JACK HILLS IRON ORE PROJECT, MURCHISON REGION, WESTERN AUSTRALIA:

ENVIRONMENTAL PROTECTION STATEMENT

VOLUME 1 - MAIN REPORT

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PREPARED FOR

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BY

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

Murchison Metals Ltd (MML) proposes to develop an open cut mine and crushing plant at the Jack Hills Iron Ore Project and truck 1.0 to 1.8 million tonnes of iron ore to the Port of Geraldton for export to overseas markets. The project is located about 350 kilometres north-east of Geraldton and 100 kilometres west of Meekatharra in the Murchison region of central Western Australia (Figure 1).

The project area comprises the proposed pit, crushing plant and camp located on Mining Lease M20/506 and the access road to the camp on portion of L51/85. The main access to the project area from Cue will be via a haul road from the Beringarra-Cue public road. This haul road route is covered by Miscellaneous Licence 20/47 and Miscellaneous Licence Application 20/53(Figure 2).

1.2 SCOPE OF PROJECT

The layout of the proposed Jack Hills project is shown in Figures 3, 4 and 5 and will comprise the following major components:

- Mining to depths of up to 140 metres (approximately 41 million tonnes of ore and waste rock).
- Construction and operation of a crushing and screening plant (1.8 million tonnes per annum) (Figure 6).
- Construction of workshop and administration buildings.
- Construction of one waste rock stockpile.
- Construction of water supply bores, associated support facilities and access roads.
- Camp to accommodate a workforce of up to 100 persons.
- Construction of a 24-kilometre haul road from the mine site to Beringarra-Cue public road.

The Jack Hills project will occupy an estimated area of 127.7 hectares, with pit (25.4 hectares) on the range and the remaining mine site infrastructure, plant, roads and camp on the adjoining plain. The extent of the proposed disturbances is given in Table 1.1.

Table 1.1: Total Areas of Disturbance

Disturbance	Area to be Cleared (ha)
Waste rock stockpile	52.6
Pit	25.4
Crusher and ROM	0.8
Workshop	0.2
Ore stockpile area	0.1
Fuel storage	0.04
Power house	Included in workshop/ administration area
Laydown	0.6
Administration area	0.2
Camp	2.8
Haul road (M20/506)	4.4
Site roads (M20/506 and L51/85)	3.9
Domestic landfill	0.2
Haul road (L20/47 and L20/53)	36.4
Airstrip	Upgrade existing Mt Hale airstrip – no new disturbance required
Explosives magazine	0.04
Sewage treatment	0.03
Total	**127.7**

Project components are discussed below:

1.2.1 Mining

The proposed Jack Hills project has an expected operational life of five years and will utilize a contract mining operation under supervision of MML personnel.

Mining of the ore lenses within the host rock will be undertaken by the conventional open cut method of drilling, blasting and excavation using hydraulic excavators and dump trucks. Approximately 8.16 million tonnes [1.99 million bank cubic metres (bcm)] of ore will be mined. Figure 7 shows a cross-section of the proposed pit.

1.2.2 Dewatering

Minor seepage from perched water lenses and incident rainfall will be pumped from in-pit sumps and the water used for dust suppression.

1.2.3 Crushing and Screening

The crusher will consist of a closed circuit mobile jaw crusher, two mobile deck screens, a mobile secondary cone crusher and two product stackers. Two products will be produced from the crushing and screening plant. Lump ore will be plus 6.3 millimetres and minus 32 millimetres and fines will be less than 6.3 millimetres in size.

A comprehensive dust suppression system will be installed, involving water spray injection at each transfer point and screen.

1.2.4 Waste Rock Stockpile

The waste rock will comprise mainly low grade iron oxide-quartz rock, banded iron-chlorite schist, which will be dumped in a waste rock stockpile located on the scree slope at the foothills of the range. None of these wastes have chemical properties that may cause heavy metal toxicities or environmental pollution. They also have no capacity to generate acid in volumes and concentrations that will give rise to environmental concern.

The volume of waste will be approximately 11 million bcm. The waste rock stockpile will be constructed in 10 metre lifts, having a final footprint of 52.6 hectares and slope angles no steeper than 18° with a maximum level difference of 80 metres between the base on the plain and the crest on the footslopes (Figures 8 and 9).

1.2.5 Water Supply

The annual water requirement for drinking water, crushing and screening water spray system and dust suppression is up to 250,000 kilolitres. All water will be obtained from bores, which will be developed in structurally controlled aquifers in the weathered granitoids at the foothills of the range. Water bores will be located along the haul road to supply water for construction and dust suppression purposes.

1.2.6 Support Infrastructure

Support infrastructure required for the Jack Hills project includes mine administration, camp, workshop facilities, power generation and reticulation, road networks, communication systems and potable water supply.

1.2.7 Power Supply

Power requirements will be provided by diesel-powered generators consisting of a 500 kilowatt generator for the camp and 50 kilowatt generators for the water bores. The crushing plant will be powered by 670 kilowatt diesel hydraulics which do not require electrification.

1.2.8 Workforce

A workforce of about 90 persons will be required for the project on site. The proposed camp will consist of approximately 100 single room demountables with ensuite, a dry-mess, wet-

mess, recreational facilities, a small store and camp administration offices. Employees of the proponent operate on a '2-weeks on and 1-week off' and a 'fly-in and fly-out' basis out of Perth.

1.2.9 Roads and Transport

The haul route from the mine to Geraldton is approximately 605 kilometres, with the staging point being the town of Cue. A 23.4 kilometres long by 14 metres wide gravel haul road will be constructed from the mine site to the existing Beringarra-Cue public road. The 181 kilometre long Beringarra-Cue Road will be upgraded to make it suitable for road trains with a bitumen-sand seal. The management of this road will be to the requirements of the Shires of Cue and Murchison. This road will join the Mt Magnet-Geraldton Road via a by-pass to be constructed by MML that avoids trucking through Cue.

1.3 EXISTING ENVIRONMENT

1.3.1 Regional Setting

The project area is located on the Jack Hills Range in the vicinity of Mt Hale and Mt Matthew and on the adjoining plains immediately north of the range. Jack Hills extend almost 300 metres (up to 700 metres AHD) above the flat plains of the Murchison, itself approximately 400 to 450 metres AHD at the project site.

The climate of the region is strongly influenced by a band of high pressure known as the sub-tropical ridge, and in the warmer months by a trough of low pressure that extends southwards from the heat low in the tropics. For most of the year the ridge is located to the south, and east to south-east winds prevail. The annual average rainfall is 236 millimetres. Half the annual evaporation of 3,576 millimetres occurs from November to February.

The Jack Hills Range is located within the Weld Land System and the surrounding plains contain a number of land systems; the most common within the project area being the Yarrameedie Land System.

1.3.2 Surface Hydrology

The Jack Hills project is located on the north-draining watershed of the Jack Hills Range, with many minor drainage lines. Creek flow is infrequent and associated with major rainfall events. Runoff rates from the catchment are typically high because of low permeability surfaces and steep slopes of the range which flow to numerous drainages and creeks on the plains. Extensive but shallow alluvial plains are associated with the Murchison River and its main tributaries.

1.3.3 Groundwater

Some perched water bodies may occur in the Jack Hills range within the vicinity of the project area. Of 58 holes drilled in the 2005 drilling programme, only eight encountered any water and this was from perched water lenses. No significant water flows were encountered in these holes. Permanent groundwater levels within the vicinity of the Jack Hills project area are deeper than 340 metres AHD, based on exploration drilling, which is below the level of proposed open pit mining.

The weathered fractured granitoid rocks occur as lineal drainage features within the foothills of the range and may represent major joint or fault fractures. These fractures could act as structural aquifers as well as drainage pathways through the enclosing granitoid rocks, and collect alkaline groundwater seepage from the banded iron formations and chloritic schists at higher elevations.

Extensive but shallow alluvial plains are associated with the Murchison River and its main tributaries. Groundwater is at shallow depths of approximately 10 metres within these alluvial systems.

1.3.4 Vegetation and Flora

Four vegetation and flora surveys of the project area have been undertaken – in October 2004, June 2005, October 2005 and March 2006.

Vegetation comprises *Acacia* shrublands and restricted *Triodia* upland plant communities on the rugged ranges and ridges and sparse *Mulga* systems on the undulating stony plains. Eighteen plant communities were mapped in the Jack Hills project area. The *Triodia* plant community is restricted to the Banded Ironstone Formation (BIF). *Triodia* plant community T3 was only found in the Jack Hills Range.

The flora of the Murchison region is diverse with about 830 recorded vascular species, of which 97 percent are endemic or near endemic. A total of 215 taxa (including subspecies and varieties) from 188 genera and 36 families were recorded within the survey area. One introduced weed species was found within the project area. No declared rare or threatened flora is known to occur in the project area. Three Priority species (*Calytrix verruculosa*, *Gunniopsis divisa* and *Verticordia jamiesonii*) occur within the project area. Two species [*Lobelia heterophylla* subsp. *pilbarensis* and A*cacia cockertoniana* (ms)] are significant as they are outliers from previously known locations.

1.3.5 Fauna

Three fauna surveys of the Jack Hills project area have been undertaken – in October 2004, September 2005 and March 2006. These surveys recorded a cumulative total of 129 vertebrate fauna species, of a possible 212 species expected to occur in the region, within the habitats of the project area, comprising four frogs, 20 mammals, 33 reptiles and 72 birds. Five introduced mammal species were recorded.

Twenty-four species of conservation significance were identified as potentially occurring within the Jack Hills project area and comprise six mammals, three amphibians, five reptiles and 10 birds. Of these, one mammal and three birds have been recorded in the project area to date. Additionally, four trans-equatorial or migratory birds listed on international treaties have been recorded in the greater Jack Hills project area. Highly localised disturbance is unlikely to impact on the conservation status of these significant species.

Species recorded were generally common arid zone species with the exception of the Schedule 4 listed species Peregrine Falcon (*Falco peregrinus*). Priority 4 CALM listed species Long-tailed Dunnart (*Sminthopsis longicaudata*) and Bush Stone-curlew (*Burhinus grallarius*). A southerly range extension was the record of the Little Broad-nosed Bat (*Scotorepens greyii*).

Consultations with Western Australian Museum have established that short range endemic (SRE) invertebrate species are likely to occur on the southern and south-eastern facing hillsides of the ranges and SRE habitat is not expected to occur, or be impacted, in the Jack Hills project area.

The geology of the Jack Hills range and the absence of groundwater does not provide subterranean habitats to support stygofaunal life forms or that are unique to potential troglofaunal life forms that may occur on the range. The shallow aquifers on the extensive plains may provide habitat for stygofaunal life forms.

1.3.6 Aboriginal Heritage

MML has entered into an Aboriginal Heritage Protection Agreement with the Native Title Parties and their Representative Body, the Yamatji Land and Sea Council, to ensure that its activities do not disturb any places of heritage significance to the claimants. Under this Agreement a number of heritage surveys have been undertaken over the project area where ground disturbing activities were proposed.

A search of the Register of Aboriginal Sites maintained by the Department of Indigenous Affairs reveal that there are no registered Aboriginal sites that would be impacted by the project. No sites of significance to the traditional custodians were located in the course of these surveys. A minor isolated artefact was recorded 20 metres off the centreline of the haul road and will not be disturbed. This does not constitute an Aboriginal site. One low density artefact scatter was located within the proposed pit layout. The site was considered by the representatives of the Wajarri Yamatji Claimant Group to be of low significance. Permission to disturb and relocate artefacts from this site will be obtained from the Minister for Indigenous Affairs under Sections 18 and 16 of the Aboriginal Heritage Act 1972.

1.4 STAKEHOLDER CONSULTATION

MML has undertaken consultations to ensure that relevant environmental concerns have been addressed in the design and management of the Jack Hills project. These consultations have included:

- Meetings with government agencies including Department of Industry and Resources (DoIR), Department of Environment (DoE), Environmental Protection Authority

(EPA), Department of Conservation and Land Management (CALM), Department of Indigenous Affairs, Western Australian Museum and Shires of Meekatharra, Cue and Murchison.

- Information mail outs to Conservation Council of WA, Wildflower Society of WA, Western Australian Naturalists' Club and Wilderness Society.
- Meetings and presentations to Conservation Council of WA and Wildflower Society.
- Distribution of draft Environmental Protection Statement (EPS) and follow-up contact with these organisations, and receipt and consideration of comments into finalising EPS documentation.
- Meetings with regulatory authorities, pastoralists, local authorities/agencies.
- Meetings, site visits and surveys with Aboriginal groups.
- Site visit with members of EPA Board and senior botanist of CALM.

Details of all issues raised and responses made during consultations are discussed and provided in the EPS. The consultations were considered to be all-inclusive and held in a very transparent and forthright manner thereby ensuring a successful outcome. MML is appreciative of the time and involvement of all respondents.

1.5 SUMMARY OF ENVIRONMENTAL PRINCIPLES AND FACTORS

The application of the Principles of Environmental Protection within the Jack Hills Iron Ore Project, as set out in the EPA Position Statement No. 7 (EPA August 2004), are addressed in Table 1.2.

Table 1.2: Summary of Principles of Environmental Protection

Principle	Relevance	Comments
1. The 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 application of this precautionary principle, decisions should be guided by – (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk – weighted consequences of various options.	Yes	The precautionary principle has particular relevance to the project, through the protection of the region's significant flora communities/species. Refer to: • Flora and Vegetation (Sections 4.9 and 8.7). • Rehabilitation, Decommissioning and Closure (Section 6.0). • Dust (Section 8.10). • Figure 10a Vegetation Communities – Mine Site. • Figure 11a Locations of Conservation Significant Flora Species – Mine Site.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	The principle of intergenerational equity has a relevance to the project's overall level of environmental management and particular relevance to processes employed for site rehabilitation, decommissioning and closure. Refer to: • Rehabilitation, Decommissioning and Closure (Section 6). • Environmental Issues and Management (Section 8). • Social Issues and Management (Section 9).
3. This principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	The principle of conservation of biological diversity and ecological integrity has relevance to the project, through the protection of the region's flora and fauna. Refer to: • Flora and Vegetation (Sections 4.9 and 8.7). • Fauna (Sections 4.10 and 8.8). • Rehabilitation,

Principle	Relevance	Comments
		Decommissioning and Closure (Section 6).
4. Principles relating to improved valuation, pricing and incentive mechanisms (1) Environmental factors should be included in the valuation of assets and services. (2) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. (3) 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 waste. (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximize benefits and/or minimize costs to develop their own solutions and responses to environmental problems.	Yes	The principles relating to improved valuation, pricing and incentive mechanisms have relevance to the project, through the management of the project's wastes and hazardous materials, and the project's rehabilitation, decommissioning and closure. Refer to: • Waste Rock Stockpile (Sections 3.2.1 and 3.6). • Solid Waste Disposal (Section 3.20). • Waste Products (Section 8.13). • Dangerous and Hazardous Substances (Sections 3.21 and 8.14). • Rehabilitation and Closure (Section 6).
5. The principles of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge to the environment.	Yes	The principles of waste minimisation have relevance to the project, through the management of the project's wastes and the project's rehabilitation, decommissioning and closure. Refer to: • Waste Rock Stockpile (Sections 3.2.1 and 3.6). • Solid Waste Disposal (Section 3.20). • Waste Products (Section 8.13). • Rehabilitation and Closure (Section 6).

