due to limited quantities of backfill material available.
2. Strategic placement of some spoil heaps to restrict public access to mining areas and to minimise visual impacts of the operation from public roads.
3. Retention of the outer escarpment of Mesa A along the north western, north eastern and south eastern sides, with mining to be conducted behind the remaining escarpment. This will offer protection for selected flora and fauna habitats and known Aboriginal heritage sites located around the escarpment, and will minimise visual impacts of both operations and post mining landforms from public roads.

4. Identification of the sensitive nature of the sand-sheet land unit located adjacent to Mesa A and the design of infrastructure and waste dumps to avoid direct and indirect impacts to this area.
5. Preservation of an area for a previously undescribed skink species known to exist in the northern gorge on the eastern escarpment of Mesa A.
6. Commencement of research into suitable habitat for troglofauna found to inhabit parts of Mesa A, in order to ensure suitable troglofauna habitat is retained.
7. Early establishment and rapid rehabilitation of outer edges of out-of-pit waste dumps.
8. Establishment of a permanent storm water diversion channel around the Warramboo mining area to achieve the following:
    - minimise erosional impacts on mining operations
    - provide protection of post mining landforms from upstream storm flows
    - maximise the return of surface water to downstream catchments.

It is a specific requirement of Rio Tinto that closure studies be periodically reviewed. The review must account for completion of specific improvement actions associated with Closure Management Plans as well as account for changes to operational activities. This review must be undertaken at least every five years and should also include a complete assessment of the appropriateness of the Closure Study and Closure Management Plans.

17.5 PROPOSED MANAGEMENT ACTIONS

Rehabilitation and closure issues at Mesa A/Warramboo, the transport corridors and associated infrastructure (including borrow pits) will be addressed by the following proposed management actions:

- Robe will develop and implement an Environmental Management Plan which will address rehabilitation for Mesa A/Warramboo including:
    - description of the rehabilitation process
    - development of completion criteria in consultation with the Department of Industry and Resources (DoIR), Department of Environment and Conservation (DEC) (Nature Conservation Division & Environmental Management Division)
    - the use of local provenance seed in rehabilitation where topsoil is considered insufficient
    - monitoring of rehabilitation
    - the establishment of recalcitrant species in rehabilitation
- Robe will develop and implement a Closure Management Plan for Mesa A/Warramboo, the transport corridors and associated infrastructure (including borrow pits), which will address the following:
    - development of suitable end land uses and objectives for closure in consultation with relevant stakeholders and the community
    - identification and evaluation of closure options and determination of preferred options
    - establishment of completion criteria

  - closure monitoring
  - cost estimates and allocation of funds for closure
  - review and update of the conceptual Closure Management Plan
- retain topsoil during all site clearing activities and use immediately on restored landforms or store in low lying stockpiles
- construct waste rock dumps such that they have a maximum height of 10 m and are profiled to an average slope of 18 – 20 degrees
- commence rehabilitation of waste rock dumps by the third year of mine operation
- undertake progressive backfill of pits at Mesa A and Warramboo.

17.6 PREDICTED OUTCOMES

Robe will prepare an Environmental Management Plan which will address rehabilitation. Robe has prepared a Closure Statement for the Mesa A/Warramboo project and is committed to developing a Closure Management Plan for the project. The plan will be reviewed and updated as appropriate on a regular basis. Development and review of the Closure Management Plan will be undertaken in consultation with relevant stakeholders, to ensure that rehabilitation and closure issues are addressed at the earliest stage in the mine life and that they are managed appropriately to meet the EPA objective for this factor.

PART 4 ORE TRANSPORT CORRIDOR – ASSESSMENT OF KEY ENVIRONMENTAL FACTORS

18. VEGETATION AND FLORA

18.1 DESCRIPTION OF FACTOR

A description of the regional vegetation and previous botanical studies undertaken in the locality is contained in Section 9.1.

The northern transport corridor was subject to a systematic flora and vegetation survey (at various times in 2005) by Biota (2006b). The road and rail options for the northern transport corridor follow the same alignment for the majority of the length of the corridor, deviating from one another at the eastern end of the corridor near Mesa J. Where they deviate, the road option travels south and crosses Robe River to enter the Mesa J mining area and the rail option continues eastward to join the existing rail line (Figure 9).

The southern rail transport corridor was subject to limited survey work and a desktop assessment of probable environmental values (Biota 2006a).

The area of the sand sheet vegetation adjacent to Mesa A (S1:CzAtGeTs) was included within the broad survey area of the transport corridor studies although the northern and southern transport corridors will not disturb this vegetation type. Therefore, descriptions and discussion of the sand sheet vegetation is not included in this Section; refer to Section 9 for descriptions of the sand sheet vegetation, discussion of potential impacts and proposed management and protection measures.

The following description of vegetation and flora for the transport corridors is from Biota (2006a, 2006b), unless otherwise stated, and the vegetation and flora is described separately for the northern and southern transport corridors[17]. The Biota reports are contained in Appendix 2.

The transport route selection will consider heritage, environmental, economic and social issues. The route will be determined pending heritage approvals. A review of the current environmental data indicates similar vegetation types along both corridors. The northern corridor is Robe's preference in term of economic considerations and also in terms of GHG emission reduction.

18.1.1 Northern road/rail transport corridor

Vegetation description

Over 40 vegetation types were recorded along the northern transport corridor. These are listed and described in Biota (2006b), contained in Appendix 2, and mapped in Figure 30 to Figure 33.

[17] The flora study of the transport corridors is separate from the other areas because surveys were initially completed on the proposed mining areas whilst potential transport corridors were still being evaluated.

The vegetation types fall into five main vegetation groups, related to topography. These five vegetation groups are described in Table 26.

No TECs listed under the EPBC Act or by DEC (Nature Conservation Division) are known to occur along the northern road/rail transport corridor.

Table 26 Description of vegetation groups recorded along the northern transport corridor

Vegetation group	Description
Stony Plains	Snakewood shrublands (*Acacia xiphophylla*) low woodlands/ tall shrublands over hummock grasslands (*Triodia wiseana, T. epactia*) and *Acacia* shrublands over hummock grasslands with some scattered trees (*Corymbia hamersleyana*).
Stony Hills and Breakaways	Snappy gum (*Eucalyptus leucophloia*) scattered trees over tall *Acacia* shrubs with other scattered shrubs over hummock grasslands (*Triodia wiseana*) on large hills. *Acacia* shrublands over hummock grasslands (*Triodia wiseana*) on low hills and slopes of taller hills.
Clayey Plains	*Acacia* shrubland over other patches of shrubs/ heaths (*Cassia* aff. *oligophylla*) over hummock grasslands (*Triodia wiseana*).
Minor Creeklines and Flowlines	*Corymbia candida* or *C. hamersleyana* and *C. zygophylla* open woodland over *Acacia* shrubland over open hummock grasslands and *Acacia* shrublands over hummock grasslands.
Major Creeklines and Floodplains	*Eucalyptus camaldulensis* (sometimes with *Melaleuca argenta*) open forest over *Acacia* shrubland and other shrubs. *Eucalyptus victrix* woodland (sometimes with *Corymbia candida*) over *Acacia* shrublands over open hummock grasslands.

Vegetation condition

Vegetation along the northern corridor alignment was generally of good condition. Weeds, particularly Buffel Grass (*Cenchrus ciliaris*), were widespread through the loamy soils of the plains, but usually as scattered individuals. Spiked Malvastrum (*Malvastrum americanum*) was also frequently present on clayey substrates.

Cattle grazing and trampling was evident in the areas of clayey habitat in the central section of the transport corridor. Other main disturbances included vehicle tracks.

Probable distribution of vegetation types

Biota (2006b) determined the probable distribution of the vegetation types that occurred along the northern transport corridor based on their correspondence with the Land Systems described in Section 2.1.2. On the whole, the vegetation types identified along the northern transport corridor are compatible with the broad descriptions of their associated Land System(s).

A PATN analysis was also undertaken for the wider project area to provide an understanding of the floristic composition of vegetation of the wider project area (e.g. northern transport corridor, Warramboo area and other areas surveyed but no longer included in the project) in relation to the surrounding region (Section 9.1.2). The PATN analysis indicated that at a broad level, most of the floristic groupings were not restricted to the wider project area (e.g. groupings contained sites from other areas in the vicinity). The exception being two groupings, which contained only sites from the current study area:

1. Floristic grouping consisted of two sites (MATMC and MATMD, Figure 32) within the Robe River at the Bungaroo Road Crossing. Species included in the grouping were *Acacia trachycarpa*, *Eucalyptus camaldulensis*, *Gossypium robinsonii*, *Melaleuca argenta* and

Rhynchosia bungarensis. It is unlikely that this vegetation type is restricted to this section of Robe River; rather it would be expected to occur in pockets throughout this drainage system, at least in the Pannawonica locality.

2. The other floristic grouping is described in Section 9.1.2 and comprised mainly Acacia ancistrocarpa and A. bivenosa shrublands over Triodia wiseana hummock grasslands on stony plains. This grouping comprised nine sites within the entire study area (2MATC05, 2MATC07, 2MATC08, MATR20, 2MATC03, MATH22, 2MATC04, YARPL01, 2MATC02) and includes sites from the transport corridor. The suite of species uniting the sites within this floristic group is not clear, but appears to include Bonamia media var. villosa, Cassia glutinosa, Corymbia hamersleyana, Polycarpaea holtzei, Ptilotus fusiformis var. fusiformis, and various species of Hibiscus.

It is probable that additional sampling in intervening areas would identify comparable floristic communities in other parts of the region, although these would be unlikely to extend beyond the western Pilbara.

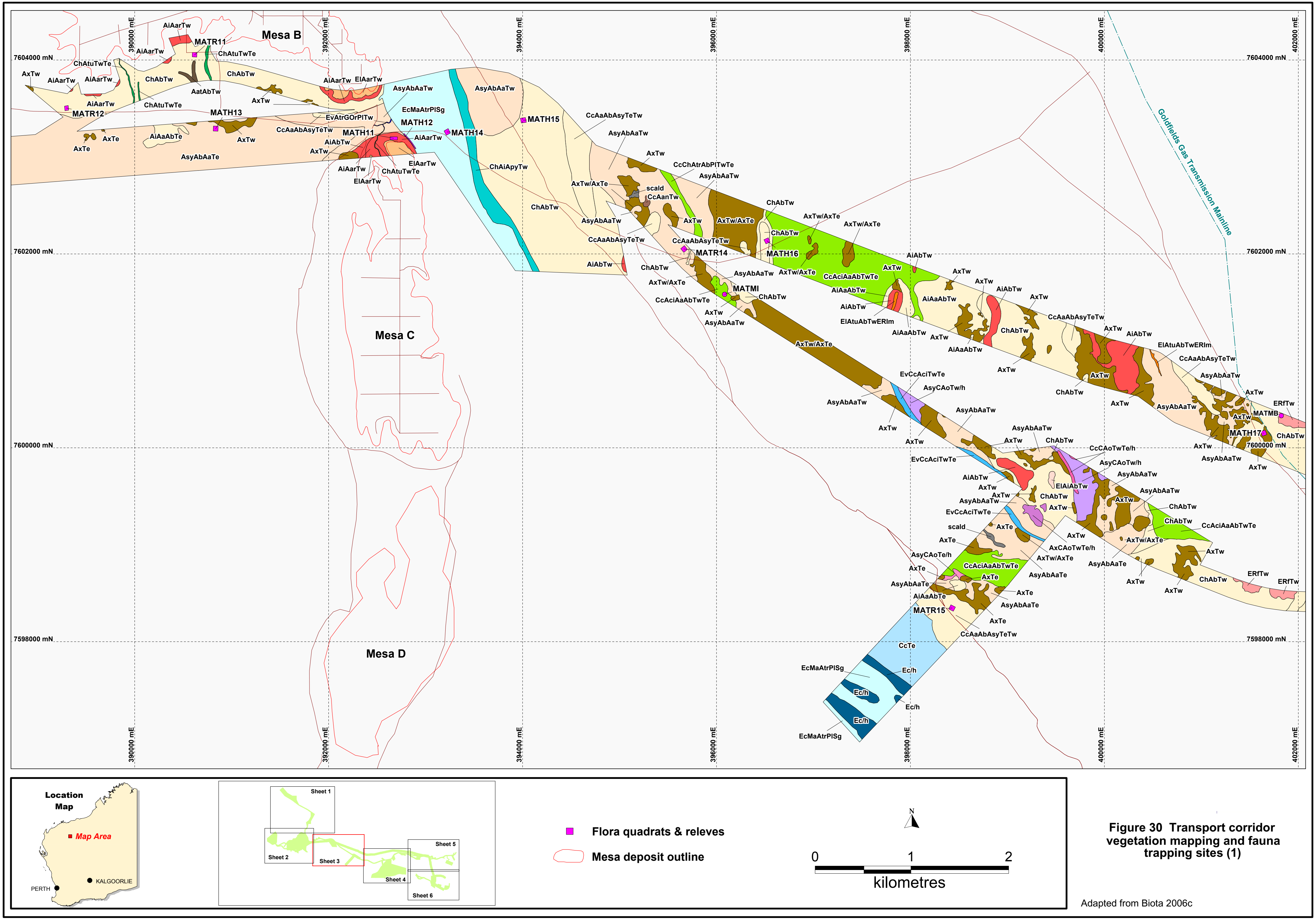


Figure 30 Transport corridor vegetation mapping and fauna trapping sites (1)

Adapted from Biota 2006c

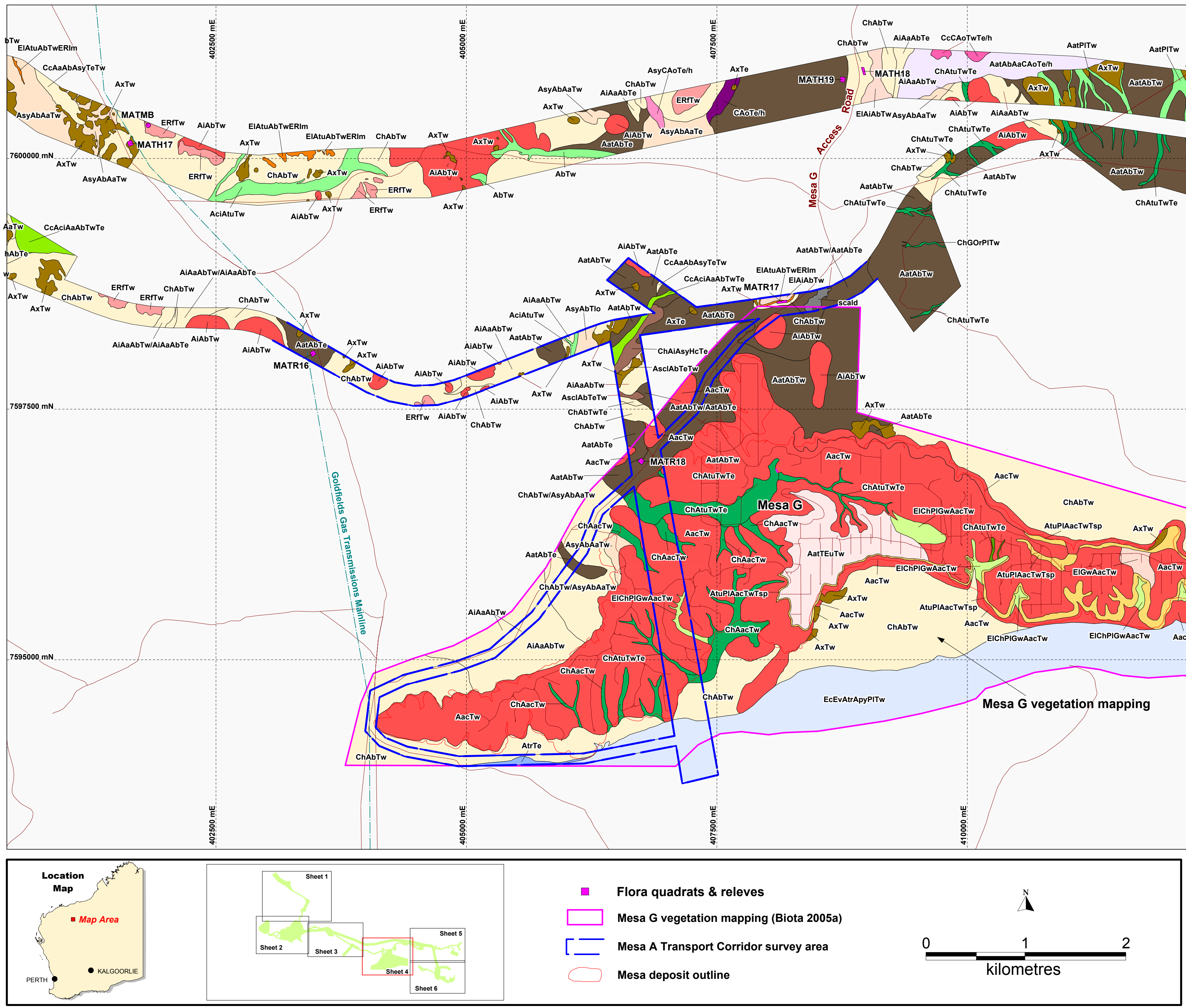
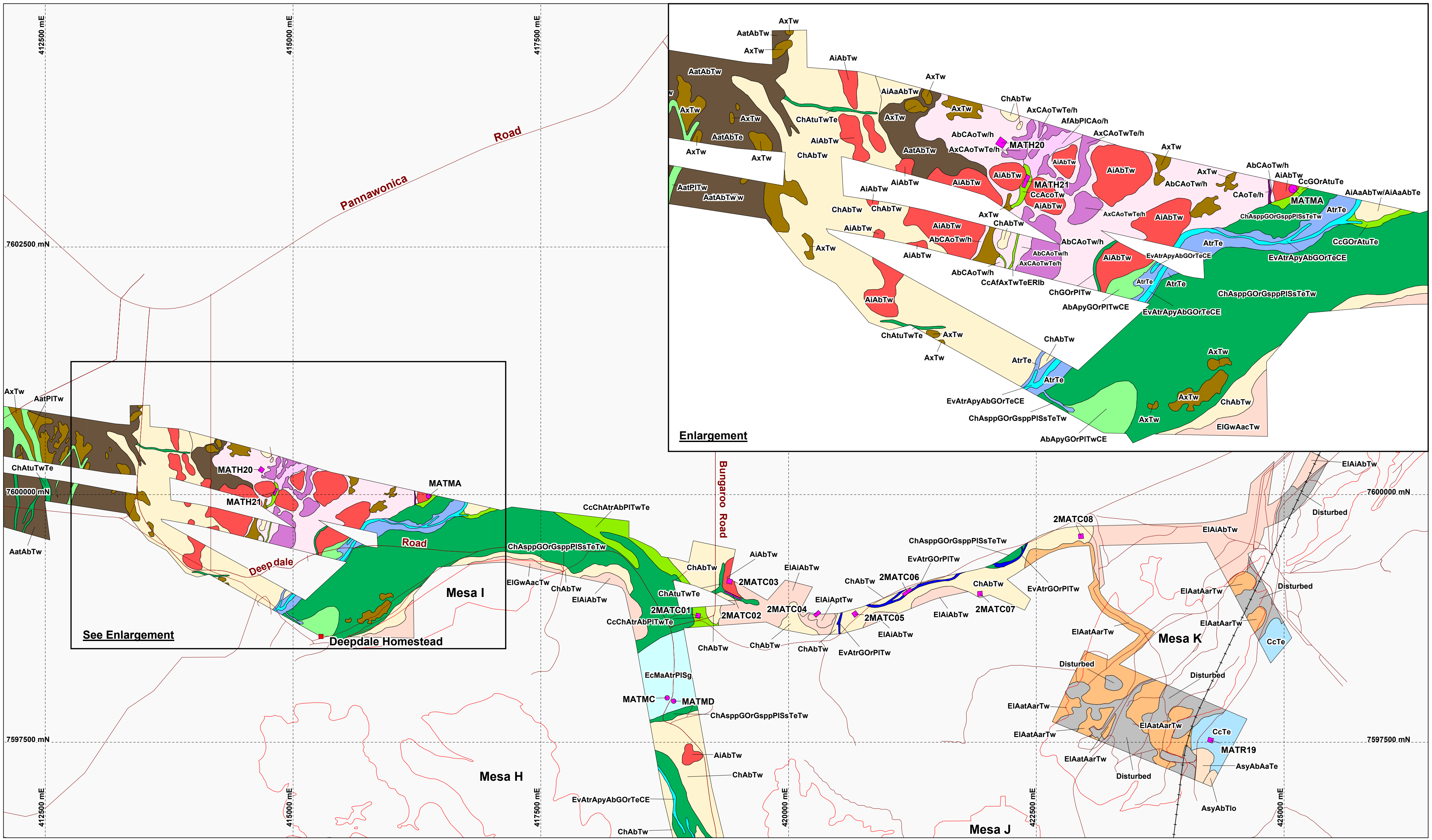


Figure 31 Transport corridor vegetation mapping and fauna trapping sites (2)

Adapted from Biota 2006c



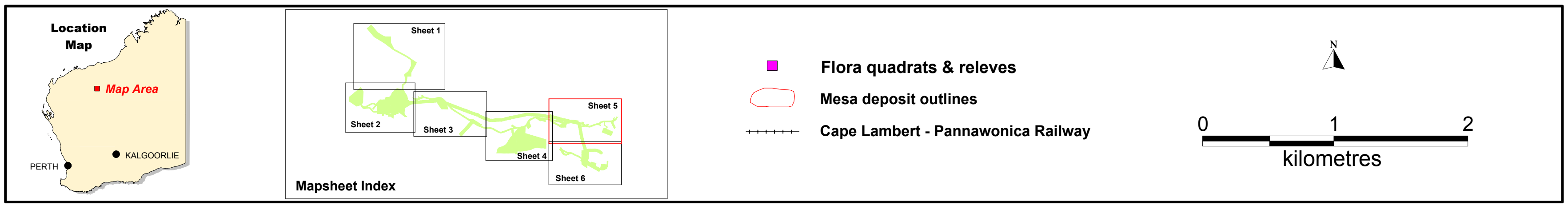
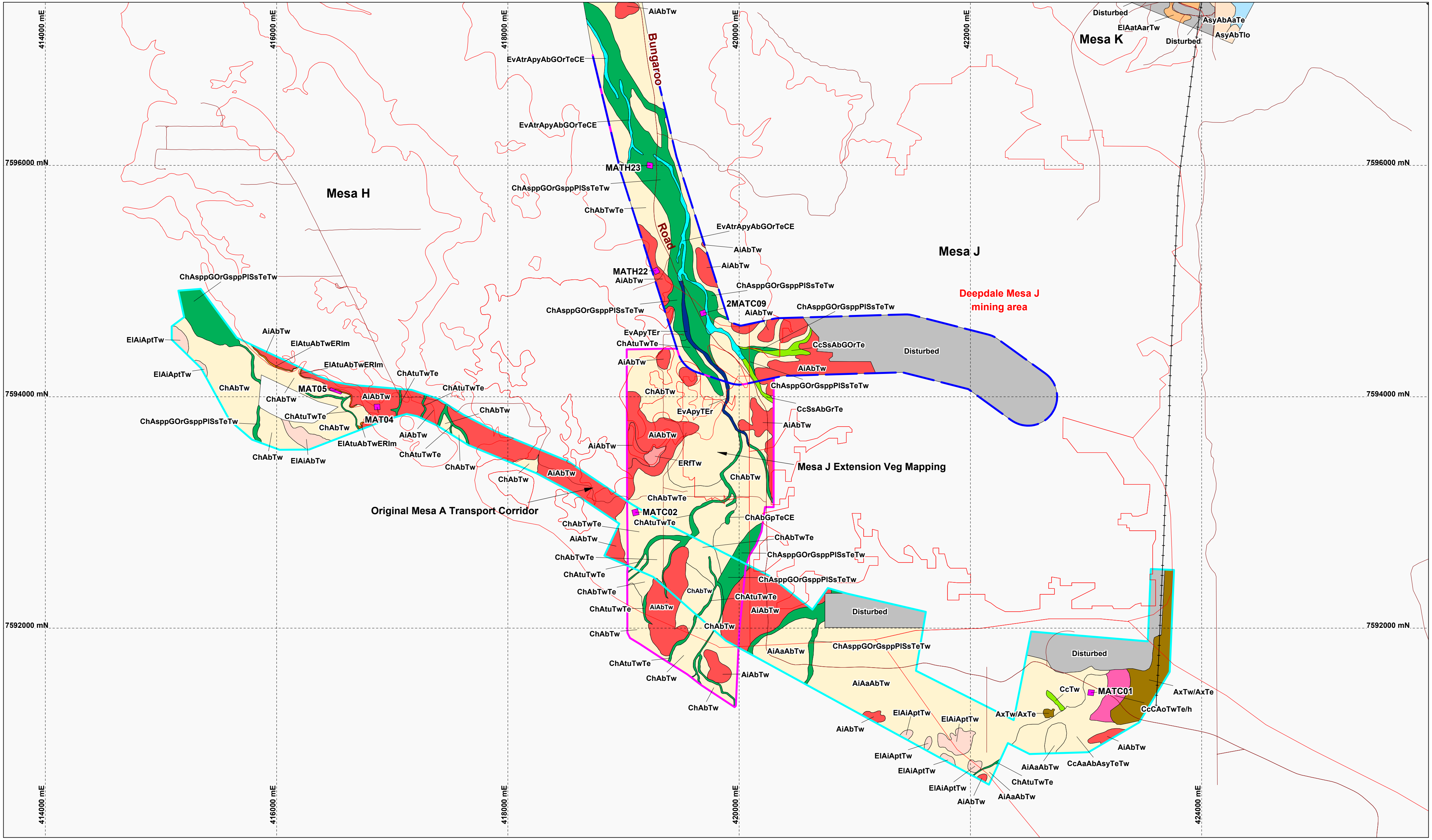


Figure 32 Transport corridor vegetation mapping trapping sites (3)

Adapted from Biota 2006c



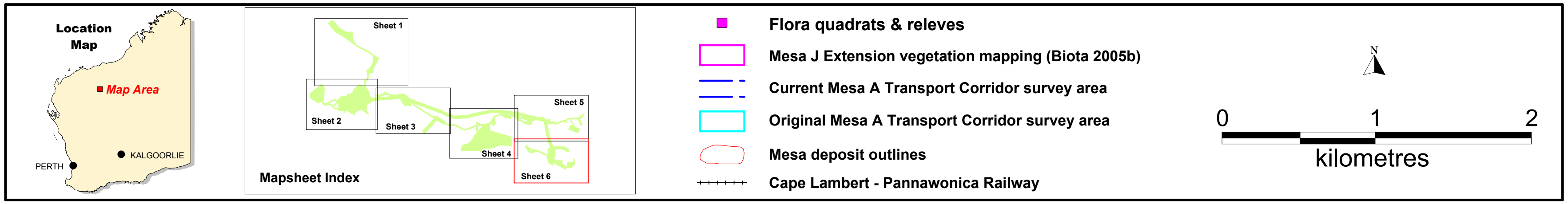


Figure 33 Transport corridor vegetation mapping and fauna trapping sites (4)

Adapted from Biota 2006c

Clayey Plains

CcCAoTwTe/h	*Corymbia candida* low woodland over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia wiseana*, *T. epactia* open hummock grassland with patches of herbland
AxCAoTwTe/h	*Acacia xiphophylla* low woodland over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia wiseana*, *T. epactia* open hummock grassland with patches of herbland
AfAbPlCAo/h	*Acacia farnesiana* tall open shrubland over *A. bivenosa*, *Petalostylis labicheoides* open shrubland over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over mixed herbland
AatAbAaCAoTe/h	*Acacia atkinsiana*, *A. bivenosa*, *A. ancistrocarpa* open shrubland to open heath over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia epactia* open hummock grassland with patches of herbland
AbCAoTw/h	*Acacia bivenosa* open shrubland over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia wiseana* open hummock grassland with patches of herbland
AsyCAoTw/h	*Acacia synchronicia* open shrubland over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia wiseana* open hummock grassland with patches of herbland
AsyCAoTe/h	*Acacia synchronicia* open shrubland over *Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia epactia* open hummock grassland with patches of herbland
CAoTe/h	*Cassia* aff. *oligophylla* (thinly sericeous) low shrubland over *Triodia epactia* hummock grassland with patches of herbland

Sand Sheets

CzAtGeTs	*Corymbia zygophylla* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* tall shrubland over *Triodia schinzii* hummock grassland

Other

Disturbed	

Adapted from Biota 2006c

Legend sheet 1 of 4

Figure 34 Legend for vegetation mapping of project area (sheets 1 to 4)

Stony Plains

Snakewood shrublands

AxTw	*Acacia xiphophylla* low woodland to tall shrubland over *Triodia wiseana* open hummock grassland
AxTe	*Acacia xiphophylla* low woodland to tall shrubland over *Triodia epactia* open hummock grassland
scald	*Triodia wiseana, T. epactia* scattered hummock grasses with scattered herbs

***Acacia synchronicia, A. bivenosa* shrublands**

AsyAbAaTw	*Acacia synchronicia, A. bivenosa, A. ancistrocarpa* open shrubland over *Triodia wiseana* open hummock grassland
AsyAbAaTe	*Acacia synchronicia, A. bivenosa, A. ancistrocarpa* open shrubland to shrubland over *Triodia epactia* open hummock grassland
AsyAbTlo	*Acacia synchronicia, A. bivenosa* open shrubland over *Triodia longiceps* hummock grassland

***Acacia atkinsiana, A. bivenosa* shrublands**

AatAbTw	*Acacia atkinsiana* open tall shrubland over *Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland
AatAbTe	*Acacia atkinsiana* open heath to tall shrubland over *Acacia bivenosa* open shrubland over *Triodia epactia* hummock grassland

***Acacia bivenosa, A ancistrocarpa* shrublands**

CcAaAbAsyTeTw	*Corymbia candida* scattered low trees over *Acacia ancistrocarpa, A. bivenosa, A. synchronicia* open shrubland over *Triodia epactia, T. wiseana* hummock grassland
AiAaAbTw	*Acacia inaequilatera* scattered tall shrubs over *Acacia ancistrocarpa, A. bivenosa* open shrubland to shrubland over *Triodia wiseana* hummock grassland
AiAaAbTe	*Acacia inaequilatera* scattered tall shrubs over *Acacia ancistrocarpa, A. bivenosa* open shrubland to shrubland over *Triodia epactia* hummock grassland
ChAbTw	*Corymbia hamersleyana* scattered low trees over *Acacia bivenosa* open shrubland to open heath over *Triodia wiseana* hummock grassland
ChAbTe	*Corymbia hamersleyana* scattered low trees over *Acacia bivenosa* open shrubland over *Triodia epactia* hummock grassland
ChAbTwTe	*Corymbia hamersleyana* scattered low trees to low woodland over *Acacia bivenosa* open shrubland over *Triodia wiseana, T. epactia* hummock grassland

Acacia* shrublands over *Triodia lanigera

ChCzAtrAaTla	*Corymbia hamersleyana, C. zygophylla* scattered low trees over *Acacia trachycarpa, A. ancistrocarpa* shrubland to open heath over *Triodia lanigera* hummock grassland
CcAsyCAoTla	*Corymbia candida* scattered low trees over *Acacia synchronicia* tall open shrubland over *Cassia* aff. *oligophylla* (thinly sericeous) shrubland over *Triodia lanigera* hummock grassland
CzAatTla	*Corymbia zygophylla* scattered low trees over *Acacia atkinsiana* shrubland to open heath over *Triodia lanigera* hummock grassland

Miscellaneous

ChAiAsyHcTe	*Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera, A. synchronicia, Hakea chordophylla* scattered tall shrubs over *Triodia epactia* hummock grassland
ChAiAsyHcTeCE	*Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera, A. synchronicia, Hakea chordophylla* scattered tall shrubs over *Triodia epactia* hummock grassland and *Cenchrus* spp. tussock grassland
CcAanTw	*Corymbia candida* low open woodland over *Acacia aneura* tall shrubland over *Triodia wiseana* open hummock grassland
AsclAbTeTw	*Acacia sclerosperma* tall open scrub over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* open hummock grassland

Adapted from Biota 2006c

Legend sheet 2 of 4

Stony Plains & Breakaways

Snappy Gum over scattered shrubs on large hills

ElAiAptTw	*Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Acacia ptychophylla* low open shrubland over *Triodia wiseana* hummock grassland
ElAiAbTw	*Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Acacia bivenosa* scattered shrubs to open shrubland over *Triodia wiseana* hummock grassland
ElAatAarTw	*Eucalyptus leucophloia* scattered low trees over *Acacia atkinsiana (A. arida)* open shrubland to tall shrubland over *Triodia wiseana* hummock grassland
ElAarTw	*Eucalyptus leucophloia* scattered low trees over *Acacia arida* shrubland to tall shrubland over *Triodia wiseana* hummock grassland
ElGwAacTw	*Eucalyptus leucophloia* scattered low trees over *Grevillea wickhamii* scattered tall shrubs to tall shrubland over *Acacia acradenia* scattered shrubs to shrubland over *Triodia wiseana* hummock grassland
ElAtuAbTwERlm	*Eucalyptus leucophloia* scattered low trees over *Acacia tumida* and/or *A. bivenosa* open shrubland over *Triodia wiseana* open hummock grassland and *Eriachne mucronata* open tussock grassland
ElAatAtuGwTw	*Eucalyptus leucophloia* low open woodland over *Acacia atkinsiana, A. tumida, Grevillea wickhamii* tall shrubland over *Triodia wiseana* hummock grassland

Shrublands on low hills and slopes of taller hills

AiAbTw	*Acacia inaequilatera* scattered tall shrubs over *A. bivenosa* scattered shrubs over *Triodia wiseana* hummock grassland
AatAiAarAbTw	*Acacia atkinsiana, A. inaequilatera (A. arida)* tall open shrubland over *Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland
AiAarTw	*Acacia inaequilatera* scattered tall shrubs over *A. arida* open shrubland to open heath over *Triodia wiseana* hummock grassland
AacTw	*Acacia acradenia* open shrubland to open heath over *Triodia wiseana* hummock grassland
ERfTw	*Eremophila fraseri* open shrubland over *Triodia wiseana* hummock grassland

Major Creeklines & Floodplains

EcMaAtrPlSg	*Eucalyptus camaldulensis, Melaleuca argentea* open forest over *Acacia trachycarpa, Petalostylis labicheoides* tall open scrub over *Stemodia grossa* low shrubland
Ec/h	*Eucalyptus camaldulensis* scattered trees over open herbland
EcEvAtrApyPlTw	*Eucalyptus camaldulensis* woodland over *Eucalyptus victrix* low woodland over *Acacia trachycarpa, A. pyrifolia, Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* very open hummock grassland
AtrTe	*Acacia trachycarpa* tall shrubland over *Triodia epactia* open hummock grassland
EvAtrApyAbGOrTeCE	*Eucalyptus victrix* woodland over *Acacia trachycarpa, A. pyrifolia, A. bivenosa, Gossypium robinsonii* tall open scrub over *Tephrosia rosea var. glabrior* low open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus* spp. open tussock grassland
EvAtrGOrPlTw	*Eucalyptus victrix* scattered trees to low woodland over *Acacia trachycarpa, Gossypium robinsonii, Petalostylis labicheoides* tall open shrubland over *Triodia wiseana* very open hummock grassland
EvCcAciTwTe	*Eucalyptus victrix, Corymbia candida* woodland over *Acacia citrinoviridis* tall open scrub over *Triodia wiseana, T. epactia* open hummock grassland
EvApyTEr	*Eucalyptus victrix* low woodland over *Acacia pyrifolia* open shrubland over *Tephrosia rosea* var. *glabrior* low open shrubland
CcTe	*Corymbia candida* scattered low trees to low woodland over *Triodia epactia* hummock grassland
ChAiApyTw	*Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Acacia pyrifolia* open shrubland over *Triodia wiseana* open hummock grassland

Adapted from Biota 2006c

Legend sheet 3 of 4

Minor Creek Lines & Flow Lines

CcAciAaAbTwTe	*Corymbia candida* low open woodland over *Acacia citrinoviridis* tall open shrubland over *Acacia ancistrocarpa, A. bivenosa* open shrubland over *Triodia wiseana, T. epactia* hummock grassland
CcAcoTw	*Corymbia candida* low open forest over *Acacia colei* tall open shrubland over *Triodia wiseana* very open hummock grassland
CcAfAxTwTeERlb	*Corymbia candida* scattered low trees to low open woodland over *Acacia farnesiana, A. xiphophylla* scattered tall shrubs to tall open shrubland over *Triodia wiseana, T. epactia* very open hummock grassland and *Eriachne benthamii* tussock grassland
CcGOrAtuTe	*Corymbia candida* low open woodland over *Gossypium robinsonii, Acacia tumida* tall open scrub over *Triodia epactia* scattered hummock grasses
CcSsAbGOrTe	*Corymbia candida* low open woodland over *Stylobasium spathulatum, Acacia bivenosa, Gossypium robinsonii* tall shrubland over *Triodia epactia* open hummock grassland
CcTw	*Corymbia candida* low woodland over *Triodia wiseana* hummock grassland
CcChAatAaTe	*Corymbia hamersleyana, C. candida* scattered low trees to low open woodland over *Acacia atkinsiana, A. ancistrocarpa* scattered tall shrubs to tall open shrubland over *Triodia epactia* open hummock grassland
CcChAtrAbPlTwTe	*Corymbia candida, C. hamersleyana* low open forest over *Acacia trachycarpa* tall open shrubland over *Acacia bivenosa, Petalostylis labicheoides* open shrubland over *Triodia wiseana, T. epactia* very open hummock grassland
ChAsppGOrGsppPlSsTeTw	*Corymbia hamersleyana* scattered low trees to low open woodland over *Acacia* spp., *Gossypium robinsonii, Grevillea* spp., *Petalostylis labicheoides, Stylobasium spathulatum* tall shrubland over *Triodia epactia, T. wiseana* hummock grassland
ChCzAtuAtrTe	*Corymbia hamersleyana, C. zygophylla* low open woodland over *Acacia tumida (A. trachycarpa)* tall open scrub over *Triodia epactia* open hummock grassland
ChCzAtuAtrCE	*Corymbia hamersleyana, C. zygophylla* low open woodland over *Acacia tumida (A. trachycarpa)* tall open scrub over **Cenchrus* spp. closed tussock grassland
ChAacTw	*Corymbia hamersleyana* low open woodland over *Acacia acradenia* open heath over *Triodia wiseana* open hummock grassland
ChAtuTwTe	*Corymbia hamersleyana* low open woodland over *Acacia tumida* var. *pilbarensis* tall open scrub over *Triodia wiseana, T. epactia* open hummock grassland
ChGOrPlTw	*Corymbia hamersleyana* low open woodland over *Gossypium robinsonii, Petalostylis labicheoides* tall open scrub over *Triodia wiseana* very open hummock grassland
ElCcAtuAarTw	*Eucalyptus leucophloia, Corymbia candida* scattered low trees over *Acacia tumida* scattered tall shrubs to tall open shrubland over *A. arida* scattered shrubs over *Triodia wiseana* scattered hummock grasses
ElChPlGwAacTw	*Eucalyptus leucophloia, Corymbia hamersleyana* scattered low trees to low open woodland over *Petalostylis labicheoides, Grevillea wickhamii* tall open shrubland over *Acacia acradenia* open heath over *Triodia wiseana* hummock grassland
AatPlTw	*Acacia atkinsiana, Petalostylis labicheoides (A. ancistrocarpa, A. tumida)* tall shrubland over *Triodia wiseana* open hummock grassland
AbTw	*Acacia bivenosa* open heath over *Triodia wiseana* very open hummock grassland
AbApyGOrPlTwCE	*Acacia bivenosa, A. pyrifolia, Gossypium robinsonii, Petalostylis labicheoides* open shrubland over *Triodia wiseana* scattered hummock grasses and **Cenchrus* spp. tussock grassland
AciAtuTw	*Acacia citrinoviridis (A. tumida)* tall shrubland to tall open scrub over *Triodia wiseana* open hummock grassland

Adapted from Biota 2006c

Legend sheet 4 of 4

Conservation significance of vegetation

See Section 9.1.2 for a description of the methodology used to determine conservation significance. Several vegetation types occurring along the transport corridor were assessed as being of high conservation significance. These include:

- most of the vegetation types occurring on the heavy clay soils, as these support habitat-restricted flora and are susceptible to erosion following physical disturbance
- Snakewood (*Acacia xiphophylla*) shrublands, which support Priority Flora and other restricted flora species
- *Acacia synchronicia* shrublands on stony plains which support Priority Flora
- *Acacia* shrublands over hummock grasslands dominated by *Triodia lanigera,* an uncommon species in the area
- vegetation types associated with the Robe River which support Priority Flora and occur on the major local drainage features
- vegetation types of creeklines through stony plains which support Priority Flora and/or occur on significant local drainage features.