The environmental factors from the proposed Jack Hills project, as determined by the EPS process, together with proposals for their management, are summarised in Table 1.3.

Table 1.3: Summary of Environmental Factors

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Biophysical					
Flora and vegetation	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.	Distribution of plant communities is outlined in Figures 10a and 10b. 215 flora species were recorded. One introduced weed species was found within the project area. 18 plant communities were mapped in the Jack Hills project area. The *Triodia* plant community is restricted to the BIF. T3 was only found in the Jack Hills Range.	Clearing of 127.7 hectares will involve the temporary or permanent loss of native vegetation. 11 of the plant communities will be impacted by the mining proposal. 6.24 hectares (63%) of T3 *Triodia* plant community will be removed for the pit. Less than 20 hectares (approximately 13.5%) of the *Triodia* plant community (T1, T2, T3 and T4) will be impacted.	Clearing activities will be managed to ensure the minimum impact on vegetation, with vegetation retained where possible. *Triodia* plant community and T3 especially, will be avoided where possible in the design and operation of the Jack Hills mine. Disturbed areas will be progressively rehabilitated. Dust control measures will be implemented. Weeds will be controlled through prevention, monitoring and early eradication. Access to the range will be restricted. Additional studies proposed on the flora and vegetation will assist in clarifying the regional context of the values as defined.	The flora and vegetation within the Jack Hills project area are represented outside the proposed clearing area associated with the proposal. The proposed clearing activities will modify the degree of representation of some species and plant communities in a local context. Additional botanical studies, weed control programmes and rehabilitation methods will assist in mitigating the impacts on flora and vegetation.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Declared Rare and Priority flora species	Protect declared rare and priority flora, consistent with the provisions of the *Wildlife Conservation Act 1950.* Protect other flora species of conservation significance.	No declared rare or threatened flora is known to occur in the project area. Three Priority species (*Calytrix verruculosa*, *Gunniopsis divisa* and *Verticordia jamiesonii*) occur within the project area. Two species [*Lobelia heterophylla* subsp. *pilbarensis* and A*cacia cockertoniana* (ms)] are significant as they are outliers from previously known locations.	Priority species and species of scientific interest will be impacted by the pit on the range and along the haul road on the plain.	The pit layout cannot change and the haul road alignment takes species into account.	All species that will be disturbed are well represented outside the project area.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
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. Protect Specially Protected (Threatened) and Priority fauna and their habitats consistent with the provisions of the *Wildlife Conservation Act 1950* and the *EPBC Act 1999*.	**Vertebrate fauna** Project area supports, or could support, a wide range of vertebrate fauna species, including 23 species of conservation significance. No fauna habitats of national or regional significance were identified within the project area. The Jack Hills Ranges supports a fauna assemblage that is distinct from that of the adjoining plains. The upland *Triodia* plant community is locally significant. Species recorded were generally common arid zone species with the exception of the Schedule 4 Listed Peregrine Falcon (*Falco peregrinus*), the Priority 4 CALM listed species Long-tailed Dunnart (*Sminthopsis longicaudata*) and Bush Stone-curlew (*Burhinus grallarius*). A southerly range extension was the record of the Little Broad-nosed Bat (*Scotorepens greyii*).	Localised areas of habitat will be disturbed as a result of the pit and infrastructure development. Death on haul road due to increased vehicle traffic. Attraction of feral animals to project area such as putrescible waste facility.	Project designed to minimise clearing of vegetation and habitats. Range habitats and upland *Triodia* plant communities have been largely avoided. Progressive clearing of vegetation will be minimised and managed to reduce the impacts on fauna. Rehabilitation will re-establish habitats and self sustaining ecosystems in the long term. Open holes and trenches will be checked regularly for trapped fauna. Drill hole covers will be checked to ensure integrity of covers. Induction programme will familiarise personnel with conservation significance, appearance, and habitats of fauna species (particularly rare, threatened or vulnerable species).	The habitats within the Jack Hills project area are well represented within the range and on the adjoining plains are common and widespread throughout the region. The fauna recorded or expected to occur within the project area are unlikely to be significantly impacted by clearing and temporary removal of these habitats. Consequently, the impact of the proposed Jack Hills project on fauna and habitat will be negligible in a regional conservation context. Clearing measures, mining and exploration procedures, feral animal programmes and rehabilitation methods will assist in mitigating the impacts on fauna and habitats.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
		Invertebrate fauna *Short Range Endemic (SRE)* SRE species, which may include snails, millipedes, spiders and other sedentary groups, may occur on the southern and south-eastern aspects of the ranges. *Subterranean Fauna* No groundwater or underground habitat exists on the range to support stygofaunal forms. No underground habitat exists within the structural aquifers of the granitoids which underlie the lower scree slopes.	No impact, as Jack Hills project not located in habitat preferred by SRE species. Removal of subterranean fauna habitat by excavation of pit. No impact on the range. No impact of bores drawing water from granitoid aquifers.	None. None.	No impact. No permanent or adverse impact.
Groundwater quantity	To maintain the quantity of groundwater 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.	Some perched water lenses may occur in the range. No significant water flows were encountered in the geological formations of the range. Groundwater associated with structural aquifers in granitoids underlying the scree slopes. Shallow aquifers occur on the plains with water encountered at depths of 10 metres.	Up to 250,000 kilolitres of groundwater will be abstracted from four bores drawing water from granitoid aquifers for water supply. Minor volumes of groundwater from perched water lenses intersected during open pit mining will be dewatered.	Abstraction, monitoring and reporting activities will be conducted in accordance with the groundwater licence conditions. Groundwater monitoring programme will include: • Extraction volumes. • Water levels. • Water quality.	Groundwater reserves within the region will not be significantly reduced. Water level drawdown from bores within the project area will be localised. On cessation of mining they will recover to pre-mining levels. Water supply to pastoral bores should remain unaffected.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Surface water	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To maintain the quality of water so that environment values or the health, welfare and amenity of people and land uses are protected, by meeting statutory requirements and acceptable standards.	The Jack Hills project is located on the north-draining watershed of the Jack Hills Range, with many minor drainage lines. Creek flow is infrequent and associated with major rainfall events. Runoff rates from the catchment are typically high because of low permeability surfaces and steep slopes of the range which flow to numerous drainages and creeks on the plains. Extensive but shallow alluvial plains are associated with the Murchison River and its main tributaries.	Erosion and deposition of sediments and increased turbidity of run-off water as a result of construction of the waste rock stockpile, and other infrastructure. Increased run-off volumes and flow rates at the regional scale.	Impacts will be managed through appropriate surface water management. Water harvesting designs on the waste rock stockpile will be implemented to reduce run-off and promote revegetation.	Mining activities are not expected to have any significant impact on water flows or quality downstream of the mine site.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Pollution Management					
Groundwater quality	To maintain the quantity of groundwater 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.	Groundwater in the structural granitoid aquifers on lower scree slopes is fresh to brackish and suitable for both drinking water (once treated) and crushing and dust suppression usage. Waste characterisation indicates there is no potential for acid drainage. Minor concentrations of soluble contaminants that may occur within surface runoff and leachates from the waste rock stockpile will be ecologically acceptable.	Contamination of underlying groundwater from seepage of leachates from waste rock stockpile.	MML will implement a groundwater quality monitoring programme of monitoring bores during the mining and crushing operations.	It is not expected that the quality of the groundwater will be affected by the project: • No chemicals are used during crushing and raw water used is fresh to brackish. • Waste rock will not generate acid and leachates will contain negligible concentrations of contaminants. • Spills of hazardous materials will be cleaned up and the site remediated.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Surface water	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To maintain the quality of water so that environment values or the health, welfare and amenity of people and land uses are protected, by meeting statutory requirements and acceptable standards.	The Jack Hills project is located on the north-draining watershed of the Jack Hills Range, with many minor drainage lines. Creek flow is infrequent and associated with major rainfall events. Runoff rates from the catchment are typically high because of low permeability surfaces and steep slopes of the range which flow to numerous drainages and creeks on the plains. Extensive but shallow alluvial plains are associated with the Murchison River and its main tributaries.	Contamination of runoff water from contaminants or acid generated from waste rock stockpile.	Impacts will be managed through appropriate surface water management. Any spills of contaminants, such as oil or fuel, which occur outside of bunded areas will be cleaned up immediately where a risk of surface water contamination occurs. Waste characterisation indicates that there is no potential for acid drainage	Mining activities are not expected to have any significant impact on water flows or quality downstream of the mine site.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Air quality (dust)	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land use by meeting statutory requirements and acceptable standards.	Mining operations located in semi-arid area with high potential for dust generation. For most of the year, the prevailing winds of the project area will be from the east and south-east.	Fugitive dust will be generated from mining and blasting activities, vehicular movement and wind erosion. Generation of dust from blasting activities cannot be mitigated using water sprays. Dust generated from blasting in the pit will potentially impact on vegetation downwind of the pit at the time of the prevailing wind when blasting occurs. Potential dust deposition on sensitive vegetation, especially the upland *Triodia* plant communities of the Jack Hills Range, in close proximity to the open pit.	Site personnel will visually monitor dust levels during construction and operation of the project. Dust suppression measures will be instituted using water sprays and other means, as necessary. The implementation of a progressive rehabilitation programme will also reduce the risk of dust generation. Prevailing wind information will be utilised to, where possible, undertake blasting when wind directions are blowing away from the remaining T3 plant community, which is located in close proximity east and north-east of the pit. Dust minimisation, management and monitoring measures will be implemented in accordance with a dust management plan.	The potential for dust generation can be managed through standard dust suppression measures and by implementation of special procedures to be observed during blasting activities. There will be no off site impacts, as dust generation will be contained by the Jack Hills operations.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Air quality (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 gases are generated as a result of vehicle emissions and power generation.	Gaseous emissions will result from burning of fuels for the power station, generator sets, engine exhausts of earth moving equipment and mine vehicles. Greenhouse gases will also be released from vegetation clearing, natural decay and soil carbon release.	Vehicles and power generation equipment will be maintained to minimise emissions. Rehabilitation will be progressive and vegetation will replicate pre-mining conditions. Emissions will be reported as part of the National Pollutant Inventory.	Greenhouse gas emissions from power generation and mobile plant will be minimised by regular maintenance and efficient use of plant, vehicles and equipment. Vegetation clearing will result in mostly a temporary loss in the carbon sink and in the release of CO_2 over a five-year mining life.
Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	Nearest residence to the project is 30 kilometres distant.	Reduction in air quality through increased noise levels.	MML will ensure that (i) noise control equipment is operating correctly, and (ii) noise emissions comply with the requirements of the *Environmental Protection (Noise) Regulations 1997* and the *Mining Act 1978.*	As there are no noise sensitive premises in close proximity to the project area, noise impacts are expected to be minimal.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Waste products	**Soil Quality** To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria. **Water Quality** 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.	Rocky ranges with skeletal lithosols. Stony plains with shallow earthy sands and hardpan clay loams.	Wastes generated by the project include: • General domestic and office refuse. • Industrial wastes. • Hazardous wastes. • Sewage.	MML will implement management measures to minimise the potential for contamination of the surrounding environment due to general waste disposal.	Through appropriate management measures in accordance with standard industry practices there is expected to be minimal impact on the environment through generation and on-site disposal of waste products.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Dangerous and hazardous substances	**Soil Quality** To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria. **Water Quality** 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.	Rugged ranges and ridges with skeletal lithosols supporting *Acacia* shrublands and restricted *Triodia* upland vegetation. Undulating stony plains with shallow earthy sands and hardpan clay loams supporting sparse *Mulga* systems.	Crushing and screening do not require use of hazardous substances. Hydrocarbons are primary type of hazardous material required on site. Explosives will be stored on site.	All activities relating to the storage, handling and management of dangerous and hazardous substances will comply with relevant Australian legislation and standards. Correct hydrocarbon storage and handling measures will be implements. Explosives will be stored in a registered explosives magazine more than 500 metres from mining and crushing activities and will be managed by a registered explosives contractor. A register of all hazardous materials on site will be developed and maintained.	By implementing appropriate storage and handling measures in accordance with industry standards and practices, dangerous goods and hazardous substances used in the Jack Hills mining and crushing operations will not present a hazard or cause environmental harm.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Social Surroundings					
Aboriginal heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	No sites of cultural significance to Aboriginal people were identified within the project area. One archaeological site of low significance occurs within the pit layout. No objections or concerns were raised by the traditional owners regarding the project.	The archaeological site will be salvaged and relocated. No impact to Aboriginal cultural heritage.	MML will obtain permission from the Minister for Indigenous Affairs to disturb and relocate the archaeological site. MML will avoid any unnecessary disturbance and employees will be made aware of Aboriginal heritage issues. Comply with the requirements of the *Aboriginal Heritage Act 1972* and will seek advice from the Department of Indigenous Affairs in the event that any Aboriginal heritage sites are identified during the life of the project.	The heritage values of the Jack Hills project area and region have been identified through appropriate survey and consultation that will be ongoing during the project. The proposed Jack Hills project has been designed, and is expected, to have no impact on any Aboriginal cultural or heritage sites of significance.
Surrounding land use	To ensure that changes to the biophysical environment do not adversely affect current land uses in the area.	Project is located on the Mt Hale, Mileura and Beringarra stations.	Damage to or interference with pastoral activities	To ensure minimal disturbance to pastoral activities, MML will continue to liaise with pastoralists, fence mining area, monitor groundwater, instruct personnel to be aware of cattle, and minimising night driving.	Consultation with pastoralists has indicated that through implementation of management measures there will be no negative impacts.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Other					
Closure	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental value.	Rugged ranges and ridges supporting *Acacia* shrublands and restricted *Triodia* upland vegetation. Undulating stony plains supporting sparse *Mulga* systems.	Failure to adequately identify appropriate closure methods and adequately budget for them	During life of mine MML will regularly update its Decommissioning and Closure Plan to identify and make available the necessary budget.	All areas except for the pit (25.4 hectares) will be returned to a condition similar to the pre-mining environment.

1.6 SUMMARY OF ENVIRONMENTAL MANAGEMENT ACTIONS

Environmental management actions proposed by MML are listed in Table 1.4. For each action reference is made to the section in which it occurs within this report. These will form part of the conditions of mining approval from DoIR. Some of these actions may form part of the conditions of environmental approval from the EPA.