The remainder of the vegetation types are considered to be of moderate conservation significance.

Flora

Species richness of the northern transport corridor

A total of 417 taxa of native vascular flora were recorded from the northern transport corridor. As reported for Mesa A and Warramboo, the Pannawonica locality is relatively species poor in comparison to areas further east in the Hamersley Range. However, in comparison to the mining areas and other study areas in the vicinity of Pannawonica, the transport corridor was relatively more species rich, reflecting:

- the greater lateral extent of the transport corridor which passes through a larger number of habitats present (e.g. clay plains, rocky hills and plains, major and minor creeklines)
- the excellent collecting conditions during the transport corridor study resulting from the sizable and sustained rainfall events experienced at Pannawonica in 2005.

Dominant species

The dominant families recorded from the northern transport corridor were the Poaceae (grass family), Malvaceae (hibiscus family), Papilionaceae (pea family), Mimosaceae (wattle family) and Amaranthaceae (mulla-mulla family). These families are typically predominant in the vegetation of the Pilbara, and usually have most representatives on flora lists from this region, due to their prominence in the Eremaean flora.

The most frequently recorded species were *Triodia wiseana, T. epactia, Acacia ancistrocarpa, A. bivenosa, A. inaequilatera, Corchorus sidoides* subsp. *sidoides, Corymbia hamersleyana, Ptilotus appendiculatus* and *Streptoglossa bubakii*. Some of these species are commonly dominant in the vegetation of the area (e.g. *Triodia epactia, T. wiseana, Acacia ancistrocarpa* and *A. bivenosa*), or at least frequently contribute to its structure (e.g. *Acacia inaequilatera* and *Corchorus sidoides* subsp.

sidoides). Others are species with wide environmental tolerance, but usually with low abundance (e.g. *Ptilotus appendiculatus* and *Streptoglossa bubakii*).

Goodeniaceae (fan-flowers) were under-represented in the flora of the northern transport corridor when compared to areas further east.

Flora of conservation significance

No DRF were recorded along the northern transport corridor and five Priority Flora species were recorded, all of which have been previously recorded from the locality:

- *Abutilon trudgenii* ms. (Priority 3): see description in Section 9.1.1.
- *Sida* sp. Wittenoom (WR Barker 1962) (Priority 3): see description in Section 9.1.1.
- *Rhynchosia bungarensis* (Priority 3): perennial creeper that sometimes forms a dense shrub. It has been recorded from other sites within the locality and it would appear to be common in the Pannawonica area but not abundant (Figure 35).
- *Hibiscus brachysiphonius* (Priority 3): low spreading perennial herb that appears to be restricted to cracking clays. Collected from several areas in the Pilbara and is unlikely to be abundant in the area.
- *Phyllanthus aridus* (Priority 3): small herb that is occasionally collected in the Pilbara, but is likely to be overlooked, except in very good seasons, due to its inconspicuous habit.

Dense shrub-form habit of *Rhynchosia bungarensis*

Flowering stem of *Rhynchosia bungarensis*

Photos: Biota (2006b)

Figure 35 Priority Flora species recorded from the northern transport corridor

In addition, several species were identified as being of conservation interest. These are flora species that are not listed as DRF or Priority species by DEC (Nature Conservation Division), but which are poorly known and/or could not be identified to species level for reasons other than poor condition of specimens. These species being:

- *Triodia* sp. nov: undescribed spinifex species occurring east of Mesa G (Figure 36). Is apparently quite common on mesas in the Robe Valley but moderately geographically restricted and also habitat restricted.

- *Portulaca* sp.: specimen collected could not be matched with any currently described species at the WA Herbarium and this may represent a new taxon.
- *Corchorus sidoides* subsp. aff. *vermicularis*: specimen collected differed from described species and collected specimen may respresent a new entity.
- *Tephrosia* ?aff. *clelandii*: specimen collected differed from described species and collected specimen may respresent a new entity.
- *Hibiscus sturtii* var. aff. *grandiflorus*: specimen collected differed from described species and collected specimen may respresent a new entity.

Growth form of *Triodia* sp. nov.

Florets of *Triodia* sp. nov.

Photos: Biota (2006b)

Figure 36 Spinifex species of conservation significance from northern transport corridor

Introduced flora

Several species of weeds were recorded along the northern transport corridor (Table 27). With the exception of Asthma Plant (*Euphorbia hirta*), Purpletop Chloris (*Chloris barbata*) and Basil (*Ocimum basilicum*), which are only infrequently recorded in the Pilbara, all of the species are common and widespread weeds of the region.

Table 27 Weed species recorded along the northern transport corridor

Species	Common name
Cenchrus ciliaris	Buffel Grass
Cenchrus setigerus	Birdwood Grass
Chloris barbata	Purpletop Chloris
Echinochloa colona	Awnless Barnyard Grass
Setaria verticillata	Whorled Pigeon Grass
Argemone ochroleuca subsp. *ochroleuca*	Mexican Poppy
Acetosa vesicaria	Ruby Dock
Malvastrum americanum	Spiked Malvastrum
Aerva javanica	Kapok
Bidens bipinnata	Beggars Ticks

Species	Common name
Sonchus oleraceus	Common Sowthistle
Citrullus colocynthis	Colocynth
Euphorbia hirta	Asthma Plant
Ocimum basilicum	Basil
Passiflora foetida	Stinking Passion Flower
Datura leichhardtii	Native Thornapple
Melochia pyramidata	Broom-wood, Pyramid Flower

Conservation significance of flora

The number of flora recorded from the northern transport corridor is relatively high compared to other areas in the vicinity (e.g. Warramboo and Mesa A). This is a reflection mainly of the variety of habitats encompassed by the transport corridor.

No DRF were recorded from the transport corridor and five Priority 3 Flora were recorded, all of which have previously been recorded from the local area. *Abutilon trudgenii* and *Sida* sp. Wittenoom are poorly collected rather than rare, and are considered to warrant removal from the Priority listing. *Rhynchosia bungarensis* is quite common in the Pannawonica area, which is the type locality for this species, and appears relatively widespread through the Pilbara. *Hibiscus brachysiphonius* and *Phyllanthus aridus* are less frequently recorded than the other three previous species, although both have relatively broad distributions through the northern part of WA.

A number of apparently new species have also been recorded from the northern transport corridor, however further work is required to determine both their taxonomic affinities and their distribution in the region. The undescribed species of spinifex, *Triodia* sp. nov., is apparently restricted to the Robe Valley.

Given that the northern corridor supports a relatively high number of species (for the locality), a number of which are either uncommon, poorly known and/or apparently undescribed, the area is considered to have a *moderate* conservation value for overall flora. Specific areas, such as the Robe River and the areas of cracking clays, have higher conservation value as they support flora restricted to these habitats.

18.1.2 Southern rail transport corridor

The description below for the southern rail transport corridor is based on limited survey work and desktop assessment only (Biota 2006a). Only the westernmost and easternmost sections of the southern transport corridor have been systematically surveyed for vegetation and flora.

Vegetation

Based on the mapping prepared to date, all of the vegetation types recorded from the southern transport corridor have also been recorded in the northern transport corridor. Vegetation types recorded from the southern transport corridor based on mapping to date are contained in Table 28. See Biota (2006a) contained in Appendix 2 for a full description of the vegetation types.

Given that the Land Systems (based on the Department of Agriculture mapping) and the landforms (based on aerial photography) within the southern transport corridor are consistent with those in the northern transport corridor, vegetation types occurring in the remainder of the southern corridor are likely to be consistent with those previously recorded for the locality.

Unlike the northern transport corridor, the southern transport corridor does not cross the Robe River itself, however there is a single crossing of a tributary of Robe River, Mungarathoona Creek, to the east of Mesa F. Given that this is the only area of major creekline habitat in the southern transport corridor, the corridor would contain only small areas of the riverine vegetation types which have been identified by Biota (2006b) as being of *high* conservation significance.

Table 28 Vegetation groups occurring in the southern transport corridor

Vegetation group	Vegetation type	Conservation significance
Vegetation of cracking clays	CcCAoTwTe/h	High
Snakewood shrublands	AxTw/AxTe	High
Shrublands over *Triodia epactia / T. wiseana* hummock grasslands	CcAaAbAsyTeTw AiAaAbTw ChAbTw ChAbTwTe	Moderate
Shrublands over *Triodia lanigera* hummock grasslands	ChCzAtrAaTla CcAsyCAoTla CzAatTla	High
Snappy Gum *Eucalyptus leucophloia* over scattered shrubs and hummock grasslands on large hills and breakaways	ElAiAptTw ElAiAbTw ElAtuAbTwERlm	Moderate
Shrublands over hummock grasslands on low hills and hillslopes of taller hills	AiAbTw	Moderate
Vegetation of minor creeklines	CcTw ChAsppGOrGsppPlSsTeTw ChCzAtuAtrTe ChCzAtuAtrCE ChAtuTwTe	High

Flora

Species richness

A total of 155 taxa of native vascular flora from 73 genera belonging to 37 families were recorded from the eastern and western most sections of the southern transport corridor (Biota 2006b). As the southern transport corridor traverses equivalent Land Systems and landforms to the northern transport corridor, it is likely that a similar suite of flora would be recorded from this area.

Rare and Priority Flora

Only the westernmost and easternmost sections of the southern transport corridor have been systematically searched for flora of conservation significance. Neither of the two DRF for the Pilbara were recorded (refer to Section 9.1.1 for details of these species)

Four Priority 3 Flora have been recorded from the southern transport corridor:

- *Abutilon trudgenii* ms. and *Sida* sp. Wittenoom (W.R. Barker 1962) were both recorded numerous times, and would be expected to be widespread and abundant throughout the southern corridor.
- *Hibiscus brachysiphonius* was recorded from a single location, and could occur elsewhere in the southern corridor on clay substrates.
- *Rhynchosia bungarensis* was recorded several times, and would be expected to occur more widely through the corridor in creekline habitat (Figure 35).

An additional Priority 3 species, *Phyllanthus aridus*, was recorded from a single creekline within the northern transport corridor, and could occur in similar habitat in the southern corridor.

Introduced flora

Only the westernmost and easternmost sections of the southern transport corridor have been systematically searched for weeds. Four weed species have been recorded from the southern transport corridor:

- *Cenchrus ciliaris* (Buffel Grass)
- *C. setigerus* (Birdwood Grass)
- *Citrullus colocynthis* (Colocynth)
- *Malvastrum americanum* (Spiked Malvastrum).

All of these species were widespread within the northern transport corridor.

In addition to the weed species listed above (Table 27), additional species that may occur along the southern transport corridor include *Parkinsonia aculeata* (Parkinsonia), *Phoenix dactylifera* (Date Palm), *Acetosa vesicaria* (Ruby Dock) and *Indigofera oblongifolia* (a pea). Parkinsonia is listed as a Declared Plant for the East Pilbara under the *Agriculture and Related Resources Protection Act 1976*, although this is not likely to be present along the southern transport corridor. Date Palms, Buffel Grass, Birdwood Grass, Ruby Dock and Kapok are all considered by DEC (Nature Conservation Division) to be serious environmental weeds.

Summary

On the basis of available information, including site-specific sampling of the westernmost and easternmost sections of the corridor, the southern rail transport corridor is likely to contain a subset of the environmental characteristics identified for the northern transport corridor. No substantially different vegetation types or flora assemblages are expected to occur, although this would need to be confirmed via a field survey.

18.2 POTENTIAL SOURCES OF IMPACT

The following aspects of the proposal may have an impact on vegetation and flora values:

- **Vegetation clearing** for the transport corridor and borrow pits, will lead to the direct disturbance of vegetation communities and potentially Priority Flora species.
- **Alterations to surface hydrology** may affect those vegetation communities that rely on surface flows.

- **Vehicle movements** could potentially introduce and/or spread weed species.
- **Dust generation** could potentially smother vegetation retarding growth.

Increased fire frequency or intensity may favour the establishment of weeds and could also prevent the regeneration of native vegetation. However, it is pastoral activities, as opposed to mining activities, that are expected to exacerbate fire regimes in the Pilbara.

Groundwater will be required for use during the construction of the transport corridor. This groundwater is expected to be sourced from the Robe River alluvium. Vegetation of the Robe River (particularly vegetation types dominated by Cadjeputs *Melaleuca argentea* and River Red Gums *Eucalyptus camaldulensis*) would be susceptible to a reduction in the groundwater level. Based on assessment of groundwater drawdown impacts on riverine vegetation along Robe River in the vicinity of the Yarralooloa Homestead, the level of groundwater drawdown from construction bores would be expected to be within the natural level of fluctuation experienced on a seasonal basis (Biota 2006b). This level of drawdown would not be expected to have a negative effect on vegetation health in the Robe River along the transport corridor. Groundwater extraction will be subject to the appropriate licensing approvals under the *Rights in Water and Irrigation Act 1914*.

18.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 9.3.

18.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

18.4.1 Vegetation clearing

In total, approximately 365 ha of vegetation will be cleared for the northern transport corridor option. This includes 20 ha of vegetation clearing already accounted for in the clearing requirements for the Mesa A/ Warramboo mine development due to the inclusion of the rail loop in both clearing calculations.

Approximately 122 ha of further clearing will result from the need for borrow pits along the northern transport corridor. Areas containing populations of significant flora and high conservation value vegetation will be avoided and protected from borrow pit disturbances as far as practicable.

It should be noted that the estimated area to be cleared for both the northern transport corridor and borrow pits are overestimates. Only a proportion of each prospective borrow pit area shown in Figure 9 will be disturbed to source fill, however as current planning cannot indicate which sections of each pit will be used, the entire prospective borrow pit areas have been included in Figure 9.

Approximately 50 ha more clearing would be required for the southern transport corridor than for the northern rail corridor option as the former route is approximately 6 km longer.

A temporary camp will be located in the vicinity of the selected transport corridor to accommodate the construction workforce. This will require additional clearing of approximately 15 ha. The camp may later be used as a fly-in fly-out village if that accommodation option is selected. Rehabilitation of all areas disturbed for the camp/village will be undertaken following decommissioning of the camp/village. Approximately an additional 6 ha will be disturbed for construction of bores for use during the transport corridor construction phase and during transport corridor maintenance activities.

The vegetation types to be disturbed are likely to be represented more widely in the Pannawonica locality. The majority of the disturbance requirements (approximately 67% or 249 ha) will occur in vegetation types of the stony hills. Some vegetation disturbance will occur on clayey plains (approximately 5% or 18 ha) and construction of bridge crossings over major waterways (e.g. Robe River in the instance of the northern transport corridor options) will result in disturbance to riverine vegetation (approximately 3% or 12 ha). A rail bridge crossing is narrower than a road bridge crossing, therefore, a rail bridge crossing of Robe River will result in less disturbance to riverine vegetation.

Table 29 Approximate area of vegetation types along the northern transport corridor option to be cleared

Vegetation type	Area (hectares)
Stony plains	
AatAbTe	11
AatAbTw	34
AatAbTw/AatAbTe	4
AxTe	<1
AxTw	12
AxTw/AxTe	18
AiAaAbTw	10
AiAaAbTw/AiAaAbTe	2
AsclAbTeTw	1
AsyAbAaTe	14
AsyAbAaTw	27
AsyAbTlo	1
CcAaAbAsyTeTw	5
CcAsyCAoTla	2
ChAbTe	<1
ChAbTw	88
ChCzAtrAaTla	16
CzAatTla	2
Sub-total	**249**
Minor creek lines and flow lines	
AatPlTw	<1
AbApyGOrPlTwCE	<1
CcAciAaAbTwTe	2
CcAfAxTwTeERlb	3
CcChAtrAbPlTwTe	2
ChAsppGOrGsppPlSsTeTw	22
ChAtuTwTe	7
ChGOrPlTw	<1
Sub-total	**38**
Clayey plains	
AbCAoTw/h	3
AciAtuTw	<1
AsyCAoTw/h	2
AxCAoTwTe/h	12
Scald	1
Sub-total	**19**
Stony plains and breakaways	
AiAarTw	2
AiAbTw	20
ElAarTw	<1
ElAatAarTw	<1

Vegetation type	Area (hectares)
ElAiAbTw	23
ElAiAptTw	1
ElAtuAbTwERIm	<1
ElGwAacTw	<1
ErfTw	1
Sub-total	**51**
Major creeklines and floodplains	
AtrTe	<1
ChAiApyTw	<1
EcMaAtrPlSg	6
EvAtrApyAbGOrTeCE	<1
EvAtrGOrPlTw	1
EvCcAciTwTe	1
Sub-total	**12**
Disturbed	4
Sub-total	**4**
Total	**365***

* The area (ha) of each type of vegetation type to be cleared has been rounded to whole numbers and therefore does not add up to the total shown in the table due to rounding errors.

Approximately 25% of vegetation disturbance (or approximately 92 ha) will occur in vegetation types that are considered to be of *high* conservation significance (as ranked by Biota 2006b). They include vegetation types from the stony plains, creeklines and clayey plains vegetation groups. These vegetation types are considered to be of *high* conservation significance as they typically support Priority Flora or habitat-specific flora species, however, they are likely to be represented more widely in the Pannawonica locality.

Taking into consideration the likely regional distribution of the vegetation types occurring along the transport corridors and the relatively small area of disturbance of vegetation types of conservation significance, the development would be expected to only have a local impact on the vegetation types present and is unlikely to have regional implications.

Several species of Priority 3 Flora may be directly affected by the development of the Northern transport corridor; *Abutilon trudgenii, Sida* sp. Wittenoom, *Rhynchosia bungarenisis, Hibiscus brachysiphonius* and *Phyllanthus aridus.* These species are known from other sites in the Pannawonica and wider Pilbara region. The loss of flora from disturbance to the project area is not expected to affect the conservation status of these Priority Flora species. Robe will minimise disturbance to Priority Flora by aligning the transport corridor route so as to avoid significant populations as far as practicable.

18.4.2 Alterations to surface hydroglogy

There are large areas of country along the transport corridor (northern and southern) with very subdued topography, and construction of the proposed transport corridor (road or rail) could lead to ponding (and subsequently vegetation death) adjacent to the embankment. In addition, numerous creeklines and minor flowlines occur throughout the study area (Biota 2006b). Robe will therefore ensure engineering design of the transport corridor will maintain existing surface water flows where possible.

Robe proposes to construct a levee bank across the gap between Mesas B and C if either of the northern transport corridor options are selected. The levee bank will be designed to prevent floodwaters from the Robe River overflowing the gap and running alongside the railway or road where it could potentially scour and cause damage to culverts. Floodwaters would be directed under the bridge and would prevent overflow into the area between Mesa A and Mesa C. The local catchment in the area west of the proposed levee bank drains north between Mesa A and B, and has driven the erosion processes that have resulted in the separation of the two mesas (Biota 2006b). In contrast, the lesser degree of separation between Mesa B and C is not associated with a major drainage system, with the only erosion being due to localised run-off from the mesas (Biota 2006b). Given that drainage in the catchment west of the proposed levee bank is largely independent of the main Robe River, the proposed levee bank would be expected to neither isolate vegetation in the area from a sustaining water source, nor impede flow from the catchment into the Robe River (Biota 2006b).

18.4.3 Weeds

Some weed species (particularly *Malvastrum americanum, Cenchrus ciliaris* and *C. setigerus*) are widespread along the northern transport corridor, although they typically occur as scattered individuals. Major weed infestations are currently localised in the vicinity of historic and present stock watering points, particularly near the Deepdale Homestead (fmr) (near Mesa I). Further earthworks in the area, particularly establishment of tracks and infrastructure, have the potential to introduce additional weed species and/or spread existing populations in the area, particularly where works occur in areas with dense weed infestations (Biota 2006b).

Implementation of a weed hygiene and control program will reduce the potential for the introduction and spread of weeds. As part of implementing this weed program, Robe will implement a weed control program along Robe River within the proponent's operational area to target stands of Parkinsonia and other priority weeds.

18.4.4 Dust and erosion

Dust will be generated during construction of the transport corridor, and during operation of unsealed haul roads. The areas of clay substrate within the western and central sections of the northern transport corridor generate large amounts of dust from even light vehicle movements. If hauling is selected as the preferred transport option rather than rail, the haul road between Mesa A and Mesa J will be sealed to minimise dust generation during operation. The haul road between Warramboo and Mesa A does not intersect similarly clayey substrates and will remain unsealed (Biota 2006b).

Erosion could likewise arise following disturbance of the soil profile and/or alteration of surface drainage patterns. Again, the clay substrates would be particularly susceptible; signs of erosion are already visible in some areas that have been subject to water flow coupled with trampling by cattle (Biota 2006b).

As a result of the Mesa A/Warramboo project, areas along new roads not currently affected by dust will be temporarily affected, however, Robe will minimise the number of tracks utilised by Robe vehicles to reduce dust and erosion impacts.

18.5 PROPOSED MANAGEMENT ACTIONS

Vegetation and flora issues for the selected transport corridor will be addressed by the following proposed management actions:

- undertake DRF and Priority Flora surveys of all areas not already surveyed along the selected transport corridor route prior to ground disturbance activities in those areas
- implement Robe's Ground Disturbance Authorisation procedure
- ensure no direct disturbance to the sand sheet with the exception of approximately 3 ha which lies within the mining area
- avoid disturbance to significant areas of vegetation as far as practicable
- avoid disturbance to significant populations of Priority Flora as far as practicable
- avoid disturbance to DRF should they be present or apply for a permit if disturbance cannot be avoided
- avoid disturbance to TECs should they be present
- design the drainage for the transport corridor to minimise the disturbance to natural surface water flows and reduce drainage shadow effects
- prepare and implement separate Construction Environmental Management and Environmental Management Plans which include weed management actions in Robe's operational areas.

18.6 PREDICTED OUTCOME

The proposed northern transport corridor will result in the removal of approximately 365 ha of native vegetation, with approximately a further 122 ha disturbed for borrow pits (although clearing estimates for borrow pits are overestimates and borrow pits will be rehabilitated). Approximatley 50 ha more clearing would be required for the southern transport corridor (as this route is longer). Approximately 20 ha will need to be disturbed for the temporary construction camp and to allow access to the construction water bores; these areas will be rehabilitated once no longer required.

The transport corridor poses an increased risk of the spread of weeds, however this will be minimised through Robe's weed control and hygiene procedures.

Although the southern transport corridor has not been systematically surveyed, no substantially different vegetation types or flora assemblages are expected to occur. Therefore, the transport corridor is not expected to have a significant effect on regional flora and vegetation values due to the wide distribution of most vegetation types and flora species found along the northern transport corridor and the control measures that will be implemented to minimise impacts on flora and vegetation values. No recorded TECs or DRF populations will be affected by the northern transport corridor.

Consistent with EPA objectives, the abundance, species diversity, geographic distribution and productivity of flora at species and ecosystem levels will be maintained conserving regional biological diversity. The botanical studies undertaken by Robe has ensured that highly significant floristic areas will be avoided and the implementation of vegetation protection measures will further ensure impacts are minimised.

19. TERRESTRIAL FAUNA

19.1 DESCRIPTION OF FACTOR

The range of habitats found over the project area is known to support a range of fauna species, including several that are endemic to the region and/or listed for protection under State and Federal conservation legislation.

The northern transport corridor was subject to a systematic fauna survey. The fauna survey was undertaken by Biota in accordance with EPA Position Statement No. 3 "*Terrestrial Biological Surveys as an Element of Biodiversity Protection*" (EPA 2002b) and Guidance Statement No. 56 "*Terrestrial Fauna Surveys for Environmental Impact in Western Australia*" (EPA 2003b), where practicable (Biota 2006c). The survey included a number of sites outside the alignment of the northern rail transport corridor, and included sampling within Mesa A, the proposed Yarraloola borefield, potential borrow pit areas, and areas within the southern road/rail transport corridor (Figure 30 to Figure 33).

The southern road/rail transport corridor was subject to limited field surveys, which were primarily restricted to the eastern end of the transport corridor (Figure 30 to Figure 33). A desktop assessment of the probable environmental values of the southern transport corridor was undertaken by Biota to determine the likely occurrence of fauna species along the length of the southern transport corridor. This desktop assessment incorporated a review of rangelands mapping, digital photography, and detailed vegetation, flora and fauna data from the northern transport corridor and easternmost section of the southern transport corridor (Biota 2006a). Field surveys of the southern transport route are currently being undertaken and are approximately 50% complete.

The following description of the fauna of the transport corridors is adapted from Biota (2006a; 2006c), unless otherwise stated, and the fauna is described for the northern and southern transport corridors together. The Biota reports are contained in Appendix 2.

19.1.1 Fauna habitat

Three main fauna habitats and several minor habitats were identified within the northern transport corridor. As the southern transport corridor traverses a subset of the same Land Systems and landforms as the northern transport corridor, no additional fauna habitats would be expected to occur. These fauna habitats are based on landforms and vegetation structure and are as follows:

- drainage lines: including riverine, floodplain and minor creekline habitats
- scree slopes and stony rises: including low stony rises, hillslopes, scree slopes and breakaway habitats
- valley floors and plains: including valley floors, stony baseplains, loamy plains, clayey plains and sand sheet habitats.

19.1.2 Fauna

The following section presents the results of a survey of the northern transport corridor. Given that the southern transport corridor would contain similar fauna habitats to those present in the northern transport corridor, similar fauna assemblages would be expected to occur. The main difference would potentially be a reduced number of waterbirds, given the small amount of riverine habitat within the southern transport corridor (at Mungarathoona Creek).

A field survey of the southern transport corridor is currently being undertaken to confirm that no substantially different fauna habitats or assemblages occur within the area if the southern transport corridor is selected. Priority areas for survey comprise the sections of the transport corridor traversing the Stuart and Sherlock Land Systems (from Mesa A to east of Mesa F) and Mungarathoona Creek.

Birds

Over 90 species of birds were recorded in surveys of the northern transport corridor (Biota 2006c).

The most species rich sites were MAT04, MAT05 and MAT18, each with 32 species recorded. Sites MAT05 and MAT18 were located adjacent to the Robe River, within the River Land System and vegetation mapping group of major creeklines and floodplains. Of the 28 sites sampled, only two sites (MATA05 & MAT08) recorded fewer than 11 species.

The most abundant birds were the Little Corella *Cacatua sanguinea*, with over 750 individuals recorded across 13 sites, and the Brown Honeyeater *Lichmera indistincta*, with over 550 individuals recorded across 18 sites.

Regional endemism and restricted taxa

A single sub-species considered to be nearly endemic to the Pilbara bioregion, the Striated Grasswren *Amytornis striatus whitei,* was recorded during the survey of the northern transport corridor (Biota 2006c). Where suitable habitat occurs in the bioregion, the species is regularly encountered (Roy Teale, pers. obs. cited in Biota 2006c). It favours *Triodia* dominated banded iron scree-slopes, mesa tops and hilltop margins (Johnstone and Storr 2004), particularly where there are bare patches of exposed rock (Roy Teale, pers. obs. cited inBiota 2006c).

A second species considered to be near endemic to the Pilbara, the Black-tailed Treecreeper *Climacteris melanura wellsi,* may be expected in habitats found within the transport corridors but was not recorded during the survey of the northern transport corridor. The species is typically found in eucalypt woodlands along watercourses, screes slopes or mesa tops.

Species of conservation significance

Based on the findings of database searches, five bird species of conservation significance could potentially occur in the transport corridors. Three of these species, *Ardeotis australis* (Australian Bustard), *Burhinus grallarius* (Bush Stone-curlew) and *Neochmia ruficauda clarescens* (Star Finch – Western) (all Priority 4 taxa) were recorded during the survey of the northern transport corridor. The other two species, *Tringa glareola* (Wood Sandpiper) and *Falco peregrinus* (Peregrine falcon), potentially occur in the area, but were not recorded during surveys of the transport corridor.

Mammals

Ground mammals

Over 15 species of mammal were recorded in surveys of the northern transport corridor. Two species of mammal (one felid and one canid) were introduced, whilst the remaining species were native.

Dasyuridae was the most abundant family of mammals, with over 100 individuals from seven species recorded across 18 sites.

Regional endemism and restricted taxa

The survey of the northern corridor recorded four species considered to be nearly endemic to the Pilbara bioregion. *Ningaui timealeyi* is widespread and common in the region, across a range of substrate types vegetated with *Triodia*, including *T. basedowii*, *T. brizoides*, *T. epactia*, *T. lanigera*, *T. longiceps*, *T. pungens* and *T. wiseana*. The distribution of *Dasykaluta rosamondae* closely follows that of *N. timealeyi* and similarly, it is found across a range of substrates dominated by *Triodia* spp. The two *Planigale* species recorded are believed to be restricted to the Pilbara bioregion (Norah Cooper, WA Museum, pers. comm. 2005, cited in Biota 2006c).

Petrogale rothschildi is the sole near-endemic that was not recorded during the survey of the northern corridor, although it has been documented in the region during previous studies at Mesa J approximately 38 km to the south-east (Ecologia 1991) and Bungaroo Creek approximately 55 km to the south-east (Biota 2005b). This species favours large boulder screes, boulder tors and breakaways with caves and overhangs.

Unresolved species complexes

Within Western Australia, the genus *Planigale* has undergone recent revision, resulting in the recognition of two new species in the Pilbara bioregion (Norah Cooper, WA Museum, pers. comm. 2005, cited in Biota 2006c). The two newly erected species may be separable on the basis of habitat type, with one frequenting heavy soils such as self-mulching clays in the Chichester Range and weakly gilgaied soils, and the second showing a preference for scree slopes, major creeks, stony plains and adjacent habitats (Roy Teale, pers. obs. cited in Biota 2006c).

Species of conservation significance

One non-volant mammal of conservation significance, the Western Pebble-mound Mouse *Pseudomys chapmani* (Priority 4), was captured at site MAT04, at the eastern end of the northern road corridor.

A second species of conservation significance, the Northern Quoll *Dasyurus hallucatus* was recorded from the area of Mesa A, and was subject to a targeted fauna survey (Biota 2005c). This species is not listed at State level, but is considered Endangered under federal statutes (*Environment Protection and Biodiversity Conservation (EPBC) Act 1999*). The targeted survey was undertaken at sites on Mesa A, B, C, J and a number of areas outside the mining lease. The surveys captured a single female Northern Quoll on Mesa B, and recorded fresh tracks on the banks of the Robe River adjacent to Mesa B (Biota 2005c).

Bats

Over 40 bats representing three species were recorded from three sampling sites along the northern transport corridor.

Species of conservation significance

One bat of conservation significance, the Ghost Bat *Macroderma gigas*, was documented from scats located in a cave at Mesa C during the survey of the northern transport corridor. This species had also been reported during a previous survey of the Mesa A study area (Biota 2005b). An additional species, the Orange Leaf-nosed Bat *Rhinonicteris aurantius*, might be expected to occur but was not recorded during the survey of the northern corridor.

Reptiles

Over 450 reptiles representing 60 species were recorded in surveys of the northern transport corridor.

Regional endemism and restricted taxa

Twelve herpetofauna species considered to be endemic or near endemic to the Pilbara bioregion were recorded during the survey of the northern transport corridor (Table 30). In addition, there are a number of species complexes that are likely to contain distinct populations that may be endemic or near-endemic to the Pilbara (see below).

Table 30 Herpetofauna species recorded during the northern transport corridor survey that are considered to be endemic or near-endemic to the Pilbara bioregion

Species name	
Acanthophis wellsi	*Egernia pilbarensis*
Diplodactylus savagei	*Lerista* sp.
Diplodactylus wombeyi	*Lerista flammicauda*
Nephrurus levis pilbarensis	*Notoscincus butleri*
Nephrurus wheeleri cinctus	*Ramphotyphlops pilbarensis*
Delma elegans	*Varanus pilbarensis*

Unresolved species complexes

A number of specimens collected during the survey of the northern transport corridor represent taxa in which the taxonomic status of different populations are currently uncertain and may be under review. Consequently, the distributions and conservation significance of these groups are difficult to ascertain. These taxa are as follows:

- The *Diplodactylus stenodactylus* species complex is currently under review, with possibly six new species occurring in the Pilbara bioregion (Mr Laurie Smith, WA Museum, pers. comm. 2004, cited in Biota 2006c). The taxonomic and conservation status of the specimens obtained by Biota during the current survey are uncertain.
- *Diplodactylus savagei* exhibits a range of morphologies within its distribution and may represent a species complex.
- The genus *Gehyra* undoubtedly contains more species than are currently recognized.
- *Oedura marmorata* may represent a species complex. Distinct differences within its distribution include differences in head shape, although there appears to be little variation within the Pilbara where it may be that only one species occurs.
- *Ctenotus* affin. *helenae* is well known, having been collected from a wide area of the Pilbara over the past few decades. A PhD student from New York, Dan Robuske, is attempting to resolve this species complex using molecular markers as an independent evaluation of morphology. Morphological variation within the complex may be related to different substrates on which the animals occur.

- *Cryptoblepharus carnabyi* is a species complex currently being reviewed by Mr Paul Horner of the Northern Territory Museum. While the taxonomic status, distribution and conservation significance of our specimens are uncertain, it appears that the taxon to which they belong may be widespread in the Hamersley subregion (Roy Teale, pers. obs. cited in Biota 2006c).
- *Glaphyromorphus isolepis* is believed to be a species complex.
- *Lerista bipes* is believed to be a species complex.
- The *Lerista muelleri* complex has been revised by Mr Laurie Smith of the WA Museum. The specimens collected during this survey have previously been recognized as a coastal form.
- *Menetia greyii* is a known species complex and the conservation status of specimens collected during the Mesa A transport corridor and Warramboo survey is unclear.
- *Furina ornata* may represent a species complex, with two distinct morphs currently recognised within the taxon.

Species of conservation significance

One species having specifically listed conservation status was recorded during the survey of the northern transport corridor:

- *Notoscincus butleri* has a restricted distribution in the arid northwest of Western Australia, and is currently listed as a Priority 4 Fauna (taxa in need of monitoring). This species has also previously been documented in March 2005 at Bungaroo Creek to the south of Pannawonica (Biota 2005d).

The Pilbara Olive Python *Liasis olivaceus barroni* (Schedule 1 species) and a blind snake *Ramphotyphlops ganei* (Priority 1 species), were not recorded during the survey, but may occur in the survey area.

Fish

Seven species of fish, representing six families were recorded from pools in the Robe River along the northern transport corridor. Most of the species are common to inland rivers and creeks, however three species typically inhabit coastal or estuarine waters but move into fresh water, often during juvenile life stages.

The fish species encountered are considered typical of the fresh-water drainages in the Pilbara, and their ranges and conservation status are unlikely to be affected by the proposed transport corridor.

Invertebrates (Short range endemics)

Millipedes

Several millipeds from the genus *Antechiropus* were collected from sites along the Pannawonica Road. These were lodged with Dr Mark Harvey of the WA Museum, who determined that they represented a new species in this genus. All collections were made from sites outside the area of impact, though it is considered likely that this taxon would also occur in suitable habitat along the proposed transport corridor alignment. It is not possible to resolve the conservation status of this taxon, though it is worth noting that all specimens were collected within 100 m of the Pannawonica Road.

A single juvenile Pachybolid millipede was collected from a site along the Pannawonica Road. As the specimen was a juvenile, its taxonomic affinities cannot be resolved. Two individuals of the recently described new genus *Austrostrophus* (Hoffman 2003) have been collected from the Pilbara, including *A. stictopygus* from Hearson Cove and *A.* affin. *stictopygus* from West Angelas. It is possible that the individuals collected from the Pannawonica area belong to this genus.

Terrestrial molluscs

At least two (and possibly three) taxa of terrestrial mollusc were recorded during Biota's (2006c) survey of the northern transport corridor (Figure 37). Heavy rain during the survey period precluded access along unsealed roads within the project area, and therefore collections were made along Pannawonica Road, which is parallel to the proposed northern transport corridor.

Based on shell morphology alone, specimens from the western end of the project area (i.e. near Mesa A and Warramboo) are most like *Rhagada convicta*, shells from the eastern end of the alignment are most similar to an undescribed taxon collected from near Mt Brockman (*Rhagada* sp "Mt Brockman"), and specimens through the central area are similar to *Rhagada radleyi* and may represent hybrids.

(a) *Rhagada convicta*

(b) *Rhagada ? radleyi*

Source: Biota (2006c)

Figure 37 Terrestrial molluscs collected from along Pannawonica road

Freshwater molluscs

Two species of freshwater mollusc were collected from an ephemeral pool on the Robe River (at 21°43’15”S 116°12’53”) (Figure 38).

(a) *Thiara balonnensis* (approximate length 33mm)

(b) *Lymnea tomentosa* (approximate length 20mm)

Source: Biota (2006c)

Figure 38 Freshwater molluscs collected from an ephemeral pool on the Robe River

Mygalomorph spiders

Two taxa of mygalomorph spiders, from the families Barychelidae and Nemesiidae, were recorded in surveys of the northern transport corridor.

19.1.3 Conservation significance of fauna

One federally listed and six state listed fauna species of conservation significance were recorded within the proposed transport corridors (Table 31). Other conservation significant species that potentially occur within the Mesa A/Warramboo project area also potentially occur in the transport corridor (Table 18), and are discussed in Section 10.