Table 1.4: Summary of Environmental Management Actions

No.	Management Action
Pit	
3.4.1	Wherever practically feasible, topsoil from the surfaces affected by the pit will be stripped and stockpiled for rehabilitation of the waste rock stockpile.
Waste Rock Stockpile	
3.6a	The waste rock stockpile will consist of a series of vertical lifts, up to 10 metres high, with a five-degree in sloping berm between lifts of 10 metres width. Final slopes of the lifts will be battered to no steeper than 18º.
3.6b	Topsoil will be directly striped and respread on an area available for rehabilitation. In the initial mine phase, completed areas on the waste rock stockpile will not be available. In this case, topsoil will be stockpiled. When areas on the top of the waste rock stockpile become available, direct return topsoil will be preferentially used before stockpiled topsoil.
6.3.3	The Waste Rock Stockpile will be designed to reduce the need to construct and maintain a comprehensive drainage system for the entire stockpile. This will include the following measures: • To prevent water from the top of the stockpiles eroding the batters, the upper surface of the Waste Rock Stockpile will be concave to provide an inward draining surface. • The upper surface of the Waste Rock Stockpile will also be compartmentalised with windrows to 0.5 metre to prevent water from collecting in a single area on the top of the stockpile. • The perimeter crest of the top of the stockpile and the leading edge of each berm will have a one-metre bund pushed up to contain water. • If available, rocky material and topsoil will be placed to a depth of about 150 millimetres over the shaped Waste Rock Stockpile. • The waste characterisation assessment (Appendix 2.5, Volume 2) has identified that dark green mafic schists and the browner BIF waste will blend well with the general landscape while also armouring the slopes and batters. • All topsoiled surfaces will be scarified on the contour to a depth of 300 millimetres. The first rip line between berms will be surveyed to ensure that it is horizontal. • The Waste Rock Stockpile will be seeded with local species, with a preference for local provenances, when available.
Roads and Transport	
3.10.2a	The 181 kilometre Beringarra-Cue public road will be upgraded to make it suitable for use by road trains. MML will continue to maintain this section of the road during the life of the project.
3.10.2b	The Beringarra-Cue public road will be upgraded with a bitumen-sand seal.
Preliminary Decommissioning and Closure Plan	

No.	Management Action
6.6	The Decommissioning and Closure Plan will be reviewed regularly through the operation to ensure it remains current and it will be implemented at the end of the mine life, which at present is estimated to be approximately five years. A timeframe for completion criteria will be developed in the subsequent version, within two years of project commencement.
Groundwater	

8.5.5a	A groundwater monitoring programme will be implemented by MML in accordance with a Groundwater Licence Operating Strategy and will include:
	• Fitting of flow meters to groundwater extraction bores to enable monitoring of extraction volumes.
	• Monthly monitoring of groundwater levels.
	• Collection of groundwater samples on a quarterly basis and analysis for the following:
	  • Samples to be filtered before analysis.
	  • pH.
	  • Electrical conductivity.
	  • Total dissolved solids (gravimetric and calculation).
	  • Ions – sodium, calcium, magnesium, chloride, potassium, bicarbonate, carbonate, sulphate, nitrate.
	  • Metals – aluminium, arsenic, barium, boron, chromium, copper, iron, manganese, lead, nickel and zinc.

8.5.5b	Data from the water monitoring programme will be collected and reviewed. Water quality results will be compared with existing baseline data and concentrations and trends analysed. Should the rate of drawdown be higher than expected or if the groundwater levels in bores used by pastoralists are found to decline to below regional groundwater level values, MML will seek to reduce drawdown by using alternative water sources.
8.5.5c	Water level and quality information will be reported to the DoE annually.
8.5.5d	The monitoring and management of groundwater abstraction and dewatering will be addressed in the Groundwater Licence Operating Strategy and will be reviewed and updated annually.
Surface Water	
8.6.5a	Impacts on surface water quality will be minimised by constructing bunds around mine infrastructure areas which have the potential to contaminate surface water flows with fuels, oils, sediment or other contaminants.
8.6.5b	Containment bunding, silt and oil traps will be established where necessary to remove sediments or pollutants from runoff before water enters local drainage.
8.6.5c	Any spills of contaminants, such as oil or fuel, which occur outside of bunded areas will be cleaned up immediately where a risk of surface water contamination occurs.
8.6.5d	Surface water management structures will be designed and constructed to minimise erosion.
8.6.5e	Diversion drains will be constructed to ensure water re-enters natural drainage lines at a velocity and depth that can be accommodated by the natural stream line without increased scouring. Regular visual monitoring will be undertaken of the diversion channels and downstream drainage lines, and the condition of vegetation in the diversion channels.
8.6.5f	Should substantial erosion occur, the cause of the erosion will be identified, erosion/ deposition areas rehabilitated as appropriate, and measures implemented to prevent further erosion.
8.6.5g	At closure, disturbed areas will be stabilised and revegetated to minimise erosion potential.
Vegetation and Flora	

No.	Management Action

8.7.5a	MML will implement the following measures during the project to minimise the impact on vegetation and maximise the conservation of the botanical values in the project area, namely:
	• The project layout has been designed to minimise the clearing of vegetation and clearing will be limited to that which is necessary for the completion of the first stage of the project. Any expansion will require further detailed investigations and approval.
	• Existing access tracks and transport routes have been used where possible.
	• New transport routes have been located away from areas of environmental sensitivity such as the range, granite outcrops and drainages as much as possible.
	• Pockets or strips of vegetation will be left undisturbed within areas cleared for infrastructure where the risk of fire, impacts on road safety or interference with mining operations is low.
	• As an alternative to clearing vegetation, areas of low shrub will be clearly marked out for laydown areas where this use is temporary only, and does not increase the risk of fire.
	• Areas to be cleared will be clearly defined on maps and the ground, and clearing activities will be supervised.
	• Vehicles and machinery are to be parked in designated areas.
	• Dust control measures will be implemented.
	• Access to the range, other than the pit area, will be restricted as follows:
	  • Only for MML personnel conducting environmental monitoring and exploration.
	  • MML induction will prohibit personnel from access to the range other than for monitoring, mining and exploration purposes.
	  • Signage prohibiting access on the entry points will be erected and maintained.
	• Conduct additional follow-up botanical surveys to include:
	  • Searches for Rare and Priority Flora will continue during the operational phase of the project.
	  • Searches for flora that are restricted or occur as range extensions will be investigated further in the field during the operational phase of the project, including additional targeted searching should be undertaken for species that occur as outliers and the three Priority species
	  • Additional detailed on-ground studies to clearly define the extent of the various Spinifex communities on Jack Hills, the Robinson Ranges and Mt Gould during the operational phase the project. The definition of the outer extent of Triodia communities was undertaken on the Jack Hills in October 2005.
	  • Undertake further integrated regional studies, in conjunction with CALM, to investigate and define the extent of the communities on the Jack Hills Ranges during the operational phase of the project.
	  • Establish permanent vegetation plots and monitor before, during, and after mining activities.

No.	Management Action

	• Management actions specific to the occurrence of rare, Priority and range extension flora are:
	  • *Acacia cockertoniana* (ms) – Undertake additional investigations into relative numbers in the different plant communities (as mapped) in order to clarify the potential impact of the proposed operations on this taxon at Jack Hills.
	  • *Verticordia jamiesonii* (Priority 3) – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
	  • *Lobelia heterophylla* subsp. *pilbarensis* – In view of the recent rains it is intended to undertake additional investigations into relative numbers both within the proposed impact area and outside the proposed impact area in coming weeks and also this taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
	  • *Amaranthus interruptus* – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
	  • *Calandrinia pleiopetala* – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
	  • *Eremophila pendulina* – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
	  • Implement rehabilitation procedures using data from mining activities in similar environments. Investigate the likely success for revegetation, addressing the issues of water relations, weed invasion, changes in topography and soil structure.
	  • Topsoil, rootstock and cleared vegetation will be retained in designated areas for use in rehabilitation.
	  • Disturbed areas will be progressively rehabilitated with native species and monitored.
	  • Respread topsoil over disturbed areas as soon as possible after clearing and stockpiling for short periods if direct return of topsoil is not feasible.
	  • Further collections of flora will be undertaken after higher seasonal rainfall events
	  • An environmental induction and awareness programme will be developed to raise the workforce awareness of conservation issues.
	  • Review other options for conserving the communities in the Jack Hills lease areas.

8.7.5b	Weeds will be controlled through prevention, monitoring and early eradication as follows: • Avoiding or minimising disturbance to areas with, or vulnerable to, weed infestation where practicable. • Inspecting vehicles and machinery for soil and seeds when entering the site and washing them in designated areas if required. • Inspecting disturbed and rehabilitated areas for weeds (particularly after rainfall events) and consulting with CALM and the Department of Agriculture as to the treating of infested areas. • Raising awareness of the workforce in weed control. • Rehabilitating disturbed areas progressively to discourage weed establishment.

No.	Management Action
8.7.5c	Weed prevention, management and monitoring measures will be implemented in accordance with a Vegetation Management Plan.
Fire Management	
8.7.5(d)	Fire management will be implemented in accordance with a Fire Management Plan.
Fauna	
8.8.5	The following measures will be implemented during the project to minimise the impact on fauna: • Clearing of vegetation will be restricted to the minimum necessary to implement the project. This will be achieved using the Murchison Metals Ltd internal "Permit to clear" procedures. • An egress will be provided at one end of pits and trenches to enable trapped wildlife to escape. • Drill hole capping will be regularly checked to ensure the integrity of the capping is maintained. • Open holes and trenches without egress will be inspected prior to 10:00am daily for trapped fauna. Trapped individuals will be released. • The environmental induction programme and ongoing provision of information will raise the awareness of the workforce about the conservation of fauna (particularly rare, threatened or vulnerable fauna) and their habitats. • Direct contact with fauna will be avoided whenever possible. • Vehicles and machinery will be parked in designated locations only to minimise habitat damage. • Refuse and the landfill site will be managed to prevent an increase in feral animal populations. • Feral animal deterrent measures and/or eradication programmes will be implemented in consultation with CALM, the Department of Agriculture and pastoralists. • Restricting traffic to established roads and parking areas.
Dust Management	
3.8.2	Dust will be suppressed by a high pressure water system in the crushing plant.
3.8.3	Dust suppression measures will include: • Water trucks will be used on a needs basis to spray water on operational surfaces to suppress dust. • The ROM stockpile area will be watered with either a water cart or sprinklers to suppress dust generation. • The unsealed haul road will be watered by water trucks to suppress dust.
3.10.4	Haulage trucks will have dust covers covering the ore in the trailers.
8.10.5a	Site personnel will visually monitor dust levels during construction and operation of the project. Dust suppression measures will be instituted using water trucks, spray bars and other means as necessary, in the event that high levels of dust are observed, and/or strong winds and dry conditions make dust generation likely.
8.10.5b	Site personnel will monitor dust deposition on the *Triodia* plant communities, and other vegetation communities visually and also using dust deposition gauges, to ensure there is no detrimental effect from dust.

No.	Management Action
8.10.5c	Prevailing wind information will be utilised to, where possible, undertake blasting when wind directions are blowing away from the remaining T3 plant community, which is located in close proximity east and north-east of the pit.
8.10.5d	Dust minimisation, management and monitoring measures will be implemented in accordance with a Dust Management Plan.
Air Emission	
8.9.5	The following management and mitigation measures will be implemented to minimise and control air emissions: • Vehicles and power generating equipment will be regularly maintained and serviced to manufacturer's specifications to ensure efficient running of equipment and optimum fuel consumption, thereby minimising exhaust emissions. • Rehabilitation will, where possible, be progressive and involve careful topsoil management and re-introduction of endemic species such that a self sustaining vegetation complex is established. • Emissions will be reported as part of the National Pollutant Inventory.
Noise	
8.11.5	MML will implement the following noise management measures to ensure that: • Noise control equipment on stationary and mobile equipment is operating correctly. • The noise emissions comply with the requirements of the *Environmental Protection (Noise) Regulations 1997* and the *Mining Act 1978*.
Waste Products	
8.13.5	MML will implement management measures to minimise the potential for contamination of the surrounding environment due to general waste disposal as follows: • General domestic and office waste will be disposed of to an on-site landfill, located above the water table. Currently there are no viable opportunities for the broad recycling of office and domestic wastes, due to the remote nature of the site. However, MML will, throughout the life of project, actively identify and look to apply, any viable opportunities for the recycling of office and domestic wastes. • Industrial waste will be disposed of to an on-site landfill, located in the waste rock stockpile. • Landfill cells will be located away from areas that may be subject to localised inundation and away from drainage lines. Surface water will be managed in the vicinity of the landfill cell to minimise runoff entering the cell. • The industrial landfill site will be regularly covered with soil to prevent access by animals and the occurrence of wind-blown litter. • The camp landfill site will be fenced and regularly covered with soil to prevent access by animals and the occurrence of wind-blown litter. • Waste oils, solvents and other hazardous material will be collected in drums and stored in a bunded area. These will be removed from site for recycling or disposal to an approved waste disposal facility. • Sewage generated during operations will be treated in approved systems and discharged to irrigation areas or leach drains. • During closure of the project, the landfill will be capped with a clayey soil layer and rehabilitated.

No.	Management Action
Dangerous and Hazardous Substances	
8.14.5	MML will implement management measures to minimise the risk of contamination of soil, surface water and groundwater and harm to employees at the site: • A register of all hazardous materials on site will be developed and maintained. This will document the hazardous material name, location, approximate volume, storage method and where applicable, disposal method for the substance and containers. • Fuel storage areas and workshops will be bunded in accordance with the DoIR and DoE requirements. • Runoff contaminated with hydrocarbons will be treated prior to discharge. • Absorbents will kept on site for minor spills. Staff will be trained on the use of the absorbents. • Oil spills in the workshop area will be directed to an oil-water separator. • Hydrocarbon spills will be cleaned up and contaminated soil will be remediated on-site. • Hazardous wastes generated by the operation will be transported offsite to licensed waste disposal facilities. This is likely to include waste oil, grease and heavy equipment fuel and oil filters. • Hazardous materials will be brought to the site in bulk packaging wherever possible. This practice will minimise the number of containers and reduce the risk of spillage. • All mobile equipment and light vehicle servicing activities including wash down will be conducted on impermeable surfaces. • The heavy vehicle workshop facility shall contain a purpose built wash down facility incorporating a triple interceptor style sediment and oil/grease removal system. • An explosives magazine will be constructed and operated in accordance with regulatory requirements. • Crushing activities will be conducted in areas where surface drainage can be captured to ensure overflows, spillages or leaks can be contained. • A Licence to Store Dangerous Goods will be obtained for the storage of all hazardous materials on site. • Spillages of hazardous materials will require incident reporting according to company policy and procedures. • All explosives will be transported by road from Perth or Geraldton and will be transported and stored in accordance with the *Mines Safety and Inspection Act 1994*, *Mines Safety and Inspection Regulations 1995* and *Explosives and Dangerous Goods Act 1961*.
Fuels and Oils	
3.14	A fuel storage log will be maintained and will include the following: • Types and volumes of fuel on site. • Location of storage facilities, storage methods, bunding and secondary containment. • Pumping, piping, transfer and separation procedures. • Maintenance, testing and audit procedures. • Waste fuel/oil collection and disposal procedures.
Surrounding Land Use	

No.	Management Action
9.1.3	Any disturbance to stock and pastoral activities arising from the project's implementation will be minimised through the following measures: • MML will liaise with the pastoralists throughout the life of the project. • The mining operations will be fenced and unused test pits and drill holes will be backfilled. • The site induction will instruct all personnel on pastoral lease activities around the project site and compliance with Company Policy requirements. • Night driving outside the Jack Hills operational area will be minimised. • The waste landfill site will be fenced and waste will be regularly covered to prevent stock entering and litter escaping. • Water levels will be measured regularly in regional bores to monitor the impact of water abstraction from the water supply bores and whether pastoral water supplies will be affected.
Aboriginal Heritage	
9.2.5	MML will avoid any unnecessary disturbance to any identified Aboriginal heritage sites. Management and mitigation measures that will be implemented to achieve this will include: • The general site induction will include information regarding the importance of cultural sensitivity, respect for land and protection of items of heritage significance. All employees and contractors will be required to participate in this induction. • Raising workforce awareness on Aboriginal heritage issues, including measures for protecting Aboriginal sites identified during Aboriginal surveys or discovered during operations. • All employees and contractors will be advised of the correct procedure to be followed in the case of any items of potential heritage significance being discovered during mining. • Comply with the requirements of the *Aboriginal Heritage Act 1972* and will seek advice from the Department of Indigenous Affairs in the event that any Aboriginal heritage sites are identified during the life of the project.