Table 31 Fauna species of conservation significance potentially occurring within the northern and southern transport corridors

Species	Classification		Presence within transport corridor		Number of sites yielding records	Broad description of habitat
	State level	Federal level	Northern route	Southern route		
Dasyurus hallucatus (Northern Quoll)	None	Endangered	Present	-	1 (individual)	Breakaways along mesa edges adjacent to large drainage lines (e.g. Robe River)
Macroderma gigas (Ghost Bat)	Priority 4	-	Present	-	1 (scat)	Breakaways along mesa edges adjacent to large drainage lines (e.g. Robe River)
Pseudomys chapmani (Western Pebble-mound Mouse)	Priority 4	-	Present	-	1 (mound)	Scree slopes and stony plains
Neochmia ruficauda clarescens (Star Finch – western)	Priority 4	-	Present	-	4 (76 individuals)	Reed beds and adjacent vegetation associated with drainage lines
Ardeotis australis (Australian Bustard)	Priority 4	-	Present	-	1 (individual)	Open lightly wooded grasslands including Triodia sandplains and flats.
Burhinus grallarius (Bush Stone-curlew)	Priority 4	-	-	Present	1 (individual)	Sparsely grassed open woodlands
Notoscincus butleri	Priority 4	-	Present	Present	3 (7 individuals)	Spinifex dominated margins of drainage lines

19.1.4 Survey limitations

The main limitations of the fauna surveys of the transport corridors were:

- The southern road/rail transport corridor was not systematically surveyed.
- Each stage of the survey comprised the first phase of a seasonal sampling exercise, the next phase of which is planned for 2006. The weather during the March and May study periods was hot, while August was relatively cool. It is likely that additional fauna species will be recorded within the study area when the sites are revisited during warm weather in early autumn.
- Bats were sampled using harp traps which were placed across the entrances of selected caves, and consequently all bats caught were cave dwelling species. Tree-roosting bats, which could be expected to have more widely available roost sites, were not adequately sampled.
- Terrestrial invertebrate sampling was targeted at specific groups, and was otherwise largely opportunistic. Identifications beyond morphotype were restricted to those invertebrates considered to be of particular interest, such as short range endemic taxa.

19.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the proposal that may potentially affect fauna values include:

- **Vegetation clearing** for transport infrastructure will directly disturb terrestrial fauna habitat and may result in the deaths of some individuals of terrestrial fauna species.
- **Weeds** may affect the diversity of native plants, which may result in a flow-on effect to native fauna.
- **Alterations to surface hydrology** may lead to the deaths of some individuals of fauna species that are susceptible to inundation.
- **Vehicle movements** on transport corridors could potentially result in the deaths of some individual fauna, particularly of less mobile species.
- **Modification to fire regimes** may potentially affect species, particularly those sensitive to fires.

Minor potential impacts include noise emissions from the ore transport, which may result in habitats close to the selected route becoming unsuitable for fauna foraging and habitat, however this is not anticipated to be a significant impact. Another minor potential impact includes dust generated during the ore transport process. The impact of this dust generation on fauna species will not be significant.

19.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 10.3.

19.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

19.4.1 Vegetation clearing

In total, approximately 365 ha of vegetation will be cleared for the northern transport corridor option. This includes 20 ha of vegetation clearing already accounted for in the clearing requirements for the Mesa A/ Warramboo mine development, and is due to the inclusion of the rail loop in both clearing calculations.

Clearing requirements for the southern transport corridor would be slighter higher than for the northern rail corridor option as this route is approximately 6 km longer.

Approximately 122 ha of further clearing will be required for borrow pits along the northern transport corridor. Clearing requirements for borrow pits for the southern transport options have not been estimated to date, however are expected to be similar to the northern transport corridor.

The northern road and rail options would result in impacts to a similar number of vegetation types (Biota 2006a). Vegetation types occurring in the southern transport corridor are not expected to significantly different to those in the northern transport corridors. However, unlike the northern transport corridor, the southern transport corridor does not cross the Robe River, but has a single crossing of the Mungarathoona Creek. Given that this is the only area of major creekline habitat in the southern transport corridor, the corridor would contain only small areas of riverine vegetation types that have been identified as being of high conservation significance. The area of impact of the river crossing of Mungarathoona Creek should therefore be reduced as far as practicable.

Both the northern rail and road options would clear less than 25% of each of the vegetation types associated with major creeklines and floodplains.

The conservation significance of fauna habitats was estimated based on a vegetation type analysis (Biota 2006b). This assessment identified twenty-four vegetation types as having high conservation significance, and a subset of these are considered to be important in terms of fauna habitat:

- Most of the vegetation types occurring on heavy clay soils (CcCAoTwTe/h, AxCAoTwTe/h, AfAbPICAo/h, AbCAoTw/h, AsyCAoTw/h, AsyCAoTe/h and CaoTe/h), and the flowlines CcAcoTw and CcAfAxTwTeERIb, as these support habitat-restricted fauna and are susceptible to erosion following physical disturbance.
- Vegetation types (particularly EcMaAtrPISg and EcEvAtrApyPITw) and permanent pools associated with the Robe River, which occur on the major local drainage feature support several Schedule or Priority fauna species, a high diversity of local and migratory avifauna.
- Vegetation types of creeklines through stony plains (EvAtrGOrPITw, EvCcAciTwTe, EvApyTEr, CcAciAaAbTwTe and CcChAtrAbPITwTe), which may support short-range endemic invertebrates including terrestrial snails and mygalomorph spiders.

Additionally, whilst the vegetation types of breakaways bordering mesas B and C are not considered to be of conservation significance in terms of fauna habitat, the mesa faces contain caves and overhangs that provide important shelter sites for several Schedule and Priority fauna species. Moreover, the area also provides a significant interface between shelters associated with the breakaways and the habitat represented by the vegetation types of the Robe River drainage.

Some material (approximately 1 ha, equating to <1% volume) will be removed from the southern end of the Mesa B escarpment for the construction of the northern transport corridor. Two cuts into Mesa B would be required, and these cuts have been estimated at approximately 40 m into the mesa for each cut and 140 m and 110 m in length. The area of the mesa disturbed by the construction of this transport corridor option will be minimised where practicable.

The remainder of the vegetation types of the transport corridor are considered to be of moderate conservation significance in terms of providing fauna habitat.

19.4.2 Weeds

Some weed species (particularly *Malvastrum americanum*, *Cenchrus ciliaris* and *C. setigerus*) are widespread throughout the study area, although they typically occur as scattered individuals. Major weed infestations are currently localised in the vicinity of historic and current stock watering points, particularly near the Yarraloola and Deepdale Homesteads. Further earthworks in the area, particularly establishment of tracks and infrastructure, have the potential to introduce additional weed species and/or spread existing populations within the study area, particularly where works occur in areas with dense weed infestations.

Cenchrus ciliaris, or buffel grass, is recognised as an environmental weed in northern Australia, yet it is the most widely sown fodder species in Australian rangelands, replacing the native grasses, particularly *Triodia* spp. and other ground cover species (Franks 2002). While the negative effect of buffel grass on the diversity of native plant species has been documented, the flow-on effects on invertebrate and vertebrate assemblages is unknown, although it is clear that buffel grass has the capacity to impact on ecosystem function in a number of ways.

Weed management practices will be employed during the construction of the transport corridor to minimise the spread of weeds along the transport corridor.

19.4.3 Alteration to surface drainage flows

There are no vegetation types/habitats within the transport corridor that would be expected to be sustained by sheet flow. However, these are large areas of land with very subdued topography, and construction of the proposed transport corridor could lead to ponding adjacent to the embankment. This could subsequently lead to vegetation death and potential drowning of terrestrial snail communities, however swale drains adjacent to major roads appear to support healthy terrestrial snail populations. Based on comparisons of external morphology, the short range endemic taxa recorded from the transport corridor to date have been shown to be distributed beyond the project area, with most records from outside the probable impact areas. It is therefore considered unlikely that the project will affect the conservation status of these species.

A levee bank is proposed to be constructed across the gap between mesas B and C if either of the northern transport corridor options are selected to prevent floodwaters from the Robe River overflowing into the area between Mesa A and Mesa C. The details of the levee bank are discussed further in Section 22. The proposed levee bank would be expected to neither isolate vegetation in the area from a sustaining water source, nor impede flow from the catchment into the Robe River. Therefore fauna habitats that are dependent on these sources of water are not likely to be significantly affected by the construction of the levee bank.

In addition, numerous creeklines and minor flowlines occur throughout the study area. Engineering design will therefore need to take into account maintenance of existing surface water flows.

19.4.4 Transport infrastructure and movement

Vehicle and equipment movement during construction of the transport corridor will potentially result in the deaths of individual fauna. Less mobile species, such as reptiles, will be more vulnerable than highly mobile species. Ongoing impacts may also arise from more frequent machinery operation, vehicle use and frequent road-train or train movements.

The predominant ongoing impacts of transporting ore along the transport corridor are likely to be on larger fauna species including kangaroos and emus. Fencing of transport corridors with standard pastoral wire-strand fencing has, in locations such as the Goldfields, been seen to contribute to deaths of these species. However, fencing of the road transport corridor would be required to prevent stock from crossing the road and preventing collisions with road trains.

Fencing of the transport corridor would not be required should the rail option be selected.

Several priority listed taxa, including the Northern Quoll *Dasyurus hallucatus*, the Pilbara Olive Python *Liasis olivaceous barroni*, the Australian Bustard *Ardeotis australis* and the Bush-stone Curlew *Burhinus grallarius*, may occasionally be affected by road-kill incidents, particularly by the haul road option. However, for all vertebrates and the majority of invertebrate taxa, it is very unlikely that the loss of individuals associated with such direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the project area.

Should the haul road option be selected, agricultural style fencing will be used to prevent stock from crossing the road transport corridor. Stock underpasses will be constructed beneath the road or rail transport corridor to allow for the passage of stock across the transport corridor. Locations of underpasses will be determined in consultation with the pastoral station manager. Native fauna will be able to use these underpasses.

The construction of the proposed rail formation through the transport corridor may act as a barrier to the movement of some fauna species, and could therefore potentially cause fragmentation of populations situated along the rail alignment. The extent to which this would affect the various fauna along the corridor is dependent on a range of factors including, but not limited to, design features of the rail (e.g. depth of cut of and height of embankment), as well as habitat preference and dispersal capabilities of the fauna.

19.4.5 Modifications to fire regimes

Track grinding and maintenance activities have the potential to increase fire frequency in adjacent areas. The presence of additional personnel and equipment in the area during construction of the rail/road may also result in unplanned fires in the area.

The consequences of this potential for increased fire frequency on fauna would depend on the affected vegetation, fauna habitats and the fauna species present. *Triodia* hummock grassland habitats dominate much of the proposed project area and these are highly flammable.

Increased fire frequency has been linked with the demise of terrestrial snails for particular areas in the Kimberley region of WA and their subsequent listing by DEC (Nature Conservation Division) on the threatened and priority species database. All of the snails recorded in the fauna survey would be aestivating in the top 5-10 cm of soil, beneath large *Triodia* hummocks and would be exposed to lethal temperatures following a fire. An increase in the frequency of fire in the project area may have a detrimental effect on the conservation status of terrestrial snails occurring in the locality.

19.5 PROPOSED MANAGEMENT ACTIONS

Fauna issues for the transport corridor will be addressed by the following proposed management actions:

- undertake the seasonal component of the fauna survey
- if the southern transport corridor is selected, undertake a fauna survey of the southern transport corridor to confirm that no substantially different fauna habitats or assemblages occur within the area compared with the northern transport corridor
- prepare and implement separate Construction Environmental Management and Environmental Management Plans which include weed management, fire management and rehabilitation actions
- design the drainage for the transport corridor to minimise the disturbance to natural surface water flows and reduce drainage shadow effects
- avoid as far as practicable disturbance to vegetation of clayey plains which provide habitat to restricted fauna species
- construct fauna/stock underpasses under the transport corridor in consultation with the pastoral station manager
- provide funding and support for research to increase knowledge of the faunal ecology of the region, with consideration given to supporting:

- research investigating the impact of buffel grass on invertebrate communities in the Pilbara region
- a genetic study of the *Rhagada* sp. collected from the project area with the aim of defining the species' distribution
- research into the Northern Quoll populations of the Robe River locality.

19.6 PREDICTED OUTCOME

The construction and operation of the transport corridor may result in the localised deaths of some fauna species. Negligable amount of fauna habitats of high conservation significance will be affected by the proposal, and there will be no significant impacts on fauna which are of conservation significance at a regional, state, national or international level. Funding for research into faunal ecology will increase the scientific body of knowledge regarding fauna ecology in the region and assist with future management of major projects in the region.

Areas of borrow pits and areas of the transport corridor not required beyond the life of the mine, will be rehabilitated to re-establish fauna habitat values.

Implementation of the proposed management actions will ensure the proposal meets the EPA objective for this factor.

20. SUBTERRANEAN FAUNA

20.1 DESCRIPTION OF FACTOR

Background information on subterranean fauna is provided in Section 11.1.

An intensive subterranean fauna sampling program was undertaken by Biota (2006f) at Mesa A and a range of sites throughout the Robe valley, including mesas B, C, F, G, H, J and K, and Middle Robe, Warramboo and Tod Bore. Results of the sampling program are discussed in Section 11, and are summarised below.

A total of 3892 invertebrate specimens, representing 23 orders, were recorded during troglofauna surveys. Eight of the orders contained species that were troglobitic, and in total 159 specimens were troglobitic (Table 20). The troglobitic groups recorded in the survey were from the orders Schizomida (Schizomids), Pseudoscorpionida (Pseudoscorpions), Araneae (Spiders), Scolopendrida (Centipedes), Polydesmida (Millipedes), Diplura (Diplurans), Thysanura (Silverfish) and Blattodea (Cockroaches) (Biota 2006f).

Short sections of the northern and southern transport corridor options have the potential to affect subterranean fauna populations, primarily through direct habitat removal in areas that require disturbance for construction of the transport route. The degree of disturbance to troglofauna habitat will vary depending on the transport option selected.

Selection of either of the northern transport corridor options would require removal of some material from the southern section of Mesa B. Selection of either of the southern transport corridor options would require a cut through Mesa F.

The proposed transport corridors also pass over or near other mesas along the Robe Valley. However, no direct impacts to these mesas are anticipated from construction and operation of the selected transport corridor.

20.1.1 Troglofauna of the transport corridor

A range of troglofauna was recorded from mesas along the transport corridor (Table 20). Of the mesas which may be directly affected by the transport corridor, the highest number of troglofauna specimens (34) were recorded at Mesa B. Specimens from Mesa B were representatives of five orders: Schizomida, Pseudoscorpionida, Scolopendrida, Diplura and Thysanura. One troglofauna specimen from the order Diplura was recorded from Mesa F. No troglofauna were recorded from Mesa H.

20.1.2 Potential sources of impact

The following aspects of the proposal have to potential to affect subterranean fauna values:

- **Direct habitat removal** associated with construction of the transport corridor.

Minor aspects that could affect subterranean fauna include changes to surface hydrology and the subterranean microclimate, surface and groundwater contamination, reduction in organic inputs, and vibration. These impacts are discussed in Section 11.4 in relation to Mesa A/Warramboo, however are not considered to be significant for the transport corridor, due to the minimial amount of subterranean habitat likely to be disturbed.

20.2 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 11.3.

20.3 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

20.3.1 Habitat removal

If selected, the northern transport corridor (road and rail) would be located between mesas B and C (Figure 9). Neither of the northern transport options would result in the direct removal of any part of Mesa C.

Construction of the northern transport corridor would require removal of some material from the southern end of the Mesa B escarpment. Two cuts into Mesa B would be required for the construction of the northern transport corridor, and these cuts have been estimated at approximately 40 m into the mesa for each cut and 140 m and 110 m in length. Mesa B has a total area of approximately 173 ha, of which approximately 1 ha would be removed to allow construction of either of the northern transport options (equating to <1% volume loss). A small amount of troglofauna habitat would therefore potentially be disturbed; however the remaining area of Mesa B will be sufficient to maintain a viable population of the Mesa B troglofauna.

The southern transport route is located through a section of Mesa F and also runs along the southern edge of Mesa H (Figure 9). Construction of the transport corridor will require a cut through Mesa F. The cut will be made through a narrow section of the mesa to minimise impacts to the mesa and would be in the order of 400 m × 110 m × 40 m. The total area of Mesa F is approximately 935 ha, of which approximately 4-5 ha would be removed to allow construction of either of the southern transport options (equating to <1% volume loss). No substantial cuts will be made through Mesa H. Mesas F and H were not sampled as thoroughly as Mesa A but the available data do not indicate any significant troglofauna communities in Mesas F and H (Biota 2006f). The area of troglofauna habitat affected by the southern transport corridor will therefore be minimal, and the conservation status of troglofauna species will not be significantly affected.

20.4 PROPOSED MANAGEMENT ACTIONS

Subterranean fauna issues for the transport corridor will be addressed by the following proposed management action:

- improve the knowledge base and understanding of troglofauna and effective management mechanisms through the troglofauna research activities proposed in Section 11.5.

20.5 PREDICTED OUTCOME

The construction of the transport corridor will potentially lead to disturbance to relatively small areas of troglofauna habitat. Disturbance of these areas may result in some localised deaths of individuals of troglofauna species, however the conservation status of the species involved will not be affected.

21. LANDSCAPE AND GEODIVERSITY

21.1 DESCRIPTION OF FACTOR

A Landscape and Geodiversity Assessment for the project area was undertaken by John Cleary Planning (2005). This assessment focussed on the mining areas of Mesa A/Warramboo, however also described the mesas within the Robe Valley region, some of which will be affected by the transport corridor.

Three routes for the transport corridor are being considered as part of the current feasibility study:

1. Northern road route – requires major river crossings in two locations, one crossing approximately 7 km east of Mesa A plus two crossings immediately north of Mesa J. Four minor creek crossings in the eastern half of the route would also be required. This option would involve the construction of a levee bank between Mesas B and C and removal of some material from the southern end of the Mesa B escarpment.
2. Northern rail route – requires a single major river crossing approximately 7 km east of Mesa A, and four minor creek crossings in the eastern half of the route. This option would involve the construction of a levee bank between Mesas B and C and removal of some material from the southern end of the Mesa B escarpment.
3. Southern road/rail route – either of these options requires a single major river crossing at Mungarathoona Creek, and several minor creek crossings in the eastern half of the route. This route would involve a cut through mesa F and also runs along the edge of Mesa H.

The following is a general description of the landscape and geodiversity values of the transport corridor, based on John Cleary Planning (2005).

21.1.1 Landscape and geodiversity assessment

Refer to Section 12.1.1 for the Landscape and Geodiversity Assessment methodology and terminology.

21.1.2 Geodiversity values

The transport corridor will be located between Mesa A and Mesa J. This area is relatively flat except for the presence of mesas and remnants of cliffs.

Intrinsic values

The intrinsic geodiversity values of the mesas that may be affected by the transport corridor are described below.

Mesa B

- discrete mesa
- double-tiered escarpment
- ridges extending out from the main body of the mesa, alternating with valleys that vary from short bowls to short narrow valleys
- contiguous flat top (Figure 39).

(a) Looking across the middle of Mesa B showing rounded ridge tops and the pattern of gullies and ridges and the eroded lower tier

(b) Looking along the escarpment of Mesa B showing the pattern of gullies and ridges and the eroded lower tier, and the contiguous flat top

Source: John Cleary Planning (2005)

Figure 39 Photographs of Mesa B

Mesa C

- discrete mesa
- long, large valleys that extend well into the body of the mesa
- various tiers – single, double and triple tiered, the latter especially on the ends of the mesa
- relatively high with substantial scree footslopes
- contiguous flat top (Figure 40).

(a) Looking across Mesa C near its northern end showing the large valley, and multiple tiers

(b) Looking across Mesa C showing the flat mesa top and lower tier

Source: John Cleary Planning (2005)

Figure 40 Photographs of Mesa C

Mesa F

- discrete mesa(s)
- variable landform with small discrete mesas making up the western end
- relatively high footslopes on the northern (Robe River) side and low on the southern side with low escarpment
- long, broad valleys penetrate the mesa with rolling top
- the eastern side has a very large lower tier with long narrow valleys and rounded tops in the south and a rolling top without valleys in the north
- sections of the eastern side are similar to Mesa A, with distinct gullies (Figure 41).

(a) Looking across the western end of Mesa F showing its fragmented nature and flat mesa tops.

(b) Looking across the eastern side of Mesa F showing a gully with very similar characteristics to the gully in the north of the eastern side of Mesa A.

Source: John Cleary Planning (2005)

Figure 41 Photographs of Mesa F

Mesa H

- discrete mesa, although tends to blend into the adjacent landform in the south-east
- moderate sized escarpment on the river/west side
- has a second tier in places
- shallow valleys and rounded tops on south side
- long valley separates two forms
- highly eroded with small mesas in the south-east
- eroded with rounded forms in the east
- stronger mesa formation in north-east (Figure 42).

(a) Looking across the western end of Mesa H with the Robe River in the foreground.

(b) Looking north-west across Mesa H showing the large dissecting valley.

Source: John Cleary Planning (2005)

Figure 42 Photographs of Mesa H

Ecological values

Northern transport corridor

The number of flora recorded from the northern transport corridor is relatively high compared to other areas in the vicinity (e.g. Warramboo and Mesa A) (Biota 2006b). This is a reflection mainly of the variety of habitats encompassed by the transport corridor.

Several vegetation types occurring along the northern transport corridor were assessed as being of high conservation significance (Biota 2006b), including the vegetation adjacent to the Robe River, snakewood shrublands and areas of cracking clays (Section 18.1.1).

No DRF were recorded along the northern transport corridor and five Priority Flora species were recorded, all of which have been previously recorded from the locality (Section 18.1.1).

A number of apparently new species have also been recorded from the northern transport corridor, however further work is required to determine both their taxonomic affinities and their distribution in the region.

Southern transport corridor

The southern transport corridor was subject to limited survey work and a desktop assessment of probable environmental values (Biota 2006a). Based on the mapping prepared to date, all of the vegetation types recorded from the southern transport corridor have also been recorded in the northern transport corridor.

No DRF were recorded along the section of the southern transport corridor that was sampled and four Priority 3 Flora were recorded (Biota 2006a).

Several vegetation types occurring along the southern transport corridor were assessed as being of high conservation significance (Biota 2006a), including the vegetation of cracking clays, snakewood shrublands and the vegetation of minor creek lines (Section 18.1.2).

Scientific values

With respect to the deposits of the Robe River, the distinctive topographic variations among the mesas A to N reflect a combination of variations in channel development and depositional environment. For example, the well defined escarpments and high grade ores at Mesa J and Mesa A originated in sharply defined channels, whereas the more undulating landscape and lower grade ores of Mesa G are likely to have their origin in a more braided channel environment. The layered nature of some mesas, such as Mesa B, suggests more complex variations through time in the evolution of the channel at that point.

Thus, all the Robe River pisolite mesas have scientific value for what they can, as palaeo-channel deposits, reveal about the evolution of the area (and the origin of the ores).

An examination of the heritage registers of the Heritage Council of Western Australia, the Australian Heritage Commission and the National Trust did not reveal any previous records of sites of significance in the Robe River valley.

21.1.3 Landscape values

Landscape character

John Cleary Planning (2005) identified six landscape character units based on the characteristics of Mesa A, Warramboo and adjacent areas (Section 12.1.3). It is anticipated that these landscape units will be represented to some extent within the transport corridor.

Landscape significance

Aesthetic

Based on the assessment of Mesa A/Warramboo, aesthetically significant landscape features of the transport corridor are likely to include:

- prominent sections of mesa escarpments
- areas with large caves
- clusters of snappy gums
- diverse stands of vegetation including the stream related vegetation
- stream gullies and their settings.

Social

Indigenous people attach special value to parts of mesas in the Robe Valley, and to watercourses in the area including the Robe River and Mungarathoona Creek.

Historic

Assessment of the historical significance of the area concluded the following:

- There are no specific recorded sites of historic significance related to the early exploration of the area.
- The Robe River mining operations in general are significant in the development of the Western Australian iron ore mining industry.
- Mesa F has moderate significance due to it being the location of the first recorded identification of iron ore in the Hamersley Iron Province by A. Gibb Maitland in 1906.

Views

The extent of area visually affected by the project is generally determined by the screening ability of the vegetation and terrain, and the size and contrast of the project elements. The sparse nature of taller vegetation (i.e. trees) in the areas suggests that landform will be the main determinant of the area potentially visually affected.

As the distance increases the impact of the project on areas affected will generally decrease. Therefore at great distances the development may be technically visible but not detectable because of the small magnitude and low contrast.

Views of parts of the transport corridor will be available from the North West Coastal Highway and Pannawonica Road. The extent of the views will depend upon the transport corridor option selected. As described below, distance zones vary between transport corridor options and within the options themselves; however the transport corridor will be located a minimum of approximately 2 km from either the North West Coastal Highway or Pannawonica Road.

Access / Community use

The North West Coastal Highway is the main travel route though the region, which carries a mix of local, industrial, and tourist traffic. Pannawonica Road is a main link road extending from the North West Coastal Highway to the town of Pannawonica. Pannawonica Road carries traffic largely related to the mine operations in the area. Other roads in the area are generally unformed pastoral access roads, many also used for mining exploration.

Distance zones provide an indication of an area’s spatial relationship to community use, and are an important variable in determining the visual magnitude of features. Distance zones for the transport corridors have been estimated as follows: the northern transport corridor is at its closest point approximately 2 km from Pannawonica Road (middleground), however is on average over 5 km away (distant middleground), and is approximately 4 km (distant middleground) from the North West Coastal Highway at its closest point; the southern transport corridor is at its closest point approximately 7.5 km from Pannawonica Road (background), and is on average is over 10 km away (background), and is approximately 4 km from the North West Coastal Highway at its closest point (Figure 9).

Wilderness quality

John Cleary Planning (2005) did not assess the wilderness quality of the transport corridor; however the transport corridor is likely to contain the following features that contribute to wilderness quality:

- good quality vegetation
- disturbance due to tracks, weeds and stock access.

Recreation and tourism values

The Traditional Owners and their families currently access the Robe River and nearby areas to participate in traditional and cultural activities such as hunting, fishing and ceremonial duties.

21.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the proposal that may potentially affect landscape and geodiversity include:

- **Construction and operation of the transport corridor** altering the appearance of the natural environment.
- **Construction and operation of the transport corridor** restricting access by Traditional Owners to the Robe River and nearby areas.
- **Placement of drainage structures** (e.g. culverts) along transport corridor.

21.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 12.3.

21.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

21.4.1 Earthworks and infrastructure

The construction of the transport corridor will result in disturbance to areas of relatively flat land between Mesa A and Mesa J, and to small areas of mesa formations.

A corridor of approximately 80 m in width will be required to accommodate the rail/haul road and service road in areas where little cut and fill is required. A greater corridor width will be required in areas where significant cut and fill is required. Additional clearing will be required at intervals along either transport corridor, to excavate borrow pits along the length of the corridor for construction of the rail and/or road. Clearing for land for the construction of the transport corridor will be minimised where possible, and borrow pits will be progressively rehabilitated to minimise impacts on landscape and geodiversity values.

If either of the northern transport options is selected, a levee would be constructed between Mesa B and Mesa C to prevent floodwaters from the Robe River overflowing the gap and running alongside the railway or road potentially scouring and causing damage to culverts. The levee bank would direct the floodwaters to flow under the bridge and would prevent overflow into the area between Mesa A and Mesa C. The levee would generally comprise an earthen bund, with a top width of approximately 3 m and a bottom width of between 10 m and 15 m. Rock armour would be placed on the upstream side, and the levee would be constructed at approximately the 1:50 year flood level. The levee may be visible from Pannawonica Road (approximately 4.5 km away), however will be shielded from view of the North West Coastal Highway by Mesas A and B.

If either of the northern transport options is selected, two cuts into Mesa B would be required. It is estimated that these cuts would be approximately 40 m into the mesa for each cut and 140 m and 110 m in length. Mesa B has a total area of approximately 173 ha, of which approximately 1 ha would be removed to allow construction of either of the northern transport options (equating to <1% volume loss). The relatively small area of Mesa B that will be removed for the construction of the transport corridor will minimise the impact on the geodiversity values of the landform.

If the southern transport corridor is selected, the route will be located through a section of Mesa F and along the southern edge of Mesa H. Construction of the transport corridor will require a cut through Mesa F. The cut will be made through a narrow section of the mesa to minimise impacts to the mesa and would be in the order of 400 m × 110 m × 40 m. The total area of Mesa F is approximately 935 ha, of which approximately 4-5 ha would be removed to allow construction of either of the southern transport options (equating to <1% volume loss). The relatively small area of Mesa F that will be removed for the construction of the transport corridor will minimise the impact on the geodiversity values of the landform. The cut through Mesa F is located approximately 13.5 km from Pannawonica Road, and over 19 km from the North West Coastal Highway, and therefore will not be highly visible by passing motorists. No substantial cuts will be made through Mesa H.

The perceived visual impact of the transport corridor on the surrounding landscape will vary due to its proximity to Pannawonica Road or the North West Coastal Highway. In general the transport corridor will be located in the distance zones of distant middleground (3 – 6 km) or background (6 – 15 km) from the North West Coastal Highway or Pannawonica Road. Some sections of the transport corridor will be visible from the North West Coastal Highway and/or Pannawonica Road, while other sections will be shielded from view where the corridor passes behind mesas or hills (Figure 6).

A construction camp/FIFO village may be constructed between Pannawonica Road and the proposed northern transport corridor (Figure 9). This camp will be visible from Pannawonica Road, and therefore traffic using Pannawonica Road will view some of the camp whilst driving past. If the construction camp is built in this location, it will be designed to blend in with the surrounding landscape as far as practical (e.g. through colour schemes and landscaping), to reduce its visual impact.

The wilderness quality of the area will be reduced by the transport corridor, due to the physical presence of the transport infrastructure and the accessibility it affords. However extensive areas of relatively high wilderness quality occur in many other areas in the region.

21.4.2 Traditional and cultural activities

Access by Traditional Owners to the Robe River and associated water holes could be restricted if the northern road/rail transport corridor options were selected. Selection of a southern transport option would not restrict access to the Robe River from the Pannawonica region but would have an impact on hunting and camping access. Safety exclusions would apply to borefields along the selected transport corridor.

If a northern transport option is selected, Robe will provide access past the transport corridor infrastructure to the Robe River by means of culverts or crossings as appropriate.

21.4.3 Drainage structures

Drainage structures, such as culverts will be constructed at regular intervals along the length of the transport corridor. These structures will be blended with the local topography through shaping and revegetation, and therefore will have minimal impact on the landscape values of the area.

21.5 PROPOSED MANAGEMENT ACTIONS

Landscape and geodiversity issues for the transport corridor will be addressed by the following proposed management actions:

- provide access past the northern transport corridor infrastructure to the Robe River by means of culverts or crossings as appropriate
- if the construction camp/FIFO village is located adjacent to Pannawonica Road, design it to blend in with the surrounding landscape as far as practical, e.g. through colour schemes and landscaping
- form and revegetate drainage structures to resemble natural topography
- undertake progressive rehabilitation of borrow pits.

21.6 PREDICTED OUTCOME

The landscape and geodiversity of the project area will be affected by the construction of the transport corridor. Impacts to the geodiversity of the transport corridor will be managed by reducing, as far as practicable, the area of vegetation to be cleared and the area of mesa formations disturbed by construction of the transport corridor.

22. SURFACE WATER AND WATER QUALITY

22.1 DESCRIPTION OF FACTOR

The transport corridor options are located in the Robe River drainage catchment (Aquaterra 2005a). The Robe River drainage catchment is the major river system in the region. Significant waterways in or near the transport corridor are the Robe River, and the Warramboo and Jimmawurrada creeks.

Mungarathoona Creek has a catchment area of approximately 1500 km^2 and has its headwaters in the Hamersley Ranges, about 50 km to the south of the catchment outlet. The outlet of the Mungarathoona Creek discharges into the Robe River, near the Goldfields Gas Transmission Pipeline. Mungarathoona Creek changes its name to Red Hill Creek just over 10 km south (upstream) from this outlet (Aquaterra 2005a).

Jimmawurrada Creek has a catchment area of approximately 1300 km^2 and has its headwaters in the Hamersley Ranges, about 60 km south east of the catchment outlet. The outlet of this creek discharges into the Robe River near Mesa J. The Jimmawurrada Creek changes its name to the Bungaroo Creek just over 10 km south (upstream) from its outlet (Aquaterra 2005a).

There are many tributaries that discharge into the Robe River from within the transport corridor area and the proposed transport corridors intercept a number of these.

As for most parts of the Pilbara, the normal condition for creeks is dry. Runoff is ephemeral, occurring only after significant and intense rainfall events. The Robe River is an intermittent river, which carries a significant underflow in its alluvial bed. The river underflow maintains permanent pools in the river channel, and these pools play an important role in the river ecosystem, by supporting a diverse range of aquatic fauna and acting as refuges during periods of drought.

The construction and operation of the road or rail transport corridor may result in impacts to surface water and water quality through alteration to natural drainage patterns and increased erosion and sediment deposition.

22.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the proposal that may potentially affect the surface water and water quality include:

- **Construction of crossings over watercourses** will result in disturbance to the watercourse and associated riparian vegetation.
- **Alterations to surface hydrology** due to the construction of the transport corridor.
- **Clearing for transport corridor** may reduce water quality by increasing sediments in runoff to watercourses.

22.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 13.3.

22.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

22.4.1 Construction of crossings over watercourses

Crossings over watercourses will be constructed using bridges for major river crossings and culverts for minor crossings. The number of river crossings required varies with the transport option selected, as described below:

1. Northern road route – would require major river crossings in two locations, one crossing approximately 7 km east of Mesa A plus two crossings immediately north of Mesa J. Four minor creek crossings in the eastern half of the route would also be required. This option would involve the construction of a levee bank between Mesas B and C.
2. Northern rail route – would require a single major river crossing approximately 7 km east of Mesa A, and four minor creek crossings in the eastern half of the route. This option would involve the construction of a levee bank between Mesas B and C.
3. Southern road/rail route – either of these options would require a single major river crossing at Mungarathoona Creek, and several minor creek crossings in the eastern half of the route.

Construction of river crossings will require some direct disturbance of in-stream and riparian vegetation, however bridges and culverts will be designed to minimise disturbance to stream function and water quality.

During construction, activities will be managed to minimise the risk of sediments or spills (e.g. from construction equipment) entering watercourses and affecting water quality.

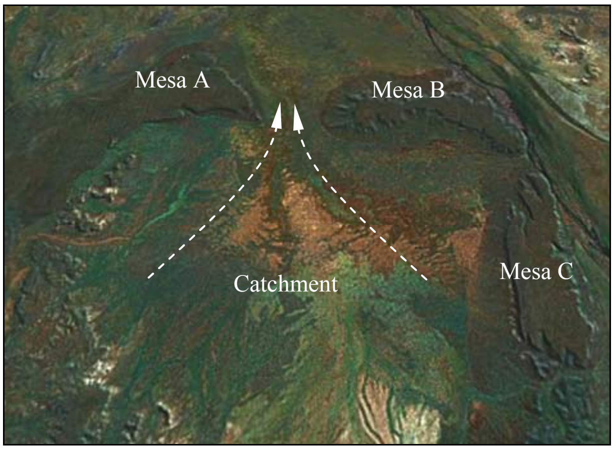
22.4.2 Alterations to surface hydrology

The proposed transport corridors intersect the Robe River and its tributaries, as described above. The transport corridor will act as a linear barrier to drainage, and therefore runoff that previously occurred as sheet runoff will be concentrated by the transport infrastructure, potentially leading to a drainage shadow effect. Drainage culverts will be constructed along the transport corridor at regular intervals. These drainage culverts will be designed to minimise the disturbance to natural surface water flows and reduce drainage shadow effects.

Localised increases in flow velocities are possible as runoff becomes concentrated in diversion channels, or alongside flood bunds or raised pads. Increases in flow velocities have the potential to increase scouring and soil erosion hence reduce downstream water quality through an increase the concentration of suspended solids. Drainage culverts will act to reduce flow velocities by enabling surface water flow to occur at regular intervals. If required, sediment traps/basins will be installed to minimise sediment loads in surface water runoff from transport corridor.

Robe proposes to construct a levee bank across the gap between Mesas B and C if either of the northern transport corridor options are selected. The levee bank would be designed to prevent floodwaters from the Robe River overflowing the gap and running alongside the railway or road potentially scouring and causing damage to culverts. The levee bank would direct the floodwaters under the bridge and would prevent overflow into the area between Mesa A and Mesa C. The levee would generally comprise an earthen bund, with a top width of approximately 3 m and a bottom width of between 10 m and 15 m. Part of the access road alignment may be used as the levee bank, making a crest width of 10 m. A short section would close the levee off on one side against the Mesa, as the access road swings away and down to a river crossing. Rock armour would be placed on the upstream side to prevent scouring, and the levee would be constructed at approximately the 1:50 year flood level.

The local catchment in the area to the west of the proposed levee bank drains north between Mesa A and B, and has driven the erosion process that has resulted in the separation of the two mesas (Biota 2006c). In contrast, the lesser degree of separation between Mesa B and C is not associated with a major drainage system, with the only erosion being due to localised run-off from the mesas. Given that drainage in the catchment to the west of the proposed levee bank is largely independent of the main Robe River, the proposed levee bank would not be expected to isolate vegetation in the area from a sustaining water source, or impede flow from the catchment into the Robe.



(a) Oblique aerial view of drainage catchment separating Mesa A and Mesa B

(b) View from Mesa B south across small valley to Mesa C

Source: Biota (2006c)

Figure 43 Local catchment in the vicinity of Mesas A, B and C

22.4.3 Clearing for transport corridor

In total, approximately 365 ha of vegetation will be cleared for the northern transport corridor option. This includes 20 ha of vegetation clearing already accounted for in the clearing requirements for the Mesa A/Warramboo mine development due to the inclusion of the rail loop in both clearing calculations. Approximately 122 ha of further clearing will be required to develop borrow pits along the northern transport corridor.

It should be noted that the estimated area to be cleared for both the northern transport corridor and borrow pits are overestimates, as discussed in Section 18.4.1.

Approximately 50 ha more clearing would be required for the southern transport corridor than for the northern corridor as the former route is approximately 6 km longer.

A temporary camp will be located in the vicinity of the selected transport corridor to accommodate the construction workforce. This will require additional clearing of approximately 15 ha. The camp may later be used as a fly-in fly-out village if that accommodation option is selected. Rehabilitation of all areas disturbed for the camp/village will be undertaken following its decommissioning.

Approximately an additional 6 ha will be disturbed for construction of bores for use during the transport corridor construction phase and during transport corridor maintenance activities.