1.7 SUMMARY OF COMMITMENTS

Environmental commitments made by MML in regards to the Jack Hills project are outlined in Table 1.5.

Table 1.5: Summary of Commitments

No.	Topic	Objective	Action	Timing	Advice
1	Environmental Management	To avoid, minimise or mitigate impact to the environment	Implement environmental procedures and management plans that address the management or avoidance of impacts to the environment such as impacts to: • Weeds. • Groundwater quantity and quality. • Surface water. • Vegetation and flora. • Fauna. • Air, including dust impact. • Heritage. • Surrounding land use. And the management of: • Fire. • Noise. • Waste. • Dangerous and hazardous substances.	During Construction	Received during preparation and assessment of EPS
2	Environmental Management	To avoid, minimise or mitigate impact to the environment	Environmental performance achieved as a result of the environmental procedures and management plans will be audited, and procedures reviewed as necessary	During Construction	

No.	Topic	Objective	Action	Timing	Advice
3	Environmental Management	To avoid, minimise or mitigate impact to the environment	Implement environmental procedures and management plans that address the management or avoidance of impacts to the environment such as impacts to: • Weeds. • Groundwater quantity and quality. • Surface water. • Vegetation and flora. • Fauna. • Air, including dust impact. • Heritage. • Surrounding land use. And the management of: • Fire. • Noise. • Waste. • Dangerous and hazardous substances.	Operation	
4	Environmental Management	To avoid, minimise or mitigate impact to the environment	Environmental performance achieved as a result of the environmental procedures and management plans will be audited, and procedures reviewed as necessary	Operation	
5	Environmental Management	To avoid, minimise or mitigate impact to the environment	MML will employ the services of suitably qualified personnel who will maintain a presence on site which is appropriate to the scale of the mining operation and different phases of implementation.	Operation	

No.	Topic	Objective	Action	Timing	Advice
6	Vegetation and Flora Surveys	To establish the further extent of conservation, significant flora species and plant communities.	MML will conduct follow-up botanical surveys to include: • Searches for rare and priority flora and flora that are restricted or occur as range extensions • Definition of extent of Spinifex communities on Jack Hills, the Robinson Ranges and Mt Gould • Integrated regional studies in conjunction with CALM, to define extent of plant communities on Jack Hills.	Operation	
7	Vegetation Monitoring	To monitor impact of mining activities on vegetation	MML will establish permanent vegetation plots and monitor before, during and after mining activities	During Construction and Operation	

2. INTRODUCTION

2.1 BACKGROUND

The Jack Hills Iron Ore Project occupies a portion of Mining Lease 20/506 in the Murchison region of Western Australia. MML proposes to open pit mine 1.0 to 1.8 million tonnes of iron ore per annum, which will be crushed and screened on-site before being transported by road to the Geraldton Port where it will be stockpiled before being shipped on a Free On Board (FOB) basis to overseas markets.

The haematite mineralisation at Jack Hills has been the subject of several exploration programmes since 1967. Most of historical exploration activity in the Mt Hale area was performed by Murchison Minerals Pty Ltd in 1970 and 1971 and by Northern Mining Corporation NL in 1973. There is record of Itoh & Co undertaking work in the late 1960's although no reports have been sighted. Work completed by Murchison Minerals included an extensive mapping and sampling programme that included the drilling of three diamond and ten percussion holes. Northern Mining Corporation extended the Murchison Minerals programme by undertaking a detailed programme that included fifty-nine percussion holes and the construction of an underground audit for a bulk test. During the late 1990s, Kingstream Steel Ltd recommenced exploration of the Mt Hale area for iron ore with work limited to reconnaissance rock chip sampling and data gathering of historical and remote sensing information.

In addition to iron ore, the Jack Hills have been explored for uranium (Nord Resources 1977/78), copper and nickel (Day Dawn Mines 1969/71, Western Mining Corporation 1969/72) and gold (Battle Mountain Australia Inc 1986/87). These programmes found nothing of significance.

MML submitted a Notice of Intent (NOI) and an Application to Clear Vegetation in August 2005. Further to the submission of the NOI and subsequent consultations with the EPA and CALM, the EPA advised that additional information was required to determine the level of assessment of the Jack Hills project.

The Jack Hills project raised several environmental factors, including:

- Mining on Banded Iron Formation (BIF).
- Impacts on vegetation and vertebrate fauna.
- Potential presence of short range endemic species and subterranean fauna.
- Visual amenity.
- Geoheritage.

In a letter of 15 September 2005 (Appendix 1, Volume 1) the Department of the Environment and Heritage (DEH) advised that the Jack Hills project is not a controlled action and no further approval is required from the Commonwealth.

On 23 December 2005 the Jack Hills proposal was referred to the EPA, who advised in a letter of 2 January 2006 (Appendix 1, Volume 1) that the project had the potential to be assessed as an EPS. This advice was advertised by the EPA in *The West Australian* on 23 January 2006.

Extensive consultation with regulatory authorities and stakeholders has been an integral part in the development and assessment process of the Jack Hills project.

2.2 OBJECTIVES

The objectives of this EPS are to:

- Describe all components of the proposal.
- Place this proposal in the context of the local and regional environment.
- Outline the potential environmental impacts resulting from the proposal, including cumulative impact, and develop management and mitigation measured to minimise potential impacts.
- Communicate clearly with stakeholders (including the public and government agencies), so that the EPA can obtain informed comment to assist in providing advice to government.
- Provide a document that clearly sets out the reason why the proposal should be judged by the EPA and the Minister for the Environment to be environmentally acceptable.

2.3 PROPONENT DETAILS

The leases covering the project are beneficially held by Murchison Metals Ltd (ACN 078 257 799), which is a publicly listed mining company. All correspondence pertaining to the proposal should be sent to Mr Frank Sibbel, Project Manager, Murchison Metals Ltd.

Address:	Level 1 610 Murray Street West Perth WA 6000
Postal address:	PO Box 904 West Perth WA 6084
Contact:	Frank Sibbel, Project Manager
Telephone:	08 9483 0500
Fax:	08 9481 7966
Email:	fsibbel@mml.net.au

The project is to be operated by MML (the Proponent) through its 100 percent acquisition of Iron Jack Pty Ltd.

2.4 LOCATION

The Jack Hills Iron Ore project is located about 350 kilometres north-east of Geraldton and 100 kilometres west of Meekatharra in the Murchison region of central Western Australia (Figure 1). The project area comprises the proposed pit, crushing plant and camp located on Mining Lease M20/506. The main access to the project area from Cue will be via a haul road from the Beringarra-Cue public road. This haul road route is covered by

Miscellaneous Licence 20/47 and Miscellaneous Licence Application 20/53.

2.5 LAND TENURE

MML is the beneficial holder of M20/506, E20/535, L51/85 and L20/47 and applicant of L20/53 (Figure 2).

Mining Lease M20/506 covers an area of 1,000 hectares and was granted on 21/10/2005. The lease is subject to the exploration and mining regulations under the Western Australian *Mining Act 1978*. The term of the Mining Lease is 21 years with the right to take successive renewals for further periods of 21 years. The Mining Lease area and surrounding land is Crown Land. There is no Freehold Land affected by the proposed mining activities.

Exploration Licence E20/535 covers eight blocks. The term of the licence is for five years from 23 March 2005 to 22 March 2010.

Miscellaneous Licence L20/47 was granted on 15 November 2005. The term of the licence is for 21 years. It includes the haul road from the project site and a proposed airstrip location. This location is no longer required, as MML will upgrade and use the existing Mt Hale airstrip. The total licence area covers 427.5 hectares. Miscellaneous Licence application 20/53 was submitted to DOIR on 13 April 2006. Re-alignment of the haul road to minimise impacts to flora species of conservation significance requires the addition of this licence to the project.

The Jack Hills project area is situated on the pastoral leases of Mount Hale, Mileura and Beringarra.

The Jack Hills project area is located in an area that involves two registered Native Title claims and one new claim that is subject to the registration test. The proposed mine is within the Ngoonooru Wadjari Native Title Claim (WC 00/012) while the haul road and bores involve both the Ngoonooru Wadjari and Wajarri Elders (WC 01/003) Native Title Claims. The two claim groups have lodged a new combined claim known as the Wajarri Yamatji Native Title Claim. This Claim is currently being assessed by the National Native Title Tribunal for registration.

MML has negotiated with both claim groups. These negotiations have resulted in a comprehensive mining agreement under which the Native Title parties have agreed to the grant of project tenures in return for a package of benefits involving monetary benefits as well as initiatives relating to training, employment, contracting, heritage protection, cultural awareness training and an ongoing consultation mechanism.

Following the signing of this Project Agreement in September 2005, the Native Title parties have signed State Deeds and withdrawn objections to facilitate the grant of the project titles.

Under the Project Agreement the Company is committed to the maintenance of high standards of environmental planning and management and compliance with all relevant environmental laws and approvals. Rehabilitation will aim to revegetate disturbed areas with native plant species of similar abundance and density to that existing before the disturbance.

The Company has also agreed to provide the Native Title party with copies of

environmental approval documents, management plans and assessment reports. Any environmental concerns raised by the Native Title party will be addressed and where possible they will be involved in environmental management work associated with the project.

2.6 TIMING OF OPERATIONS

The proposed timing of operations is directed toward having the crushing and screening plant equipment delivered and commissioned by July 2006. Key dates are as follows:

- Commence construction of mining infrastructure, crushing plant and pre-production mining – May 2006.
- Handover to MML and commence production – May/June 2006.

MML is seeking environmental approval for the Jack Hills project by May 2006 in order to meet these proposed development timelines.

3. PROPOSAL

3.1 KEY CHARACTERISTICS OF THE PROJECT

The total area of disturbance associated with the Jack Hills project is anticipated to be approximately 127.7 hectares. The key characteristics of the Jack Hills project are presented in Table 3.1 and the proposed site layout is presented in Figures 3, 4, 5 and 6.

Table 3.1: Characteristics of the Proposed Jack Hills Iron Ore Mine and Crushing Plant

Element	Description
Life of project (mine production)	5 years
Size of orebody: • Ore • Waste	 8.16 million tonnes (1.99 million bcm) 32.7 million tonnes (10.94 million bcm)
Depth of mine pit	Approximately 140 metres below ground surface (on highest side of range)
Area of disturbance (including pit, associated infrastructure and access)	127.7 hectares
Mine operation	12 hours, 7 days a week
List of major components: • Open cut pit • Run of Mine (ROM) pad • Topsoil and low grade stockpiles • Waste rock stockpile • Crushing and screening circuits • Generators for camp and administration/workshop areas • Fuel farm • Production bores • Monitoring bores • Haul roads and other access roads • Laydown areas • Mine administration offices and contractor's workshops • Borrow pits for construction materials • Other supporting infrastructure	Refer to Figures 3 and 4 (mine layout), Figure 5 (haul road route) and Figure 6 (crushing plant layout)
Crushing: • Design rate • Annual rate	 Approximately 350 tonnes/hour (based on 12 hr day) Approximately 1.8 million tonnes pa

Element	Description
Waste rock stockpile:	
• Level difference	80 metres
• Slope batters	18°
• Lifts	10 metres
Water supply:	
• Source	4 production bores (within granitoid structural aquifer)
• Annual requirement	250,000 kL
Power supply:	
• Crushing plant	670 kW (diesel hydraulic – not requiring electricity)
• Accommodation camp	500 kW
• Administration/workshop area	100 kW
• Bores	50 kW
Fuel storage capacity and quantity used	
• Mining and crushing (2 tanks)	220 kL
• Accommodation camp (1 tank)	20 kL

The visual impact of the Jack Hills project, following decommissioning of the mining operations, is shown in three-dimensional computer generated views based on an aerial photograph draped over the regional contours of the area (Visual Plates 1 to 3).

3.2 SITE SELECTION AND LAYOUT

The overall site layout (Figures 3 and 4) shows the position of the open pit and proposed location of the crushing plant, ROM pad, waste rock stockpile, and supporting mining infrastructure. Figure 5 shows the alignment of the haul road to Beringarra-Cue Road.

The design and location of the mining, crushing/administration infrastructure, camp and roads have taken into account environmental and engineering constraints that include:

- Drainage and breakaways associated with the Jack Hills Range.
- Vegetation communities associated with BIF.
- Priority flora known to occur on the range and haul road route.
- Natural drainage features on the plain.

3.2.1 Waste Rock Stockpile

The waste rock stockpile was previously located west of the pit over *Triodia* hummock grassland vegetation community and associated drainage and breakaway features associated with the Jack Hills Range.

The waste rock stockpile has now been sited north of the pit at the foothills of the Jack Hills Range. The footprint of the waste rock stockpile has been reduced by increasing the height of the waste rock stockpile and making use of the more efficient storage capacity

of the underlying landform. Portions of the scree slope and granite outcrop will be impacted, however these features are well represented within the region and of less value than the area associated with the original waste rock stockpile location.

3.2.2 Haul Road and Access Roads

The haul road was originally located near to the north-facing foothills of the Jack Hills Range. For engineering and drainage reasons, the road alignment is now located further onto the plains, which are well represented in the region. Following targeted flora surveys in March 2006, the haul road has subsequently been re-aligned along three sections of the proposed route to avoid recorded populations of the Priority 1 *Gunniopsis divisia* and minimise the impact of Priority 1 *Calytrix verruculosa*.

The access road to the accommodation camp and to the Mt Hale airstrip will be located on existing station roads and tracks.

3.2.3 Airstrip

The airstrip was originally located on the plains north of the new haul road alignment. MML has now arranged to upgrade the existing Mt Hale airstrip located further east of the Jack Hills project area, thereby avoiding the need to clear up to nine hectares.

3.2.4 Crushing Plant and Administration Area

The crushing plant and administration area has been located onto a higher-lying area within the terrain to minimise upstream catchment runoff and adjoining drainages on the plains.

3.3 SITE PREPARATION

Site preparation activities will be conducted prior to, and concurrently with, the mining operations. Areas to be cleared will be outlined by survey and delineated in the field with survey pegs and flagging tape before clearing commences.

The open pit, ROM pad, waste rock stockpile, crushing plant, ore stockpile areas and other infrastructure sites will be cleared of vegetation by bulldozer. Vegetation will be stockpiled with topsoil for re-spreading over the areas during rehabilitation. Topsoil will be removed to a depth of up to 200 millimetres from these cleared areas and placed in stockpiles not exceeding two metres in height for use in future rehabilitation work. Other than the stockpiling of topsoil from the initial footprint of the waste rock stockpile topsoil will be directly returned onto progressively rehabilitated landforms during waste rock stockpile construction.

Topsoil stockpiles will be situated adjacent to where they will be used in rehabilitation, whilst being appropriately positioned so that they are not eroded by surface water or traffic. The exact location of the topsoil stockpiles has yet to be determined and this will be decided following a field inspection.

3.4 MINING OPERATIONS

3.4.1 Mining Schedule and Method

Mining will be by conventional open cut methods, involving drilling, blasting, excavation using diesel powered hydraulic excavators and dump trucks.

The deposit occurs as near vertical lenses and the initial pit is centred on the H3 and H4 lenses (Figure 7). The lode areas have been identified based on the previous exploration drilling and bulk testing and recent exploration drilling. Additional lode areas will be developed following future definition drilling. Figures 3 and 4 show the location and size of the current conceptual pit, waste rock stockpile and associated infrastructure.

Initial production is scheduled for one million tonnes per year increasing to 1.8 million tonnes per year after year one. On the current reserve model, mine life is anticipated to be five years.

Table 3.2 outlines the five year mining schedule for the Jack Hills Iron Ore project.

Table 3.2: Five Year Mining Schedule

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Ore (tonnes) (000,000's)	1.24	1.42	1.74	1.93	1.83	8.16
Ore(bcm) (000,000's)	0.36	0.35	0.41	0.44	0.43	1.99
Waste (tonnes) (000,000's)	3.69	5.86	8.06	8.93	6.17	32.70
Waste(bcm) (000,000's)	1.23	1.96	2.69	2.99	2.06	10.94

Mining of the ore lenses within the host rock will be undertaken by the conventional open cut method of drilling, blasting and excavation using hydraulic excavators and dump trucks. Mining will be undertaken by an experienced open pit mining contractor under the supervision of MML personnel.

Wherever practically feasible, topsoil from the surfaces affected by the pit will be stripped and stockpiled for rehabilitation of the waste rock stockpile **(Management Action 3.4.1)**.

The ore may be blended from different areas in the pit to produce a final product suitable for export. Ore will be stockpiled separately at the ROM to enable blending, if required.

Backfilling of the open pit is not an option for the following reasons:

- Backfilling open pits with waste is typically used for massive tabular orebody type deposits when the deposit is initially mined to full depth at one end and then mined out along its extent, normally in the direction of strike. Using this strategy would normally require an external dump in the initial stages of mining. The Jack Hills orebody is not a massive tabular orebody type deposit and as such is not amenable to this type of mining strategy.
- Backfilling is usually only cost effective if it can be done in step with the mining activities and not after. The cost of supporting a mining fleet for the purpose of backfilling the open voids would render the project uneconomic.
- Backfilling can be implemented in situations with an exhausted open pit, in close proximity to a developing open pit. The current proposal does not have an existing

open pit void available. If the ore body geology extends beyond the base of the current pit floor, future economics may make it feasible to deepen the pit. Backfilling in this situation would preclude this option and is not recommended.

3.4.2 Pit Design

The pit will be up to 140 metres depth, which, due to topographical variations will result in wall heights ranging from 80 metres in the flank of the hill, to approximately 140 metres where mining cuts into the hill.

Initially up to two smaller pits may be excavated within the pit layout to eventually form one larger pit. These pits will be entered via a ramp with a typical slope of one vertical per 10 horizontal units along its centre line.

The pit will be mined in five metre flitches in ore and up to 10 metre flitches in waste with five metre wide berms at $\leq$10 metre intervals. A strict grade control will be implemented with laboratory testing of all drill samples. An overall slope of up to 45 degrees will be applied to all pit walls, following a geotechnical assessment. The stability of the pit walls will be monitored regularly.

Assuming a bulking factor of 30 percent, it is estimated that on completion of mining, the total volume of waste from the pits will be about 14 million loose cubic metres (lcm). The waste will be used to build the waste rock stockpile and will cover an area of 52.6 hectares.

A safety bund in compliance with the requirements of the DoIR will be established around the pit.

3.4.3 Pit Dewatering

There are minor isolated perched water lenses located within the pit, but these are not expected to be large due to the elevated location of the proposal. Information on wet samples from drilling logs has shown that water has been intercepted from differing depths in the same drill hole indicating perched water. For example drill hole MHRC003 produced wet samples at 15 depths between 0 and 142 metres, whilst the other drill holes did not produce wet samples until 90 metres. Of the 58 drill holes investigated, only eight holes produced wet samples.

Water ingress from intersection of perched water lenses and incident rainfall is expected to result in small volumes to be dewatered. Minor seepage from perched water bodies and incident rainfall within the pit will be pumped from in-pit sumps and the water used for dust suppression.

3.4.4 Equipment and Machinery

Machinery and equipment will include the following or similar, although it must be stressed that considerable flexibility in the choice or machinery and equipment will be required:

- Excavators: 1-2 x 120 tonnes.
- Dump trucks: 4-8 x 85 tonnes.
- Dozer: 1 x Cat D9N.

- Wheel water cart 1 x 50,000 litres.
- Grader: 1-2 x Cat 16G.
- Drill rig: 1-2 x 125 millimetre diameter.

3.4.5 Blasting and Explosives

Drilling and blasting will be undertaken by the mining contractor under the control of a nominated person who is a holder of a Western Australian Shotfirer's Certificate. Blasting will only be conducted at times set by MML in accordance with the *Mine Safety and Inspection Regulations 1995*.

Explosives will consist of ANFO as a primary explosive, booster primed with delay timed, non-electric downlines. Where wet holes are encountered, packaged or bulk emulsion explosive, such as Powergel, is envisaged, with the same form of initiation.

A surface primary explosives magazine and detonator magazine will be established in conformance with the *Explosives and Dangerous Goods Regulations 1992*.

All explosives will be transported from the magazine to the pit using vehicles, which are licensed under the *Explosives and Dangerous Goods Act 1961*, and the Australian Code for the transportation of explosives by road and rail.

3.5 CRUSHING OF ORE

The crusher will consist of a closed circuit mobile jaw crusher, two mobile deck screens, a mobile secondary cone crusher and two product stackers. Figure 6 shows the layout of the crushing and screening plant. The site is relatively flat and will require minimal earthworks. It is proposed to use a contractor to undertake the crushing of the ore. Two products will be produced from the crushing and screening plant. Lump ore will be plus 6.3 millimetres and minus 32 millimetres and fines will be less than 6.3 millimetres in size.

Run-of-mine (ROM) ore will be delivered by haul trucks and dumped onto the run-of-mine pad and stockpiled by ore type. A front-end loader will be used to reclaim and transport ore from the stockpiles to the ROM bin.

A comprehensive dust suppression system will be installed, involving water spray injection at each transfer point and screen. The ROM stockpile and product stockpile areas will be watered with either a water cart or sprinkler to suppress dust generation.

3.6 WASTE ROCK STOCKPILE

Approximately 11,000,000 bcm (14,000,000 lcm) of waste rock will be dumped into one waste rock stockpile located 1.2 kilometres north of the pit, at the foothills of the range on a scree slope and low granite outcrop. It will be constructed to levels 205 metres below the ridgeline of abutting hills. The toe of the stockpile will be at levels of 385 metres AHD and the upper crest at levels of up to 465 metres AHD, which is a difference of 80 metres.

The waste rock stockpile will consist of a series of vertical lifts, up to 10 metres high, with a five-degree in sloping berm between lifts of 10 metres width. Final slopes of the lifts will be battered to no steeper than 18º **(Management Action 3.6a)**. The final footprint of the proposed waste rock stockpile is 52.6 hectares and is shown in Figures 3 and 4. Typical cross-sections of the waste rock stockpile are provided in Figures 8 and 9. These standards conform to the 'Guidelines for Mining in Arid Environments' published by DME (1996).

The waste rock stockpile will be constructed primarily using a 'top-down' construction method by dumping waste rock from the uppermost levels of the stockpile layout adjacent to the scree slope to form the top lift and advancing (downslope) in steps to form lower lifts The bottom lift may also be constructed using a 'bottom-up' method, the method commonly used in construction of the gold mine stockpiles in the region, by dumping waste rock along the lower slopes which form the outer perimeter of the bottom lift.

Topsoil will be progressively stripped from the lower (more gentle) slopes of the waste rock stockpile footprint in advance of the tipping face. Topsoil will be stripped from approximately 415-420 metres AHD, depending on the steepness of the slope, to the lower edge of the waste rock stockpile.

The objective is to directly strip topsoil and respread it on an area available for rehabilitation. In the initial mine phase, completed areas on the waste rock stockpile will not be available. In this case, topsoil will be stockpiled. When areas on the top of the waste rock stockpile become available, direct return topsoil will be preferentially used before stockpiled topsoil **(Management Action 3.6b)**.

A bulldozer will progressively shape the final stockpile surfaces. The need for reshaping will be kept to a minimum by adopting an appropriate dumping schedule. Rehabilitation of the waste rock stockpile will consist of spreading topsoil over final surfaces to a depth of approximately 150 millimetres and scarifying on the contour to a depth of about 300 millimetres to create conditions necessary to establish self-sustaining native vegetation. The ripping will greatly enhance water infiltration and substantially reduce runoff.

The waste rock stockpile will be designed to prevent water from the top of the stockpile draining down the batters and causing erosion. The top surface will be concave to provide storage capacity for water to then infiltrate into the waste rock stockpile. The top will also be graded to establish compartments for water storage and infiltration. This policy will enhance establishment and survival of native vegetation on the top of the waste rock stockpile.

The overall aim will be to create surface conditions that enhance establishment of self-sustaining native vegetation. Most of this vegetation will be established from the seed bank in salvaged topsoil. In the event that seed is required, then only species native to the region will be used.

Rehabilitation of the waste rock stockpile will result in a stable landform with an erosion-resistant surface and revegetation that will establish self-sustaining native vegetation. This will provide additional surface stability and establish habitats for local fauna.

3.7 DRAINAGE AND SURFACE WATER DIVERSION

The main mining contractors fuel facility will use self bunded storage tanks. Bunding will be constructed around other mine hydrocarbon storage areas that may potentially contaminate surface water with fuels, oils and sediment or other contaminants.

Surface water diversion drains will be rock armoured where necessary to prevent erosion and revegetated to a similar condition to the existing drainage lines.

The workshop site will be located on a site that incorporates a hydrocarbon recovery system. The crusher and ROM pad area will drain to a central sump to enable containment of any contaminate spillage.

Flooding of the pit is not considered to be a significant factor as the pit does not intercept major drainage lines and is located high in the landscape. Nevertheless, the pit safety bund, as required by DoIR, will also serve to divert surface runoff that has the potential to enter the pit.

3.8 WATER SUPPLY

All water required for the mining and crushing operations will be obtained from new bores, which will be developed in structurally controlled aquifers in the weathered granitoids at the foothills of the range. The total annual water requirement for the project is estimated at 250,000 kilolitres. MML has a Licence to Construct or Alter Well number CAW158131(1) (Appendix 1.2, Volume 1) and is currently drilling to determine suitable locations within this tenement. Once the location of the bores has been finalised, separate approvals to develop these bores will be secured from DoE. The Licence to Construct or Alter Well has been obtained from the DoE with the permission of the pastoralists involved.

3.8.1 Potable Water

The daily potable water requirement is estimated to be about six kilolitres. This will be pumped from the nearest freshwater bore and stored in a potable water tank on site. Should the bore water quality not be to potable standards, a reverse osmosis (RO) plant will be installed to provide potable water quality. To date the indications are that the water quality is of potable standard and no RO treatment will be required.

3.8.2 Crushing Plant

Dust will be suppressed by a high pressure water system in the crushing plant **(Management Action 3.8.2)**.

Dust prevention methods shall include:

- Water sprays operating in the primary crusher feeder/hopper (F01) through the

crushing operation (CR01), along with fully skirted under conveyor (CV01) to the first transfer point where the head end will be fitted with a frame and canvas cover.

- Conveyor hoops shall be fitted to all external conveyors from hopper exits to just short of the head drums (CV02, 8, 10, 11, 12, 13 and 14) for fitment of full coverage canvas if required.
- Full skirting on all "under conveyors" (CV3 and 4) along with canvas coverage on selected perceived high dust areas (CV05, CV06, CV07 and CV09).
- Head chutes (CV10), head chute with sampling station (CV07 and CV04) and canvas socks on selected transfer points (CV11 to CV12 and CV13 to CV14)and frame and canvas protection on other transfer points excepting CV08 to F02 and CV03 to CV08, both of which will be carrying extensively oversize only.
- All plant will be equipped with water spray facilities, complete with shut off/turn on control at each station for use when and if required.

3.8.3 Dust Suppression

Bore water will be used for dust suppression within the pit, on roads and during waste rock stockpile construction requiring an annual supply of up to 120,000 kilolitres. The local groundwater has a total dissolved solids (TDS) concentration of approximately 1,000 milligrams per litre.

Dust suppression measures **(Management Action 3.8.3)** will include:

- Water trucks will be used on a needs basis to spray water on operational surfaces to suppress dust.
- The ROM stockpile area will be watered with either a water cart or sprinklers to suppress dust generation.
- The unsealed haul road will be watered by water trucks to suppress dust.

3.8.4 Fire Water

There will be no reticulated fire water at Jack Hills. Fire protection will be by use of hand held extinguishers within buildings and with a fire protection trailer providing plant coverage at Jack Hills. The trailer will have fire hoses, a 900-litre water container and a fire pump.

All mining equipment and generating sets will be equipped with fire extinguishers.

3.9 POWER SUPPLY

The electrical power supply for the Jack Hills Project will be provided by diesel-powered generators as follows:

Facility	Generator	Fuel Storage Capacity
Camp	500kW	20,000L
Bores	50kW	5,000L
Administration/ workshop area	100kW	Will be taken off the main mining storage, which consists of 2 x 110,000L self-bunded tanks

The crushing plant will be powered by diesel hydraulics which do not require electrification.

Fuel storage at each of the generators will comply with AS1940-2004: The Storage and Handling of Flammable and Combustible Liquids.

3.10 ROADS AND TRANSPORT

3.10.1 Access and Trucking Arrangements

Access to the Jack Hills project area is on highways, local roads and miscellaneous licences. Figures 1, 2 and 5 show the haulage route from the project area to Geraldton. The haul route from the mine to the Port of Geraldton is approximately 605 kilometres, with the staging point being the town of Cue. The Great Northern Highway from Perth and the Geraldton-Mount Magnet Road are the main access routes, from Perth and Geraldton respectively, to the town of Cue. Main Roads WA manages these roads.

The practicalities of shift rosters, haulage distance, loading at the site and unloading at Geraldton will mean that the haulage contractor will have the haulage fleet located at the mine site, Cue and Geraldton. This will require driver accommodation and truck assembly facilities at all three locations.

At Cue, a truck assembly area is required to cater for overnight stops for the drivers. MML is negotiating with Harmony Gold to utilise an existing cleared area at the mine site, some five kilometres north of Cue. This location is adjacent to the haul route itself, so there will be no need for road trains to deviate from the proposed route.

3.10.2 Beringarra-Cue Public Road

The main access to the project area from Cue will be via the Beringarra-Cue public road, which is currently an unsealed gravel road. The 181 kilometre Beringarra-Cue public road will be upgraded to make it suitable for use by road trains. MML will continue to maintain this section of the road during the life of the project **(Management Action 3.10.2a)**. The management of this road will be to the requirements of the Shires of Cue and Murchison.