The clearing of vegetation for construction of the transport corridor may result in an increase in the sediment load in runoff entering watercourses. Runoff of surface water within the transport corridor that originally occurred as sheet flow will be concentrated by the proposed railway/haul road embankment and associated diversion channels, flood bunds or raised pads. This will result in a localised increase in flow velocities, and increased soil erosion.

Clearing of vegetation for the construction of the transport corridor will be avoided, as far as practicable, and sediment traps/basins will be installed, if required, to minimise sediment loads in surface water runoff from transport corridor.

22.5 PROPOSED MANAGEMENT ACTIONS

Surface water and water quality issues for the transport corridor will be addressed by the following proposed management actions:

- design bridges and culverts to minimise disturbance to stream function and water quality
- design the drainage for the transport corridor to minimise the disturbance to natural surface water flows and reduce drainage shadow effects
- avoid, as far as practicable, clearing of vegetation for the construction of the transport corridor
- install sediment traps/basins along the transport corridor if necessary.

22.6 PREDICTED OUTCOME

The construction of the transport corridor will result in changes in natural surface hydrology in the project area and may result in minor, temporary changes in water quality (e.g. through increased concentration of suspended solids during construction). Design and construction of the transport corridor will be managed to mitigate the changes in surface hydrology and water quality and to meet the EPA objective for this factor.

23. DUST

23.1 DESCRIPTION OF FACTOR

Dust is defined and described in Part 3, Section 15.1. Dust will be generated from the transport corridor primarily by road traffic operating on unsealed service roads. Dust will also increase due to clearing of vegetation within the transport corridor, causing exposed soil surfaces to be more susceptible to wind erosion. The amount of dust generated will differ with the method of transport (road train or rail) selected.

23.2 POTENTIAL SOURCES OF IMPACT

Activities or aspects of the mining operations that may significantly affect dust emissions include:

- **Physical disturbance of the land surface** during construction of infrastructure (eg. removal of vegetation, construction of transport corridor).
- **Vehicle movements** on unsealed roads.
- **Lift-off from ore** during loading, transportation and unloading.
- **Wind episodes** over unsealed roads.

23.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 15.3.

23.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

23.4.1 Physical disturbance of land surface

Approximately 365 ha will be required to be cleared for the transport corridor, based on the northern corridor option, plus approximately 122 ha to establish borrow pits (Section 18.4.1). Robe will minimise clearing requirements and rehabilitate disturbed areas with minimal delay (e.g. borrow pits) so as to reduce the area of exposed land.

Active construction areas along the transport corridor will be regularly wetted on an as needed basis to reduce dust lift-off.

23.4.2 Vehicle movements

Should the road transport option be selected, the haul road will be sealed over its entire length. This will eliminate dust emissions generated by movement of haulage vehicles along the corridor. The movement of trains along the rail corridor options is not expected to result in the generation of any significant dust emissions.

Movement of service vehicles on service vehicle tracks alongside the transport corridor may result in dust emissions. Signage and enforcement of speed limits will be used to minimise dust generation from vehicles travelling on unsealed roads in the project area.

23.4.3 Lift-off from ore

Robe will minimise dust emissions from haulage of ore along the transport corridors Through moisture content control or other suitable measures such as use of a deluge system at the load-out facility as described in 15.4.3.

23.4.4 Wind episodes

Wind episodes leading to wind erosion of dust from bare surfaces represent a significant potential source of dust from mining operations, particularly under dry climatic conditions and strong windy conditions.

Should the road option be selected, the entire length of the haul road will be sealed with the road shoulders remaining unsealed. Both the road and rail options will include construction and use of an unsealed service road and other unsealed areas such as laydown areas. These unsealed areas will be potential sources of dust duringwindy conditions.

Robe will rehabilitate all disturbed areas (e.g. borrow pits, tracks which are no longer required) as soon as practicable following disturbance. Early rehabilitation ensures the total cleared area is minimised and reduces the potential for dust during windy conditions.

23.5 PROPOSED MANAGEMENT ACTIONS

The management of dust along the transport corridor will be addressed by the following proposed management actions:

- control dust generation through ore moisture content control or other suitable measures
- apply water or other suitable dust suppressants to minimise dust generation from unsealed areas during construction
- install signage and enforce speed limits to minimise dust generation from roads
- avoid, as far as practicable, clearing of vegetation
- undertake progressive rehabilitation to minimise total exposed area.

23.6 PREDICTED OUTCOME

The transport corridor options are relatively remote and are at distance from any sensitive premises. Robe will implement dust management actions that will be sufficient to ensure that the proposal will be managed to meet the EPA objective of not adversely affecting environmental values or the health, welfare and amenity of people and land uses. The proposed management actions will also ensure that dust emissions from the operations will meet statutory requirements and acceptable standards.

24. ABORIGINAL HERITAGE

24.1 DESCRIPTION OF FACTOR

Numerous archaeological and ethnographic surveys have been carried out in the general area of the transport corridor route options over the last three decades. However, Aboriginal heritage surveys have not yet been undertaken specifically for development of the proposed transport corridor route options.

Section 16 detailed the results from the following more recent surveys in the project area:

- Wood and Westell (2003; 2005): archaeological surveys of Mesa A and Warramboo areas.
- Stevens (2003; 2004a; 2004b; 2005): ethnographic surveys Mesa A and Warramboo areas.

The description below of Aboriginal heritage values along the transport corridors is based on the above surveys, other surveys undertaken in the general area and from data obtained from the Department of Indigenous Affairs (DIA) Site Register.

Numerous Aboriginal heritage sites are listed on the *Register of Places and Objects* (often known as the *Sites Register*), which is maintained by the DIA, as being located near the proposed transport corridor routes. The majority of sites listed on the Sites Register were located along Robe River and its tributaries with other sites at Mesa A and Warramboo (Section 16), Mesa J and other mesa formations.

Sites along the waterways were identified as being camping and meeting places and sources of water; several sites along the waterways were also identified as burial and ceremonial sites. Sites at distance from the waterways (e.g. mesas and valleys) consisted mainly of artefacts/ scatters, scarred (modified) trees and rock shelters.

As a general rule, Aboriginal people throughout the Pilbara attribute some value to all their sites and would prefer that no sites are impacted. In general, main waterways (e.g. Robe River in the project area) are of heritage significance to Aboriginal persons as they represent foci for camping, ceremonies and other activities. Rock shelters (mainly found on mesa escarpments in the project area) and burial areas are also of high heritage significance whereas artefact scatters and scarred trees, being common in the Pilbara region, are typically assessed as having a low degree of significance.

24.2 POTENTIAL SOURCES OF IMPACT

The primary aspect of the transport corridor that has the potential to have an impact on Aboriginal heritage values is:

- **Physical disturbance of the land surface and waterways** during construction of the transport corridor has the potential to disturb heritage sites and affect ethnographic values.

24.3 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 16.3.

24.4 ASSESSMENT OF POTENTIAL IMPACT, MITIGATION AND RESIDUAL RISK

24.4.1 Disturbance to land surface and waterways

Although detailed Aboriginal heritage surveys have not yet been undertaken along the proposed transport corridor routes, it is likely that construction activities will need to disturb some archaeological sites and subsequently affect any associated ethnographic values. The extent and nature of the impact will not be known until such surveys are complete and in some instances it may be practicable for the transport corridor to avoid heritage sites (should any heritage sites be present).

There are several locations along the transport corridor route options that are likely to comprise significant Aboriginal heritage values. These include Robe River and other main creeks crossings (e.g. Mungarathoona Creek), and the various mesa escarpments. The northern transport corridor options will cross the Robe River as well as numerous other minor creeks. The southern transport corridor route will cross Mungarathoona Creek on one occasion as well as numerous other minor creek crossings. All corridor options will require some disturbance of mesa escarpments at various locations along the corridors.

24.4.2 Management measures

In accordance with Rio Tinto Iron Ore's '*Aboriginal Heritage*' Policy and Procedures, Robe will ensure that the transport corridor is surveyed to determine archaeological and ethnographic significance prior to any disturbance activities. These surveys will be undertaken in consultation with Kuruma Marthundunera. Final transport corridor alignments will be modified to avoid significant heritage sites (should they be present) wherever practicable.

Where a heritage site cannot be avoided, Robe will seek consent to disturb the site(s) from the Minister for Indigenous Affairs through a section 18 application under the *Aboriginal Heritage Act 1972*, in consultation with Kuruma Marthundunera. Robe will undertake disturbance in accordance with the conditions of the section 18 consent and will consult and involve Kuruma Marthundunera in mitigative heritage work prior to disturbance of the site. This will include detailed recording of sites and salvage of artefacts.

24.5 PROPOSED MANAGEMENT ACTIONS

Aboriginal heritage issues along the transport corridor will be addressed by the following proposed management actions:

- undertake archaeological and ethnographic surveys of the selected transport corridor prior to any disturbance of the area, in consultation with Kuruma Marthundunera
- avoid disturbance to significant heritage sites where practicable
- where avoidance of a site is not practical, seek consent to disturb the site from the Minister for Indigenous Affairs through a section 18 application under the *Aboriginal Heritage Act 1972*, in consultation with Kuruma Marthundunera.

24.6 PREDICTED OUTCOME

A number of recorded Aboriginal heritage sites are known to occur in the vicinity of the proposed transport corridor routes (north and south); a large number of these are in proximity to Robe River. It is likely that some heritage sites will need to be disturbed by the construction of the transport corridor, however, the corridor will avoid disturbance to significant heritage sites where practicable.

Robe will continue to consult and work with Kuruma Marthundunera regarding management of Aboriginal heritage sites and values and, consistent with the EPA objective for this factor, will manage Aboriginal heritage sites in accordance with the Aboriginal Heritage Act.

25. REHABILITATION AND CLOSURE

25.1 DESCRIPTION OF FACTOR

The transport corridor options under consideration include: a northern road route of approximately 43 km; a northern rail route of approximately 39 km; and a southern road or rail route of approximately 45 km. The northern routes involve crossings of the Robe River and all of the transport corridor options involve at least one major and several minor creek crossings. One transport corridor option will be selected prior to commencement of project construction.

The construction of the chosen transport corridor will require the development of borrow pits at intervals along the length of the corridor. The location and frequency of these will be dependent on the transport route and method selected.

25.2 KEY STATUTORY REQUIREMENTS, ENVIRONMENTAL POLICY AND GUIDANCE

Refer to Part 3, Section 17.2.

25.3 REHABILITATION

25.3.1 Objectives

Refer to Part 3, Section 17.3.1.

25.3.2 Rehabilitation approach

Robe's general approach to rehabilitation is outlined in Section 17.3.2. Items which are relevant to the transport corridor are the transport infrastructure, associated tracks and other cleared areas and borrow pits.

The transport corridor may be retained to assist in future development in the Robe Valley. However, should areas of the transport corridor be decommissioned, these areas will be rehabilitated in accordance with procedures described in Robe's Rehabilitation Handbook. Once they are no longer required, tracks and other cleared areas along the transport corridor will also be rehabilitated as decribed in Robe's Rehabilitation Guidelines.

Approximately 122 ha of clearing will be required for borrow pits along the northern transport corridor. Clearing requirements for borrow pits for the southern transport options have not been estimated to date, however are expected to be similar to the northern transport corridor. Borrow pits will be designed and rehabilitated in accordance with the procedures described in Robe's Rehabilitation Handbook.

25.3.3 Rehabilitation procedures

Rehabilitation will be undertaken in accordance with procedures described in Robe's Rehabilitation Handbook. For borrow pits and tracks these procedures include:

1. Recovery and stockpiling of cleared vegetation and topsoil for use on rehabilitation areas.

2. Establishing a suitable landform and drainage pattern.
3. Re-spreading topsoil and vegetative material.
4. Ripping or scarifing to prevent erosion, retain water and promote plant establishment.
5. Monitoring progress of rehabilitation.

25.3.4 Completion criteria

Refer to Part 3, Section 17.3.5.

25.4 CLOSURE

Transport corridors and related infrastructure may be retained to assist in future development in the Robe Valley. If the transport corridors and related infrastructure are not required, they will be decommissioned and rehabilitated in accordance with Robe's Rehabilitation Handbook. The potential closure of transport corridors and associated infrastructure will be addressed in the Closure Management Plan.

25.5 PROPOSED MANAGEMENT ACTIONS

Rehabilitation and closure issues for the transport corridor will be addressed by the following proposed management actions:

- develop and implement a Construction Environmental Management Plan which includes actions for rehabilitation of borrow pits, tracks and other cleared areas that are not required following completion of construction
- address rehabilitation of the transport corridor and associated infrastructure in the rehabilitation section of the Environmental Management Plan to be developed and implemented under Section 17.5
- address closure of the transport corridor and associated infrastructure in the Closure Management Plan to be developed and implemented under Part 3, Section 17.5.

25.6 PREDICTED OUTCOMES

Robe is committed to rehabilitation of borrow pits and decommissioned sections of the transport corridor. These issues will be addressed in the Construction Environmental Management Plan, Environmental Management Plan and Closure Management Plan. These plans will be regularly reviewed and updated throughout the project, to ensure that rehabilitation and closure is managed appropriately to meet the EPA objective for this factor.

PART 5 PROPOSED ENVIRONMENTAL MANAGEMENT PROGRAM AND ENVIRONMENTAL OUTCOMES OF PROJECT

26. ENVIRONMENTAL MANAGEMENT

Robe will protect and prevent, as far as practicable, impacts on the environment through ongoing management actions, which includes:

- maintaining an Environmental Management System (EMS) and business systems
- developing environmental improvement plans each year for priorities identified in review of systems and performance
- improving mechanisms to measure water, energy use and greenhouse gas emissions
- controlling waste and spills of hydrocarbons
- improving the efficiency of use of natural resources
- updating plans for disturbance and closure, progressively rehabilitating and measuring success
- training staff and contractors in environmental requirements of their work
- ensuring that community views are sought, respected and considered
- reporting regularly to stakeholders on performance
- aligning with the Rio Tinto Iron Ore Health, Safety and Environmental Policy and the Pilbara Iron and Robe River Joint Venture Environmental Policy.

Robe acknowledges the environmental protection principles listed in S4a of the EP Act through its strong commitment to sustainable development and environmental management at its operations (Section 5). These principles are clearly reflected in Robe's environmental policy (Section 26.1), Iron Environmental Management System (Section 26.2) and the Rio Tinto corporate environmental standards that are being implemented across the Rio Tinto Group.

26.1 PROPONENT'S ENVIRONMENTAL POLICY

Robe aims to conduct business in an efficient and environmentally responsible manner that is compatible with the expectations of shareholders, the government and the community. Robe also recognises that environmental responsibilities go beyond those required under statutory regulations to encompass social obligations, leadership in sustainable development and minimising environmental impacts.

The Pilbara Iron and Robe River Joint Venture Environmental Policy was signed in August 2004 by the company's executive management. The Environmental Policy is the guiding document for driving environmental management and provides context and specific direction for continuous improvement.

Environmental policy

Our goal is to create long-term value as a responsible iron ore mining company. In doing this we need to care for the environment with our aims including:

- *efficient use of natural resources*
- *to meet our legal and other obligations along with the targets we set*
- *to minimise pollution and clean up any accidents quickly*
- *leaving areas as close as practical to how we found them*
- *to continually improve performance*
- *ensuring employees know their environmental accountabilities and act on them*
- *being proactive to better understand the impact of our operations now and for the future*
- *providing opportunities for communities and others to tell us what they think.*

To achieve this, our actions will be:

- *managing our environmental issues through our EMS and business systems*
- *developing environmental improvement plans each year for priorities identified in review of systems and performance*
- *improving our ability to measure water, energy use and greenhouse gas emissions*
- *minimising waste and spills of hydrocarbons*
- *improving the efficiency of our use of natural resources*
- *updating plans for disturbance and closure, progressively rehabilitate and measure success*
- *recognising good environmental performance*
- *training staff and contractors in environmental requirements of their work*
- *that community views are sought, respected and considered*
- *reporting regularly to stakeholders on our performance*
- *aligning with the Rio Tinto Iron Ore Health, Safety and Environmental Policy.*

26.2 IRON ENVIRONMENTAL MANAGEMENT SYSTEM (IEMS)

Robe operates under an ISO14001 framework through the IEMS. ISO14001 is an internationally recognised standard for continuous improvement model. The key elements of ISO14001 include assessing environmental risk and identification of legal requirements, developing objectives and targets for improvement, training, operational control, communication, emergency response, corrective and preventative actions, audits and review. Robe sites gained ISO14001 certification in July 2005. In order to maintain ISO14001 certification Robe sites are required to successfully complete regular external independent surveillance audits.

26.3 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

A Construction Environmental Management Plan (CEMP) will be prepared and implemented specifically to address management of environmental issues arising from proposal construction activities, including those associated with the activities of a large construction workforce.

26.4 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

An Environmental Management Plan (EMP) will be prepared and implemented to specifically address management of environmental issues arising from the operation of the Mesa A/Warramboo operation. The EMP will address the following aspects:

- flora and vegetation
- weeds
- fauna
- subterranean fauna
- feral animals
- water (surface and groundwater)
- dust
- hydrocarbons
- waste (mineral and non-mineral)
- noise
- fire
- Aboriginal heritage
- greenhouse gas and energy conservation
- rehabilitation
- auditing and reporting.

The EMP will also include details of monitoring that will be undertaken and the EMP will be regularly reviewed and revised where relevant.

26.5 SUMMARY OF ENVIRONMENTAL CONTROLS

Table 32 outlines the controls that exist or will be put in place to ensure environmental compliance and appropriate management of the Mesa A/Warramboo operation in regard to each environmental factor and issue. Key controls are as follows:

- compliance with Ministerial Conditions, Key Characteristics or Proponent Commitments, in the Ministerial Statement
- relevant controls in Construction Environmental Management Plan (CEMP), which includes all environmental aspects of construction and must be approved by DEC (Environmental Management Division)
- relevant controls in Environmental Management Plan (EMP), which must be approved by DEC (Environmental Management Division)
- conditions of the DEC (Environmental Management Division) Works Approval (under EP Act) for construction of prescribed premises

- conditions of the DEC (Environmental Management Division) Licence (under EP Act) for prescribed premises (processing, landfill and sewage facility)
- conditions of the Licences to Take Water (under *Rights in Water & Irrigation Act 1914)*
- relevant Rio Tinto Environmental standards.

Other relevant controls include s18 approval to disturb Aboriginal heritage sites under the Aboriginal Heritage Act and annual environmental reporting requirements.

26.6 SUMMARY OF PROPONENT'S COMMITMENTS

The proponent (Robe) proposes the Environmental Management Commitments for the management of Mesa A/Warramboo as detailed in Table 33.