The road will be upgraded with a bitumen-sand seal **(Management Action 3.10.2b)** as shown in Plate 1. This has the benefit of dramatically decreasing the need for ongoing

dust suppression and grading maintenance.

Plate 1:Bitumen Sand Seal

3.10.3 Haul Road from Mine Site to Beringarra-Cue Public Road

The length of haul road to be cleared will be 23.4 kilometres long and 14 metres wide (36.4 hectares). The haul road for the project is located on Miscellaneous Licence 20/47 and Miscellaneous Licence application 20/53

Three borrow pits of 0.5 hectare each will be excavated along the haul road route within the Miscellaneous Licences. The borrow pits will be a maximum three metres deep and will be sources of cladding for the haul road.

Water bores and standpipes will be constructed within Miscellaneous Licence 20/47. The water will be used for construction and dust suppression along the haul route.

3.10.4 Dust Management Measures

Haulage trucks will have dust covers covering the ore in the trailers **(Management Action 3.10.4)**. The unsealed haul road on the mine site will be watered by water trucks to suppress dust.

3.10.5 Consultation with Authorities and Landowners

Consultation and haul road related correspondence from local government, Main Roads WA, pastoralists and other leaseholders is discussed in Section 7 and provided in Appendix 2.1. MML is continuing negotiations to finalise agreements with these parties to allow haulage to occur.

3.11 AIRSTRIP

An agreement has been entered into with the lessors of the Mt Hale station where MML has the right to use an airstrip approximately five kilometres north-east of the proposed mine. The airstrip was constructed in the early 1970s in support of the exploration programmes at that time. It consists of three strips that form a triangle; the longest strip is approximately 1,200 metres long. The strip will be upgraded and fenced for use in the fly in fly out operations.

3.12 BUILDINGS

3.12.1 Administration Complex

A transportable administration office and first aid room, approximately 170 square metres in area, with reverse cycle air conditioning will be provided. Offices will be available for senior supervisory personnel. A conference room and open areas for geological mapping, survey and mine planning will be provided. The office will be provided with furniture, photocopier, facsimile and a personal computer network complete with printers and software.

3.12.2 Contractors Yard and Workshop

A steel frame, colourbond clad workshop, approximately 170 square metres in area, will be established. A transportable stores/maintenance office will be attached to the workshop and a fenced storage yard will be located adjacent to the workshop. The workshop area will drain to an oil-water separator that will be regularly maintained.

3.13 HOUSING AND ACCOMMODATION

The proposed camp will consist of approximately 100 single room demountables with en-suite, a dry-mess, wet-mess, recreational facilities, a small store and camp administration offices. A catering company familiar with the needs of mining operations in Western Australia will be awarded the contract of camp administration, catering and cleaning.

The camp will be located about 3.7 kilometres north-east of the crushing and screening plant and 3.5 kilometres from the closest pit edge (Figures 3 and 4). The proposal is to construct the camp with minimal clearing of vegetation.

3.14 FUELS AND OILS

Fuel storage facilities will be provided by a fuel supplier as part of a build, own, operate contract. Fuel will be stored on-site in bulk self bunded storage tanks. The main fuel storage will be for the mining fleet and the diesel hydraulic crushing plant and will consist of two 110,000 litre self bunded storage tanks. A second 20,000 litre self bunded storage tank will be required for the camp generator. Individual storage tanks supplying generators for the water bores will be supplied from the main storage tanks. Fuel storage at each of the generators will comply with AS1940-2004: The Storage and Handling of Flammable and Combustible Liquids.

Any fuel and lubricants stored in 1,000 bulk pods or 200 litre drums will be held in bunded areas. In areas where fuel and lubricant dispensing occurs, provision will be made to contain accidental spillage. All washwater from the floor of the workshops and washdown areas will be directed via sumps to an oil-water separator. Waste hydrocarbons will be collected and disposed of in an appropriate manner (such as contractor removal for recycling). All fuel filters and oily rags will be collected for removal off site by a contractor.

In the event of a fuel spillage, the extent of the spillage will be assessed. If minor, it will be remediated *in-situ* utilising bioremediation absorbents. Larger scale spillages will receive an application of bioremediation absorbents and then be excavated and disposed of at the project's industrial waste landfill (located within the waste rock stockpile). The remedial approach relies on natural processes of contaminant degradation to reduce contaminants in soil and groundwater. These processes include degradation by microbial activity (assisted by bacterial/bioremediation absorbents), volatisation and absorption of contaminants onto soil particles. The need for ongoing monitoring will be assessed.

A fuel storage log will be maintained and will include the following **(Management Action 3.14)**:

- Types and volumes of fuel on site.
- Location of storage facilities, storage methods, bunding and secondary containment.
- Pumping, piping, transfer and separation procedures.
- Maintenance, testing and audit procedures.
- Waste fuel/oil collection and disposal procedures.

3.15 WORKFORCE

A workforce of about 90 persons will be required for the project on site, including 65 for the mining and crushing contractor and the rest being MML employees and the camp contractor. Another 110 employees will be engaged by the haulage contractor with 60 of those based in Cue and the rest residing in Geraldton.

Employees of the proponent operate on a '2-weeks on and 1-week off' and a 'fly-in and fly-out' basis out of Perth. A thirteen-day fortnight is observed as parts of the proponent's operational policy.

3.16 COMMUNICATIONS

Application has been made to Telstra for the provision of phone communication on site. A satellite system will provide data communications for the Jack Hills operations. On-site communications will be by a network of UHF radios. All vehicles will be fitted with these radios and they will be required to be turned on at all times.

3.17 MOBILE EQUIPMENT

In addition to the contractor supplied mining fleet, mobile equipment will be provided to support the operation. Administration and senior supervisory staff will be provided with personal vehicles. Utility vehicles will be used to service the operations and general maintenance requirements. It is anticipated that this will consist of 10 light vehicles including one integrated tool carrier, one crane, one service truck and a front end loader.

Specialised equipment will be sourced on a needs basis from local contractors where possible.

3.18 TYRES

Used tyres will be buried in the industrial landfill located in the waste rock stockpile. Less than 100 light vehicle tyres will be generated within each 12 month period. A small number of machinery tyres will also be generated. Those that are not used as traffic barriers will also be buried. A request for this disposal will be included in the application to the DoE for an Environmental Operating Licence.

The mining Contract will stipulate that all used tyres generated by the mining contractor are sent off site for disposal or recycling.

3.19 SEWERAGE

Septic tank sewerage systems will be provided for the crushing plant site and administration office ablutions and for the camp. These will be designed and operated in compliance with the health requirements of the Health Department of Western Australia and the relevant Shires of Meekatharra and Murchison.

3.20 SOLID WASTE DISPOSAL

Inert industrial waste will be disposed to a dedicated location within the waste rock stockpile. A small putrescible landfill site will need to be constructed to cater for camp and office wastes. The landfill site will conform to requirements in the Code of Practice for Rural Landfill Management (2000).

3.21 DANGEROUS GOODS AND HAZARDOUS SUBSTANCES

The crushing and screening of ore uses water and does not require the use of chemicals or reagents.

Diesel fuel and oils and explosives will be the main dangerous goods and hazardous substances stored on site. This is covered in Section 3.14.

Licences will be obtained or ammended from DoIR for handling and storage of dangerous goods and explosives.

3.22 BATTERIES

Used batteries will be stacked in single layers on pallets at the workshop for transport to a licensed disposal facility off site. Handling of the batteries will be undertaken in accordance with safe operating procedures prepared by MML.

3.23 NOISE

All of the mining and crushing operations will comply with the noise regulations of the DoIR. Periodic noise surveys will be undertaken to ensure compliance with noise regulations and to identify where noise controls need to be improved.

All machines and equipment used for mining will be fitted with appropriate mufflers to reduce noise levels, and in designated areas all operators will be required to wear accepted noise protection equipment.

Noise from the mining operations will not affect the accommodation camp, which is located about 3.7 kilometres north-east of the crushing and screening plant and 3.4 kilometres from the closest pit edge.

3.24 INDUCTION AND TRAINING

On commencement of employment on the Jack Hills project all personnel will be inducted in compliance with the Company's Project Management Plan (PMP). As required by the *Mines Safety and Inspection Act 1994* the occupational hazards associated with the project will be fully considered in the PMP and presented in the induction programme. Ongoing training and meetings for review of work practices and safety issues will be conducted on a regular basis under the auspices of the Registered Mine Manager. Regular operational meetings will be held to cover immediate requirements.

3.25 SAFETY AND RISK MANAGEMENT

A first aid room will be established in the administration area and personnel suitably qualified in Occupational First Aid will be available on site. A vehicle able to be used as an ambulance will also be located on site. In the event of an accident or illness, injured or ill personnel will be treated on site, or if necessary transferred to Meekatharra for medical attention by road or RFDS for emergency evacuation. The Jack Hills airstrip will be registered with the RFDS in the event that an air evacuation is ever required.

In common with all mining operations, the proposed mining and crushing operations will present hazards and risks. MML has a Corporate Occupational Health and Safety Policy (Appendix 1.4) for all of its operations and it is Company policy to maintain all risks to below an acceptable industry minimum.

Hazards inherent in the excavation and handling of ore and overburden attract specific risks. These risks are minimised through education of the workforce in the proper, safe and efficient usage of all equipment and machinery by implementing a Code of Safe Work Practices.

All contractors employed by MML will be required to have their own documented Code of Safe Work Practices. In addition, all on-site contractors are required to also comply with the Company's Code of Safe Work Practices and to be trained in the proper work procedures on all equipment that might be used on-site. This includes attending on-site training courses and safety meetings.

3.26 PORT FACILITIES

A storage shed will be built on Geraldton Port Authority land. A Works Approval (number 4141) for construction of the shed has been issued by DoE (Appendix 1.3). The building specification will meet all the environmental and statutory requirements as per the existing Port approvals.

4. EXISTING ENVIRONMENT

4.1 REGIONAL SETTING

Jack Hills extend almost 300 metres (up to 700 metres AHD) above the flat plain of the Murchison, itself approximately 400 to 450 metres AHD at the project site. The hills form an arc-shaped structure trending NE-SW and extend for about 60 kilometres. The Murchison plain extends without any terrain impediments virtually to the coast.

The project area containing the Mount Hale and Mount Matthew summits is located within the Weld Land System. The surrounding plains contain a number of land systems; the most common within the project envelope is the Yarrameedie Land System.

4.2 CLIMATE

Meekatharra, 100 kilometres to the west, is the closest climate recording site to the project area.

Meekatharra has a dry climate with hot summers and mild winters. The annual average rainfall is 236 millimetres. Although fairly well distributed throughout the year, there is considerable annual variation. Chart 4.1 shows the climate data for Meekatharra.

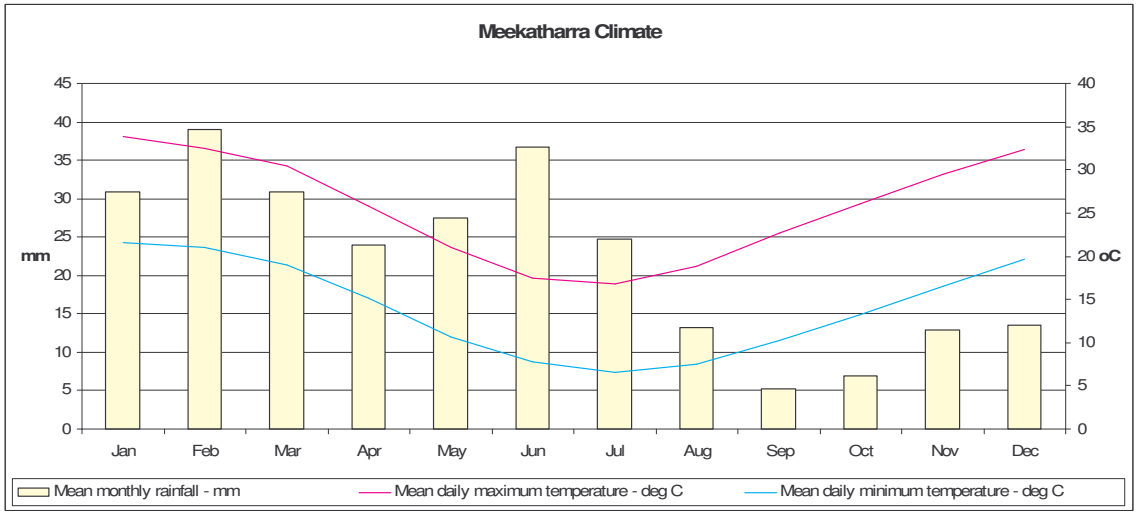
The climate of the region is strongly influenced by a band of high pressure known as the sub-tropical ridge, and in the warmer months by a trough of low pressure that extends southwards from the heat low in the tropics. For most of the year the ridge is located to the south, and east to south-east winds prevail. Occasionally during the cooler months the ridge moves far enough to the north to allow cold fronts to pass over the area.

Winters are mild with the July average maximum and minimum temperatures being 18.8°C and 7.4°C respectively. June is the wettest month with an average rainfall of 33.2 millimetres on six days. The other wet months are January to March when thunderstorms can often produce heavy localised falls in short periods. Although rare, tropical lows or weakening tropical cyclones that usually originate off the Pilbara coast can bring widespread rain to the region.

January is the hottest month, with an average temperature of 38.1°C. Temperatures above 41°C typically occur when hot, dry, northeast to north-westerly winds prevail. With only an average of 46 wet days each year, the air is generally dry, particularly in summer when afternoon relative humidity typically drops below 20 percent. Even during the cooler months the average 9:00 am relative humidity is only about 60 percent.

Half the annual evaporation of 3,576 millimetres occurs from November to February. The average daily evaporation rate in January is 16.5 millimetres per day while on a hot blustery day it can be well over 20 millimetres. During winter the average daily evaporation decreases to 3.7 millimetres (Bureau of Meteorology 2005).

Chart 4.1: Climatic Data



4.3 LAND SYSTEMS

A land system is an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation (Christian and Stewart, 1953 and 1968). The land systems of the Murchison have been described by Curry *et al*. (1994). The land systems occurring in the project area are:

4.3.1 Weld Land System

The Weld Land System is 350 square kilometres in area and consists of the Mount Weld Range and the Jack Hills system. The Weld Land System is described as rugged ranges and ridges of mainly Archaean metamorphosed sedimentary rocks; supports acacia shrublands. The Weld Land System is made up of three major landscape units, which all occur within the Jack Hills project area:

- **Landscape Unit: Mountain Ranges, Peaks and Summits**

  This unit is characterised by rugged ironstone and jaspilite ranges, ridges to 200 metres high (occasional summits to 400 metres) and up to two kilometres wide with slopes to 25%, aligned approximately north-east to south-west. The slopes have extensive outcropping of ironstone and jaspilite and dense mantles of stones and cobbles on slopes.

- **Landscape Unit: Footslopes and Interfluves**

  This unit is characterised by broad concave inclines extending to 1.5 kilometres long; slopes in upper parts 10% grading to three percent or less downslope, also minor interfluvials slopes between parallel drainage lines up to one kilometre wide with pronounced convex crests or rises several metres high; generally covered with dense quartz or ironstone mantles.

- **Landscape Unit: Valley Floor**

  Valley floors between ridges, up to 500 metres wide and often extending for 10 kilometres or more along strike valleys, dendritic creek patterns in upper parts, creek channels incised into bedrock.

4.3.2 Yarrameedie Land System

The Yarrameedie Land System is 520 square kilometres. Two landscape units occur within the Jack Hills project area. The Yarrameedie Land System is described as undulating stony interfluves, drainage floors and pediment plains below major ranges of crystalline rocks (such as the Weld Land System) supporting sparse mulga systems:

- **Landscape Unit: Stony Plains and Interfluves**

  This unit is characterised by broad, gently sloping plains and slightly rounded interfluves to one kilometre wide with slopes less than one percent, dissected by alluvial fans and associated drainage lines; lower plains are typically almost flat and carry moderately dense mantles of mixed pebbles and gravels, with small tracts of laterite, hardpan and low sandy banks.

- **Landscape Unit: Footslopes and Hill Spurs**

  This unit is characterised by concave or convex inclines and piedmont tracts with slopes one to three percent, occasional low rounded crests to 10 metres relief, with total relief generally less than 20 metres. All surfaces densely to very densely strewn with ironstone, greenstone, gabbro or quartz pebbles.

4.4 SOILS

General stripping of the original landscape has intermittently exposed fresh country rocks of granite, gneiss and greenstone (metamorphosed volcanic rock that forms mainly low hills above colluvial slopes and peneplains). The heavily mantled colluvial pediments with more or less incised drainage lines drain onto broad flat 'wash' plains carrying sheet flow down extremely shallow gradients. The wash plains consist of alluvium partly derived from pallid zone materials of the older lateritic land surface and partly from weathered granite, gneiss and metamorphic rock (Curry *et al.* 1994).

The Weld Land System is made up of three major landscape units, which all occur within the Jack Hills project area:

- Mountain Ranges, Peaks and Summits soils are mostly skeletal lithosols confined to pockets of dark red loamy or clayey sands, with infrequent clay subsoils less than 50 centimetres deep overlying parent material.
- Footslopes and Interfluves have reddish-brown or dark red shallow red earths less than 50 centimetres deep with varying metamorphic rock fragments.
- Valley Floors have red earthy sands overlying various metamorphic substrates less than 50 centimetres deep.

The Yarrameedie Land System is made up of two major landscape units, which both occur in the Jack Hills project area:

- The Stony Plains and Interfluves unit soils are dark red or reddish brown earthy sands to hardpan clay loams over various substrates less than 50 centimetres deep.
- Footslopes and Hill Spurs soils are dark red earthy sands, shallow red earths or occasional duplexes, overlying various metamorphic parent materials.

4.5 REGIONAL GEOLOGY

The Jack Hills range is a syncline of Archaean age meta-sedimentary and meta- igneous rocks some 35 kilometres long and up to seven kilometres wide. The Archaean granite gneiss complex that makes up much of the Yilgarn shield surrounds this greenstone belt. The Jack Hills greenstone belt shows an increase in metamorphic grade to the west and in places has a high enough grade for garnet to develop. Within this belt, unlike other major WA greenstone belts, pelitic and psammite metasediments predominate with quartz-mica schists and phyllites containing chlorite, green muscovite and iron oxides. Also present are conglomerates, cherts and banded iron formations (BIF). The BIFs have developed in units from several centimetres thick to several hundred metres thick. In places, it is these BIFs that have been enriched to form lenses of massive haematite. Besides sediments, the sequence contains a number of metavolcanic rocks varying from mafic to ultramafic in composition. An aeromagnetic survey programme has been completed over this greenstone belt and it clearly distinguishes banded iron and ultramafic units that outcrop. It also delineates some additional banded iron units that are covered by alluvium.

Although some iron ore bands are highly magnetic due to the presence of magnetite, others correspond to magnetic lows due to the iron ore being almost totally composed of haematite.

These iron ore deposits are similar in most ways to that of the other nearby greenstone belts, which also contain significant iron ore deposits, for example, Koolyanobbing, Tallering Peak, Blue Hills and the Weld Ranges.

4.6 LOCAL GEOLOGY AND MINERALISATION

In the 1970s a detailed and extensive mapping exercise was carried out on the Jack Hills area. The area was mapped on a scale of 1 inch:200 feet (1:2400). This programme was able to delineate a number of separate iron ore bodies. It however was impaired because well over half the ground is covered with scree that obliterates much of the outcrop, including some of the iron ore units in the aero-magnetic survey.

The majority of rocks in the exploration licence area are banded haematite quartzites that are composed of alternating bands of haematite and quartz. There are two main types; one with 40 percent to 50 percent iron and a second more siliceous ore with about 25 percent iron. Within these pods are regions that have developed with high-iron grades of greater than 65 percent iron as virtually total haematite. Interbedded between these banded iron units are clay bearing phyllites and thin ultramafic sills.

All rocks are intruded by small, late stage pegmatites characterised by large crystals of phlogopite mica and haematite crystals that are up to 30 centimetres in diameter. These rocks have been heavily laterised to form both iron-rich and iron-poor laterites that were originally overlying most of the area, but are now weathered to leave lateritic remnants. The major hilltops correspond to outcrops of the more weathering-resistant haematite bodies, while around the hill slopes the resultant scree has become cemented with limonite to form canga. Canga in this area contains greater than 60 percent iron and as such offers potential for additional, low-cost ore reserves. Individual units dip from 60^{o} to the south-east to near vertical. Some flatter dips are known to occur on the nose of folds. The detailed mapping has also shown a tendency for haematite bodies in particular to be widest at the nose of folds or drag folds.

The area has been extensively and regularly faulted by a series of longitudinal right-lateral strikeslip and wench faults.

4.7 GROUNDWATER

Jack Hills falls in the Murchison Province, which is the westernmost of the three granite-greenstone terraces of the Archaean Yilgarn Craton (Watkins and Hickman 1990).

The weathered fractured granitoid rocks occur as lineal drainage features within the foothills of the range and may represent major joint or fault fractures. These fractures could act as structural aquifers as well as drainage pathways through the enclosing granitoid rocks, and collect alkaline groundwater seepage from the banded iron formations and chloritic schists at higher elevations.

Extensive but shallow alluvial plains are associated with the Murchison River and its main tributaries. Groundwater is at shallow depths of approximately 10 metres within these alluvial systems. No information is available on the possibility of occurrence of deeper palaeochannels associated with the Murchison River. Calcrete occurs in places along the Murchison River and its main tributaries such as Whela Creek and Pindabarn Creek and may provide aquifers of high permeability and recharge properties.

4.7.1 Groundwater Levels of the Jack Hills Range

Of the 58 holes drilled in the Jack Hills 2005 drilling programme only eight encountered any water. These holes indicate the presence of minor isolated perched water lenses at depths in excess of 83 metres below natural ground levels. No significant water flows were encountered in these holes.

The lack of water encountered during exploration drilling indicates the permanent water table must be below 340 metres AHD. The pit base is at 460 metres AHD and therefore the permanent water table is well below the level of proposed open pit mining.

4.7.2 Groundwater Quality

Much of the water in the main river channels and creeks of the alluvial plains is brackish to saline.

Water below 1,000 milligrams per litre is confined to the more elevated recharge localities such as in alluvial slopes and hills. There are currently no monitoring bores in the immediate project area. Analysis of the groundwater quality (Table 4.1) indicates good water quality that is suitable for the purposes required in the project.

Table 4.1: Water Quality Analysis of Water in the Project Area

Analyte	Units	Concentration	Guideline Limit*
pH Lab		7.79	6.5-8.5
Conductivity at 25°C	mS/m	170	
Total Alkalinity as CaCO3	mg/L	170	
Alkalinity as HCO3	mg/L	201	
Hardness as CaCO3	mg/L	336	
Aluminium - Unfiltered ICP	mg/L	<0.008	
Antimony UNICP-OES	mg/L	<0.002	
Arsenic UNICP-OES	mg/L	<0.002	0.007
Barium UNICP-OES	mg/L	0.08	0.7
Beryllium UNICP-OES	mg/L	<0.002	
Boron ICP	mg/L	0.56	
Cadmium UNICP_OES	mg/L	<0.0002	0.002
Calcium ICP	mg/L	60	
Chloride	mg/L	305	250
Chromium UNICP-OES	mg/L	0.0005	0.05
Copper ICP	mg/L	0.009	2.0
Iron - Unfiltered ICP	mg/L	0.012	0.3
Lead UNICP-OES	mg/L	<0.002	0.01
Magnesium ICP	mg/L	45	
Manganese - Unfiltered ICP	mg/L	<0.002	0.1
Molybdenum UNICP-OES	mg/L	0.002	
Nickel UNICP-OES	mg/L	<0.002	0.02
Nitrate + Nitrite as Nitrogen	mg/L	22	
Potassium ICP	mg/L	12	
Sodium ICP	mg/L	210	180
Sulfate ICP	mg/L	82	250
Zinc ICP	mg/L	<0.02	3.0

* Australian Drinking Water Guidelines (NHMRC and ARMCANZ 1996)

Fracture controlled aquifers within the granitoid rocks, should produce high quality water. Entrapment of water in weathered fractured granitoid rocks should ameliorate alkalinity and this water should have lower salinity and hardness than water from the alluvial plains.

4.8 SURFACE HYDROLOGY

The project area is on a major water shedding ridgeline, with many minor drainage lines shedding north-west and south-east. Creek flow is infrequent and associated with major rainfall events. Construction of the waste rock stockpile abutting the hillside will alter a number of the minor drainage channels. Diversion drains will need to be constructed to channel surface drainage down the side of the waste rock stockpile to sediment control

basins.

The project area can be subdivided into three surface hydrology areas, each with specific characteristics as follows:

- **Open pit (25 hectares)**

  The open pit is characterised by being internally draining. The safety bund required to be constructed by DoIR around the pit perimeter also serves to isolate surface drainage from entering the pit. All water entering the open pit is contained and can only exit by infiltration through the pit floor and walls, or by pumping.

- **Elevated landscape (ridges, hills and waste rock stockpile) (80 hectares)**

  This landscape is characterised by many, small catchment area, ephemeral drainage lines, with steep gradients that can result in significant erosion potential during rainfall periods.

- **Plain (five hectares)**

  The plain landscape is characterised by very flat topography containing both broad wash areas and defined creek channels

Bureau of Meteorology data shows on average there are only three to four rain days per month. Observations from other locations in the region indicate that rainfall events of five to 10 millimetres are required to produce local creek flows. Rainfall events of larger than 10 millimetres produce regional creek flow.

Rainfall intensities for the two, five, 10, 20 and 50 year average recurrent intervals (ARI) for one, 12, 48 and 72 hour intervals have been tabulated for the Jack Hills project areas. The values were determined by using graphical interpolation and analytical calculations based on methods described in 'Australian Rainfall and Runoff' (1987). This data is tabulated in Table 4.2.

Table 4.2: Recurrent Rainfall Intensities, Jack Hills Project Area

Recurrent Intervals (hours)	Rainfall Duration (hours)	Rainfall Intensity (mm/hour)
2	1	17.50
	12	2.90
	48	1.05
	72	0.75
5	1	22.00
	12	3.80
	48	1.35
	72	1.00
10	1	27.50
	12	5.00
	48	1.75
	72	1.30
20	1	34.00
	12	7.00
	48	2.65
	72	1.75
50	1	42.50
	12	8.50
	48	3.20
	72	2.30

Source: Morgan (2005)

4.9 FLORA AND VEGETATION

4.9.1 Background

The flora of the Jack Hills project area has been described and collected systematically during surveys undertaken by MBS Environmental in October 2004, June 2005, September 2005 (fauna studies) and by Mattiske Consulting Pty Ltd in October, November 2005 and March 2006. Selective opportunistic collecting was further undertaken at additional sites in plant communities of like structure and floristic composition. A total of 18 sites were established by MBS Environmental (pre-October 2005) and 100 sites were established by Mattiske Consulting Pty Ltd in October 2005 on the lease areas. An additional four sites were established on Mt Gould and Robinson Ranges. The recent collections from MBS Environmental (October 2005) and Mattiske Consulting Pty Ltd (October 2005) were identified by botanists from Mattiske Consulting Pty Ltd. The MBS Environmental collections (October 2004 and June 2005) were identified by botanist Dr Eleanor Bennett.

There is a research project currently being undertaken by CALM on plant species and plant communities associated with the relictual ironstone communities. The findings from this latter research project were not available at the time of the current survey on the Jack

Hills project area.

The detailed spring flora and vegetation survey of October 2005 was undertaken by Mattiske Consulting Pty Ltd in accordance with EPA Guideline Statement No. 51 and in consultation with Dr. Neil Gibson of CALM. The field study was undertaken from 10 to 15 October 2005 and comprised sites located over all areas of mining infrastructure and incorporated quadrats established for CALM's regional Banded Ironstone Formation (BIF) flora survey. The survey area covered the entire mining lease (M20/506), the exploration lease area, the mining infrastructure areas, the haul road route (L20/47) and selected areas on Mt Gould and Robinson Ranges.

An additional field trip was undertaken and additional sites established on the Mt Gould area by Mattiske Consulting Pty Ltd to clarify the communities.

The recent work entailed collecting site parameter data and presence/absence data for flora species at each site. Time allocated for the work in October 2005 did not allow detailed quantitative data to be collected on plant densities or projection foliage cover.

The results of these surveys are provided in a report titled "Flora and Vegetation on the Jack Hills Project Area" (December 2005) prepared by Mattiske Consulting Pty Ltd (Appendix 3.1, Volume 3).

A targeted survey was undertaken by Mattiske Consulting Pty Ltd in March 2006 for Priority flora along the proposed haul road and for significant species within the vicinity of proposed pit area. The results of this survey are provided in Section 4.9.5.

4.9.2 Survey Effort and Coverage

The survey effort was undertaken over several seasons with multiple trips. Some 122 sites were established over the period of survey work, with further sites located on Mt Gould and the Robinson Ranges for comparative reasons. In view of the multiple trips it is predicted that a significant part of the flora was collected. The coverage of the flora species was assisted by these multiple trips. The work undertaken to date addresses the key groupings of plant communities in the area.

The October 2005 spring flora survey is considered to have been suitably timed to adequately assess the impacts to flora with sufficient flowering to allow selection and identification of annuals and perennial species. Annual species were collected on each field trip.

In terms of analysing the data, it would have been preferable to have access to the regional studies currently being conducted by CALM. As these findings were not available the interpretations below are based on the work undertaken by MBS Environmental (2005) and Mattiske Consulting Pty Ltd in October 2005.

The March 2006 targeted survey for flora of conservation significance followed recent extensive rainfall events of February and March and is considered to be very well timed, taking advantage of post rain flowering.

4.9.3 Flora

The flora of the Murchison region is diverse with about 830 recorded vascular species, of

which 97 percent are endemic or near endemic. Mulga (*Acacia aneura*) and cotton bush (*Ptilotus obovatus*) are the most ubiquitous perennials (Curry *et al.* 1994).

A total of 215 taxa (including subspecies and varieties) from 188 genera and 36 families were recorded within the survey area. The dominant families, which typify this region included Mimosaceae (35 taxa), Myoporaceae (22 taxa), Poaceae (18 taxa), Chenopodiaceae (16 taxa) and Asteraceae (15 taxa). One introduced species was recorded in the survey area (**Cuscuta planiflora*). The latter lack of introduced species reflected the lack of intensive agriculture in the region. There was some local damage to selected flora from the grazing pressure of goats on the vegetation.