Table 32 Environmental compliance and management controls for Mesa A/Warramboo

Factor	Topic / aspect	Ministerial Condition [1]	Proponent Commitment	CEMP [2]	EMP [3]	Works Approval	DEC (Environmental Management Division) Licence	Licence to Take Water/ Permit to Interfere with Bed and Banks	Corporate Standard
Noise and vibration	Noise and vibration management			✓	✓				✓
Waste management	Mineral				✓				✓
	Liquid waste			✓	✓		✓		✓
	Solid waste disposal (landfill)			✓	✓	(✓) [4]	(✓)		✓
	Sewage (including treatment facility)			✓	✓	(✓)	(✓)		
Hazardous materials	Hazardous substances / dangerous good storage			✓	✓	(✓)	(✓)		✓
Greenhouse gases	Emission reductions				✓				✓
	Reporting				✓				
Public risk and safety	Blasting management		✓						
	Interaction with public roads		✓						
Vegetation and flora	Extent of ground disturbance			✓	✓				
	Protection of areas not approved to be cleared		✓	✓	✓				
	Protection of riverine habitat			✓				✓	
	Weed management			✓	✓				
	Fire management			✓	✓				
	Pre-construction flora and vegetation surveys		✓						
	Research		✓						
Terrestrial fauna	Extent of ground disturbance			✓	✓				
	Protection of areas not approved to be cleared		✓	✓	✓				
	Protection of riverine habitat			✓				✓	
	Pre-construction fauna surveys		✓						
	Research		✓						
Subterranean fauna	Extent of ground disturbance			✓	✓				
	Protection of areas not approved to be cleared		✓	✓	✓				
	Further research into subterranean fauna		✓		✓				
	Monitoring of subterranean fauna habitats		✓		✓				

Factor	Topic / aspect	Ministerial Condition [1]	Proponent Commitment	CEMP [2]	EMP [3]	Works Approval	DEC (Environmental Management Division) Licence	Licence to Take Water/ Permit to Interfere with Bed and Banks	Corporate Standard
Landscape and geodiversity	Extent of ground disturbance			✓	✓				
	Protection of areas not to be disturbed		✓	✓	✓				
Surface water and water quality	Drainage management – mine			✓	✓				
	Drainage management – railway		✓	✓	✓				
	Prevention of surface water contamination			✓	✓	✓	✓		✓
Groundwater and water supply	Groundwater abstraction			✓	✓			✓	✓
	Water use minimisation			✓	✓			✓	✓
Dust	Dust management			✓	✓	✓	✓		✓
Aboriginal heritage	Disturbance of sites			✓	✓				
	Protection of sites / heritage values		✓	✓	✓				✓
	Consultation with Kuruma Marthundunera Native Title Claimant Group		✓	✓	✓				✓
	Pre-construction archaeological and ethnographic surveys of the Mesa A escarpment and other areas of proposed disturbance not yet surveyed		✓						
Rehabilitation and closure	Rehabilitation Plan for the Mesa A/Warramboo operation				✓				✓
	Closure Management Plan for the Mesa A/Warramboo operation		✓		✓				✓

[1] Ministerial Conditions are to be assigned at a later date

[2] Construction Environmental Management Plan/Program

[3] Environmental Management Plan

[4] (✓) Works Approval required subject to project requirements

Table 33 Proponent's Environmental Management Commitments for the management of Mesa A/Warramboo

No.	Topic	Objective	Commitment	Timing	Advice from
1	Environmental studies	To establish a baseline environmental dataset for the areas affected by the project	Undertake the following surveys of the Mesa A escarpment and other areas of proposed disturbance: a) Aboriginal archaeological and ethnographic surveys b) DRF and Priority Flora surveys c) seasonal component of the terrestrial fauna survey d) terrestrial fauna survey of the southern transport corridor if it is selected.	Prior to ground disturbance	Native Title Claimants, DEC (Nature Conservation Division)
2	Construction Environmental Management Plan (CEMP) (Transport and infrastructure)	To minimise environmental impacts and public risk during construction of the transport corridor and infrastructure	Prepare a CEMP for the construction of the Mesa A/Warramboo transport corridor and infrastructure that addresses the environment management of the following issues: a) flora (avoid DRF and Priority Flora populations where feasible) b) vegetation (minimise clearing as far as practicable and protect the sand sheet with the exception of approximately 3 ha which lies within the mining area) c) weeds d) fauna e) subterranean fauna f) water (surface and groundwater) g) dust prevention h) hydrocarbons i) waste (non-mineral) j) noise k) fire l) rehabilitation of borrow pits and temporary construction areas m) Aboriginal Heritage.	Prior to ground disturbance	DEC (Environmental Management Division & Nature Conservation Division), DIA
3	Construction Environmental Management Plan (CEMP) (Transport and infrastructure)	As above	Implement the CEMP prepared under commitment 2.	During construction	DEC (Environmental Management Division & Nature Conservation Division), DIA
4	Environmental Management Plan (EMP) (Operations)	To minimise environmental impacts and public risk during operation of the project	Prepare an EMP for the operation of the Mesa A/Warramboo project that addresses the following environmental issues: a) flora and vegetation (minimise clearing and protect the sandsheet with the exception of approximately 3 ha which lies within the mining area)	Prior to operation	DEC (Environmental Management Division & Nature Conservation Division)

No.	Topic	Objective	Commitment	Timing	Advice from
			b) weeds c) fauna d) subterranean fauna e) feral animals f) water (surface and groundwater) g) dust during activities related to mining and transport h) hydrocarbons i) waste (mineral and non-mineral) j) noise k) fire l) progressive rehabilitation of mining areas m) Aboriginal Heritage n) greenhouse gas and energy conservation o) auditing and reporting.		
5	Environmental Management Plan (EMP) (Operations)	As above	Implement the EMP prepared under commitment 4.	During operation	DEC (Environmental Management Division & Nature Conservation Division)
6	Public Risk and Safety	To minimise public risk and public inconvenience	Prepare a Public Risk and Safety Management Plan which addresses the following issues: • North West Coastal Highway closure requirements and procedures during blasting and heavy equipment crossing • measures to reduce risk to public safety during blasting • methods to provide advance public notification of highway closures.	Prior to construction	Main Roads Western Australia
7	Public Risk and Safety	As above	Implement the Public Risk and Safety Management Plan prepared under commitment 6.	During construction and operation	Main Roads Western Australia

No.	Topic	Objective	Commitment	Timing	Advice from
8	Subterranean Fauna	To improve scientific knowledge and understanding of troglofauna and to develop and evaluate options for management of troglofauna	Finalise the Troglobitic Fauna Management Plan (TMP) including the following actions: • investigation of the distribution of troglofauna populations in potential exclusion areas at Mesa A • mitigation of indirect impacts to troglofauna habitat including prohibiting clearing (except for access tracks and drill holes required for troglofauna sampling purposes) and hydrocarbon storage in the areas retained as troglofauna habitat • monitoring of biophysical parameters throughout the life of the mine • ongoing troglofauna sampling throughout the life of the mine • undertake geophysical analysis to identify the extent to which vibration may be extending into the adjoining retained mesa habitat • develop criteria to trigger management actions which may include consideration of down-hole trickle irrigation or larger scale groundwater re-injection.	Prior to ground disturbance for mining	DEC (Nature Conservation Division)
9	Subterranean Fauna	As above	Implement the Troglobitic Fauna Management Plan (TMP) prepared under commitment 8.	During construction and operation	DEC (Nature Conservation Division)
10	Rehabilitation & Closure	To satisfactorily decommission the mine and transport corridor and to rehabilitate the site and its environs upon closure	Prepare a Closure Management Plan for Mesa A/Warramboo, the transport corridors and associated infrastructure that addresses the following: • development of suitable end land uses and objectives for closure in consultation with relevant stakeholders and the community • identification and evaluation of closure options and determination of preferred options • establishment of completion criteria • closure monitoring • review and update of the Closure Management Plan.	Two years prior to closure of the operation	DoIR, DEC (Nature Conservation Division)
11	Rehabilitation & Closure	As above	Implement the Closure Management Plan prepared under commitment 10.	Closure	DoIR, DEC (Nature Conservation Division)
12	Mitigation of environmental impacts	To protect identified environmental values of Mesa A, including: • viability of the troglofauna population. • habitat for significant fauna • significant	Establish appropriate exclusion zones including the two sandsheet habitats (except 3 ha which lies within the mining area) and the three identified gullies. Establish an exclusion zone of at least 50 m around the rim of the escarpment (except for the area where the escarpment will be breached to allow access from the pit to the plant area). Retain a volume of pisolite ore body at least 15 x 10^6 m^3 to maintain a viable troglofauna population. The exclusion zone will be determined taking into account the findings of the investigation of the distribution of troglofauna populations in potential exclusion areas at Mesa A that is required under commitment 8.	Prior to ground disturbance	DEC (Nature Conservation Division)

No.	Topic	Objective	Commitment	Timing	Advice from
		populations of DRF and Priority Flora species • significant geodiversity values (escarpment and gullies) • Aboriginal heritage values including rock shelters and other values as identified by the survey required by commitment 1(a).			
13	Environmental Offsets	To improve scientific knowledge and understanding of Pilbara ecology	Fund the establishment of a research facility to assist in the identification of short range endemic species in the Pilbara region, including troglofauna (approximately $1M). Establishment of a fund (of approximately $1M) to support the following studies: a) Longer term research program addressing the troglofauna of the Robe valley mesas, including: • investigation of the characteristics of relevant subterranean habitat • investigations into the ecology and ecosystem processes for troglofauna communities • additional sampling of troglofauna. b) Further genetic studies and morphological and taxonomic descriptive work, including establishment of facilities for DNA analysis of troglofauna. c) Other appropriate ecological research including: unresolved floristic taxonomy of Pilbara flora species and Northern Quoll populations of the Western Pilbara.	Prior to mining	DEC (Nature Conservation Division)

27. CONCLUSION

The key environmental factors identified by the proponent, government agencies and other stakeholders in regard to the development and operation of the Mesa A/Warramboo project were:

- Flora and fauna (terrestrial and subterranean): conservation of regional biodiversity.
- Landscape and Geodiversity: retention of important features of the landscape.
- Sourcing water: protection of groundwater source and ecosystems dependent on groundwater source.
- Aboriginal heritage: protection of significant Aboriginal sites and consultation with the Kuruma Marthudunera Native Title Claimant Group.

27.1 ENVIRONMENTAL IMPACTS AND MITIGATION

In summary, the potential environmental impacts of the proposal and proposed management measures are as follows:

- Progressive removal of approximately 2250 ha of native vegetation over the life of the project for mining areas, with eventual rehabilitation to native vegetation. Removal of up to 600 ha of native vegetation for the transport corridor, sidings, borrow pits, laydown areas and construction camp.
- Increased risk of the spread of weeds, however this will be minimised through Robe's weed control and hygiene procedures.
- Loss of fauna habitat leading to the reduction in local abundance of some fauna populations (terrestrial and subterranean), however this will not have a significant effect on representation of fauna at a regional level.
- Potential restrictions on fauna movement from the construction and operation of the transport corridor, however Robe will install culverts to allow the passage of fauna across the corridor.
- Potential for mining operations to have an impact on the surrounding troglofauna habitat, however Robe will mitigate indirect impacts and monitor trogolofauna habitat throughout the life of the mine. Robe will also retain sufficient volume of Mesa A to maintain a viable trologfauna popultaion.
- Alteration to visual amenity values of the local landscape primarily caused by mining infrastructure and operations.
- Change in the immediate landscape from removal of mined material and the resultant depression in the restored landform.
- Local alterations to surface drainage patterns and diversion of minor drainage lines, however this should not have an impact on the quality or quantity of water in the major waterways themselves.
- Localised drawdown in the deep aquifer, however this will not have a significant impact on regional groundwater.
- Disturbance to a number of Aboriginal heritage sites, however the proposal will avoid disturbance of those sites identified to be of significance where practicable.

27.2 ENVIRONMENTAL OFFSETS

A number of environmental offsets are proposed, including:

- Funding a study of an unresolved floristic taxonomic issue in a Pilbara flora species.
- Funding a study into the Northern Quoll populations of the Robe River locality.
- Undertaking a longer-term research program addressing the troglofauna of the Robe valley mesas, including:
    - investigation of the characteristics of relevant subterranean habitat
    - investigations into the ecology and ecosystem processes for troglobitic communities
    - additional sampling of troglofauna
    - further genetic studies and morphological and taxonomic descriptive work.
- Providing funding to assist with establishment of facilities for DNA analysis of troglofauna.

27.3 OTHER IMPACTS AND MITIGATION

Other likely impacts and proposed management measures are as follows:

- Inconvenience to users of the North West Coastal highway due to the need for road closures during blasting, however Robe will implement measures to provide advance notice of road closures.
- Potential restriction on or inconvenience to pastoral activities, however Robe will continue to liaise with the pastoral leaseholders to ensure impacts on pastoral activities are minimised.

In addition, the ongoing activities of Robe will continue to support towns in the Pilbara and Robe will also continue to support a variety of community groups and public projects in WA through mechanisms described in Section 5.2.1.

27.4 ENVIRONMENTAL RISKS AND MANAGEABILITY

The approach taken in this environmental review has been based on a risk assessment approach to characterise environmental factors, determine potential impacts and develop mitigation measures.

The proponent has extensive experience in managing the development, operation and environmental compliance of similar projects (including the existing Mesa J operation) and this experience is anticipated to lead to a greater certainty in achieving desirable environmental outcomes.

The environmental aspects of the proposal will be primarily managed through the Mesa A/Warramboo EMP, the site IEMS, relevant licences and the implementation of proposed Environmental Management Commitments for Mesa A/Warramboo. Robe will also ensure an acceptable closure outcome through preparation of a Closure Management Plan for the Mesa A/Warramboo to the satisfaction of stakeholders.

The proponent has consulted with stakeholders (including Government agencies) to scope the potential impacts of the proposal and to determine the significance of environmental issues and the acceptability of mitigation. This process substantially improves the likelihood that all significant environmental issues have been identified, investigated and mitigated as far as practicable.

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29. SHORT TITLES AND ACRONYMS

Table 34 sets out the short titles and acronyms used in this report.

Table 34 Short titles and acronyms

Short title or acronym	Long title
$\mu g/m^3$	Micrograms per cubic meter
μm	Micrometres
A$	Australian dollars
Aboriginal Heritage Act	*Aboriginal Heritage Act 1972* (WA)
AGO	Australian Greenhouse Office
ATAL	Aboriginal Training and Liaison Unit
CALM	Department of Conservation and Land Management (WA)
CCEF	Coastal Community Environmental Forum
CEMP	Construction Environmental Management Plan
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivilants
DEC	Department of Environment and Conservation
DEH	Department of the Environment and Heritage (Commonwealth)
DIA	Department of Indigenous Affairs (WA)
DoE	Department of Environment (WA)
DoIR	Department of Industry and Resources (WA)
DRF	Declared Rare Flora
EMP	Environmental Management Plan
EPA	Environmental Protection Authority (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPASU	Environmental Protection Authority Service Unit
EP Act	*Environmental Protection Act 1986* (WA)
FIFO	Fly-in fly-out
GL/yr	Gigalitres per year
GW	Gigawatt
GWh/a	Gigawatt hour per annum
ha	Hectares
IBRA	Interim Biogeographic Regionalisation Area
IEMS	Iron Environmental Management System
kg	Kilogram
kL/a	Kilolitre per annum
km	Kilometer
Kuruma Marthudunera	Kuruma Marthudunera Native Title Claimant Group
Loc.	Location
LRP	Lump Re-screening Plant
L/s	Litres per second
m	Metres
m^2/d	Square metres per day

Short title or acronym	Long title
mg/L	Milligrams per litre
ML	Mining lease
ML/yr	Megalitres per year
mm/yr	Millimetres per year
Mtpa	Million tonnes per annum
MW	Megawatt
NEPC	National Environment Protection Council
NEPM	National Environmental Protection Measure
NGS	National Greenhouse Strategy
PER	Public Environmental Review
PM_{10}	Particulate matter with an equivalent aerodynamic diameter 10 μm or less
PNTS	Pilbara Native Title Service
Robe	Robe River Mining Company Pty Limited
ROM	Run of mine
SKM	Sinclair Knight Merz
TEC	Threatened Ecological Community
TEOM	Tapered element oscillating microbalance
TSP	Total suspended particulates
UCL	Unallocated crown land

Appendix 1
DEH decision on controlled action

Australian Government

Department of the Environment and Heritage

Ms Fiona Bell
Environmental Approvals Specialist
Pilbara Iron
GPO Box A42
PERTH WA 6837

Dear Ms Bell

Rio Tinto Iron Ore/Robe Valley/Mining/WA
EPBC Reference 2006/2698

Thank you for the above referral, received on 16 March 2006, for decision whether or not approval is needed under Chapter 4 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The referral has now been considered under the EPBC Act and I have decided that the action is not a controlled action. Approval is therefore not needed under Part 9 of the Act before the action can proceed.

Please note that this decision only relates to the potential for significant impact on the specific matters of *national* environmental significance protected by the Australian Government under the EPBC Act. There may be a need for separate State or Local Government environmental assessment and approval to address potential impacts on State, regional or local environmental values.

A copy of the document recording my decision is attached for your information. I have written separately to Mr Warwick Smith of Rio Tinto Iron Ore to advise of my decision.

Yours sincerely

Ms Jane Campbell
Acting Assistant Secretary
Environment Assessment Branch

13 April 2006

COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

DECISION THAT ACTION IS NOT A CONTROLLED ACTION

Jane Campbell, Acting Assistant Secretary, Environment Assessment Branch, Department of the Environment and Heritage, a delegate of the Minister for the Environment and Heritage for the purposes of section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*, decided that the proposed action, set out in the Schedule, is not a controlled action on 13 April 2006.

SCHEDULE

The proposed action to develop and operate two iron ore mines at Mesa A and Warramboo and to develop and operate associated infrastructure, including a transport corridor between Mesa A and Mesa J, in the Robe River Valley near Pannawonica, Western Australia, and as described in the referral received under the Act on 16 March 2006 (EPBC 2006/2698).

Appendix 2
Supporting studies and investigations

APPENDIX 2 SUPPORTING STUDIES AND INVESTIGATIONS

The following supporting studies and investigations are contained on CD inside the back cover of the PER:

Vegetation and flora and fauna

Biota Environmental Sciences (Biota) 2005a, *Vegetation and Flora Survey of Mesa A and Mesa G, near Pannawonica*, unpublished report prepared for Robe River Iron Associates, July 2005.

Biota Environmental Sciences (Biota) 2005b, *Fauna Habitats and Fauna Assemblages of Mesa A and G, near Pannawonica*, unpublished report prepared for Robe River Iron Associates, July 2005.

Biota Environmental Sciences (Biota) 2006a, *Desktop assessment of probable environmental values of the Mesa A Southern Transport Corridor*, unpublished document prepared for Robe River Iron Associates, January 2006.

Biota Environmental Sciences (Biota) 2006b, *A Vegetation and Flora Survey of the Proposed Mesa A Transport Corridor, Warramboo Deposit and Yarraloola Borefield*, unpublished report prepared for Robe River Iron Associates, January 2006.

Biota Environmental Sciences (Biota) 2006c, *Fauna Habitats and fauna assemblages of the Mesa A transport corridor and Warramboo – fauna habitats and fauna assemblage survey*, unpublished report prepared for Robe River Iron Associates, January 2006.

Biota Environmental Sciences (Biota) 2006d, *Mesa A/Warramboo and Yarraloola borefield development – Baseline stygofauna assessment,* unpublished report prepared for Robe River Iron Associates, January 2006.

Biota Environmental Science (Biota) 2006e, *Mesa A and Robe Valley Troglobitic Fauna – Draft Troglobitic Fauna Management Plan,* unpublished report prepared for Robe River Iron Associates, June 2006.

Biota Environmental Sciences (Biota) 2006f, *Mesa A and Robe Valley Mesas Troglobitic Fauna Survey – Subterranean Fauna Assessment*, unpublished report prepared for Robe River Iron Associates, March 2006.

Landscape and geodiversity

John Cleary Planning 2005, *Mesa A-Warramboo Robe River: Landscape and Geodiversity Assessment Study*, unpublished report prepared for Robe River Iron Associates.

Hydrogeological

Aquaterra 2005a, *Mesa A/Warramboo Development*, Memorandum Doc 039a, March 2005.

Aquaterra 2005b, *Mesa A Water Supply Investigation*, unpublished report prepared for Robe River Iron Associates, November 2005.

Closure

Sinclair Knight Merz (SKM) 2005a, *Mesa A Closure Statement*, unpublished report prepared for Robe River Iron Associates, December 2005.