A full list of all flora recorded during these surveys is given in Table 4.3.

Table 4.3: Flora Species Recorded During Surveys of the Jack Hills Project Area

Species Name	Species Name
Adiantaceae	
Cheilanthes sieberi	
Poaceae	
Aristida contorta	*Cymbopogon ambiguus*
Enneapogon caerulescens	*Eragrostis eriopoda*
Eriachne helmsii	*Eriachne ?helmsii*
Eriachne aristidea	*Eriachne mucronata*
Eriachne pulchella	*Eriachne pulchella* subsp. *pulchella*
Monachather paradoxus	*Neurachne minor*
?*Panicum* sp.	*Triodia basedowii*
Triodia melvillei	*Triodia ?scariosa*
Triodia sp.	*Tripogon loliiformis*
Anthericaceae	
Thysanotus manglesianus	*Thysanotus speckii*
Casuarinaceae	
Casuarina pauper	
Proteaceae	
Grevillea berryana	*Grevillea deflexa*
Grevillea pyramidalis	*Grevillea striata*
Hakea lorea subsp. *lorea*	*Hakea preissii*
Loranthaceae	
Amyema maidenii subsp. *maidenii*	
Chenopodianceae	
Atriplex semilunaris	*Atriplex ?semilunaris*
Atriplex codonocarpa	*Dysphania kalpari*
Dysphania rhadinostachya subsp. *inflata*	*Dysphania rhadinostachya* subsp. *rhadinostachya*
Enchylaena tomentosa	*Maireana ?villosa*
Maireana carnosa	*Maireana triptera*

Species Name	Species Name
Rhagodia eremaea	*Sclerolaena ?eurotioides*
Sclerolaena cuneata	*Sclerolaena diacantha*
Sclerolaena eriacantha	*Sclerolaena eurotioides*
Amaranthaceae	
Amaranthus interruptus	*Ptilotus chamaecladus*
Ptilotus exaltatus	*Ptilotus exaltatus* var. *exaltatus*
Ptilotus gaudichaudii var. *gaudichaudii*	*Ptilotus helipteroides* var. *helipteroides*
Ptilotus obovatus	*Ptilotus obovatus* var. *obovatus*
Ptilotus petiolatus	*Ptilotus polystachyus* var. *polystachyus*
Ptilotus roei	*Ptilotus rotundifolius*
Ptilotus schwartzii var. *georgei*	
Aizoaceae	
Gunniopsis divisa (P1)	*Tetragonia cristata*
Portulacaceae	
Calandrinia eremaea	*Calandrinia pleiopetala*
Calandrinia ?pleiopetala	*Calandrinia polyandra*
Calandrinia ptychosperma	*Calandrinia schistorhiza*
Calandrinia sp.	
Capparaceae	
Cleome viscosa	
Brassicaceae	
Cuphonotus andraeanus	*Lepidium oxytrichum*
Lepidium platypetalum	
Mimosaceae	
Acacia aneura	*Acacia aneura* var. *aneura*
Acacia aneura var. *fuliginea*	*Acacia aneura* var. *intermedia*
Acacia aneura var. *major*	*Acacia aneura* var. *?microcarpa*
Acacia aneura var. *tenuis*	*Acacia citrinoviridis*
Acacia cockertoniana (ms)	*Acacia coolgardiensis* subsp. *effusa*
Acacia ?coriacea subsp. *coriacea*	*Acacia cuthbertsonii*
Acacia cuthbertsonii subsp. *cuthbertsonii*	*Acacia cyperophylla* subsp. *cyperophylla*
Acacia demissa	*Acacia grasbyi*
Acacia kempeana	*Acacia ligulata*
Acacia ?paraneura	*Acacia pruinocarpa*
Acacia quadrimarginea	*Acacia* aff. *quadrimarginea* (straight phyllodes)
Acacia ramulosa	*Acacia ramulosa* var. *linophylla*
Acacia ramulosa var. *ramulosa*	*Acacia rhodophloia*
Acacia aff. *rhodophloia* (woody pods)	*Acacia sibilans*
Acacia stowardii	*Acacia subtessarogona*

Species Name	Species Name
Acacia synchronicia	*Acacia tetragonophylla*
Acacia wanyu	*Acacia xiphophylla*
Acacia sp.	
Caesalpiniaceae	
Petalostylis labicheoides	*Senna artemisioides* ?subsp. *oligophylla* x *helmsii*
Senna artemisioides subsp. *helmsii*	*Senna artemisioides* subsp. *x sturtii*
Senna glaucifolia	*Senna glutinosa* subsp. *chatelainiana*
Senna ?*glutinosa* subsp. x *luerssenii*	*Senna glutinosa* subsp. *pruinosa*
Papilionaceae	
Mirbelia rhagodioides	
Geraniaceae	
Erodium cygnorum	*Erodium* sp.
Zygophyllaceae	
Tribulus suberosus	*Zygophyllum compressum*
Zygophyllum iodocarpum	*Zygophyllum kochii*
Rutaceae	
Philotheca brucei subsp. *cinerea*	
Euphorbiaceae	
Euphorbia boophthona	*Euphorbia* sp.
Stackhousiaceae	
Stackhousia muricata	
Sapindaceae	
Dodonaea pachyneura	*Dodonaea petiolaris*
Dodonaea viscosa subsp. *spatulata*	
Rhamnaceae	
Stenanthemum petraeum	*Stenopetalum anfractum*
Tiliaceae	
Corchorus crozophorifolius	
Malvaceae	
Abutilon oxycarpum subsp. *prostratum*	*Hibiscus* ?*brachychlaenus*
Hibiscus ?*sturtii* var. *forrestii*	*Hibiscus sturtii* var. *forrestii*
Lawrencia spicata	*Sida calyxhymenia*
Sida cardiophylla	*Sida* aff. *excedentifolia*
Sida ?*excedentifolia* (ms)	*Sida* aff. *rohlenae*
Sida sp. unisexual (N.H. Speck 574)	*Sida* sp.
Malvaceae sp.	
Myrtaceae	
Aluta aspera subsp. *hesperia*	*Calytrix desolata*
Calytrix verruculosa (P1)	*Corymbia ferriticola* subsp. *ferriticola*

Species Name	Species Name
Corymbia sp.	*Eucalyptus victrix*
Homalocalyx echinolatus	*Micromyrtus sulphurea*
Thryptomene decussata	*Verticordia jamiesonii* (P3)
Haloragaceae	
Haloragis trigonocarpa	
Apiaceae	
Trachymene pilbarensis	
Convolvulaceae	
* *Cuscuta planiflora*	*Ipomoea calobra*
Boraginaceae	
Halgania gustafsenii var. *gustafsenii* (ms)	*Heliotropium heteranthum*
Trichodesma zeylanicum var. *grandiflorum*	
Lamiaceae	
Prostanthera wilkieana	*Prostanthera* sp. G. Byrne 239
Solanaceae	
Nicotiana occidentalis subsp. *occidentalis*	*Solanum ashbyae*
Solanum ellipticum	*Solanum lasiophyllum*
Solanum phlomoides	
Myoporaceae	
Eremophila clarkei	*Eremophila exilifolia*
Eremophila forrestii	*Eremophila ?forrestii*
Eremophila forrestii subsp. *forrestii* (ms)	*Eremophila fraseri*
Eremophila fraseri subsp. *galeata* (ms)	*Eremophila fraseri* subsp. *parva* (ms)
Eremophila glutinosa	*Eremophila ?jucunda* subsp. *jucunda*
Eremophila lachnocalyx	*Eremophila latrobei* subsp. *latrobei*
Eremophila macmillaniana	*Eremophila maitlandii*
Eremophila margarethae	*Eremophila oldfieldii* subsp. *oldfieldii*
Eremophila pendulina	*Eremophila platycalyx*
Eremophila platycalyx subsp. *platycalyx* (ms)	*Eremophila shonae* subsp. *shonae* (ms)
Eremophila spathulata	*Eremophila* sp.
Rubiaceae	
Psydrax latifolia	*Psydrax rigidula*
Psydrax suaveolens	
Lobeliaceae	
Lobelia heterophylla	*Lobelia heterophylla subsp. pilbarensis*
Goodeniaceae	
Brunonia australis	*Goodenia berardiana*
Goodenia pinnatifida	*Goodenia tenuiloba*
Scaevola spinescens	

Species Name	Species Name
Asteraceae	
Actinobole uliginosum	*Brachyscome ciliocarpa*
Calocephalus multiflorus	*Calocephalus* sp. Pilbara-Desert (ME Trudgen 11454)
Cephalipterum drummondii	*Gnephosis arachnoidea*
Helipterum craspedioides	*Pluchea dentex*
Podolepis gardneri	*Pterocaulon sphacelatum*
Rhodanthe citrina	*Rhodanthe maryonii*
Schoenia filifolia subsp. *filifolia*	*Streptoglossa cylindriceps*
Streptoglossa liatroides	

4.9.4 Vegetation

The Jack Hills project area occurs within the Murchison Region as defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995 and Environment Australia 2000, 2005). These subdivisions largely relied on the earlier physiographic work of Beard (1976).

The Murchison region is well known for the dominance of the Mulga (*Acacia aneura*) woodlands (Beard 1976, 1990). Optimum conditions for the Mulga occur on the extensive flats and plains. The communities defined by Beard (1976) have recently been updated and refined by Hopkins *et al.* (2001). The dominant vegetation types as defined by Hopkins *et al.* (2001) within the Murchison area are the mulga woodlands.

Arid shrublands make up the vast majority of vegetation types encountered in the Murchison region. Most landscapes are dominated by mixed shrubland/scrubland, with few or no trees or perennial grasses, with shrubs apparently randomly scattered or loosely aggregated, and with large amounts of bare ground and shallow red soils exposed between the shrubs (Curry *et al.* 1994).

Eighteen plant communities were defined and mapped by Mattiske Consulting Pty Ltd (December 2005), as shown in Figures 10a and 10b. These community types consisted of three communities near the creekline and drainage lines (C1, C2 and C3), one community on the flats near the major creeklines (F1), two denser Mulga communities (M1 and M2), five open Mulga and *Acacia* communities on the flats and hills (A1, A2, A3, A4 and A5), four *Triodia* communities with variable shrubs (T1, T2, T3 and T4), one shrub community on the breakaways (B1) and two *Ptilotus* dominated communities with variable shrub cover (P1 and P2). The *Triodia* communities were subdivided on the basis of the floristics, the proportion of different species in different communities and the interpretation of the aerial photographs.

On the basis of current information (regional mapping by Beard and land systems), it appears that the communities on the ironstone ridge are locally and regionally significant. The Spinifex communities appear to be restricted to the central part of the Jack Hills Range (near Mt Hale and the proposed operational areas) and to a section of Mt Gould. There is some overlap between some of the floristic components of the communities with similar communities on the Robinson Ranges; however there is insufficient regional data available at the scale needed to clarify some of these issues. The latter may become more evident

when the current studies being undertaken by CALM are finalised in 2006.

A description of each plant community is provided in Table 4.4.

Table 4.4: Plant Communities in the Jack Hills Project Areas

Community	Description	Currently Undisturbed (ha)	Previously Disturbed (ha – Outside of Operational Footprint)	Total Area in Exploration Lease (ha)
Near Creeklines and Drainage Lines				
C1	Low Open Woodland of *Acacia cyperophylla* subsp. *cyperophylla, Acacia citrinoviridis, Acacia tetragonophylla, Acacia aneura* var. *aneura, Grevillea berryana* over *Dodonaea petiolaris, Ptilotus obovatus* var. *obovatus* and a range of grasses in major flow-lines.	53.97	-	53.97
C2	Low Woodland of *Acacia aneura* var. *aneura, Acacia citrinoviridis, Acacia tetragonophylla, Acacia rhodophloia, Acacia pruinocarpa, Psydrax latifolia* over *Dodonaea petiolaris, Ptilotus obovatus* var. *obovatus* and a range of grasses in minor flow-lines.	169.30	0.12	169.42
C3	Low Open Woodland of *Eucalyptus victrix, Acacia cyperophylla* subsp. *cyperophylla, Acacia citrinoviridis, Acacia tetragonophylla, Grevillea berryana* over *Dodonaea petiolaris, Ptilotus obovatus* var. *obovatus* and a range of grasses in major flow-lines.	9.13	-	9.13
Flats near Major Creeklines				
F1	Low Woodland of *Acacia aneura* var. *aneura, Acacia tetragonophylla*, *Acacia citrinoviridis* over *Eremophila forrestii* subsp. *forrestii, Eremophila fraseri* subsp. *parva, Senna* species and a range of grasses including *Aristida contorta* on plains near major flow lines.	20.19	-	20.19
Denser *Mulga* Communities				

Community	Description	Currently Undisturbed (ha)	Previously Disturbed (ha – Outside of Operational Footprint)	Total Area in Exploration Lease (ha)
M1	Low Woodland of *Acacia aneura* var. *aneura, Acacia aneura* var. *?microcarpa, Acacia tetragonophylla*, *Acacia pruinocarpa,* with patches of *Acacia xiphophylla,* over *Eremophila forrestii* subsp. *forrestii, Eremophila fraseri* subsp. *parva, Senna* species and a range of grasses including *Aristida contorta* on plains and flats.	9.48	-	9.48
M2	Low Open Woodland of *Acacia aneura* var. *aneura, Acacia tetragonophylla*, *Acacia pruinocarpa, Grevillea berryana* over *Solanum lasiophyllum, Senna* species, *Ptilotus exaltatus, Goodenia tenuiloba* and *Aristida contorta* on broad plains and flats.	-	-	-
Open *Mulga* and *Acacia* Communities on Flats and Hills				
A1	Low Open Woodland of *Acacia aneura* var. *aneura, Acacia aneura* var. *major, Acacia kempeana, Acacia rhodophloia, Grevillea berryana* over *Solanum lasiophyllum, Senna* species, *Ptilotus obovatus* var. *obovatus, Goodenia tenuiloba* and *Aristida contorta* on broad plains and flats.	1096.5	4.64	1,101.14
A2	Low Woodland of *Acacia aneura* var. *aneura* over *Thryptomene decussata, Eremophila maitlandii, Eremophila margarethae, Ptilotus obovatus* var. *obovatus* and *Goodenia tenuiloba* on deeper sandy soils on ridges and upper slopes.	3.7	0.03	3.73
A3	Low Open Woodland of *Acacia aneura* var. *aneura, Acacia aneura* var. *?microcarpa, Acacia ramulosa* var. *linophylla, Acacia rhodophloia, Acacia xiphophylla* over *Aluta aspera* subsp. *hesperia, Thryptomene decussata, Eremophila margarethae* over *Solanum lasiophyllum, Senna* species, *Ptilotus obovatus* var. *obovatus, Goodenia tenuiloba* and *Aristida contorta* on shallow quartz and gravel slopes.	178.27	1.29	179.56

Community	Description	Currently Undisturbed (ha)	Previously Disturbed (ha – Outside of Operational Footprint)	Total Area in Exploration Lease (ha)
A4	Low Open Woodland of *Acacia rhodophloia* over *Dodonaea petiolaris, Thryptomene decussata, Calytrix desolata, Eremophila latrobei* subsp. *latrobei* over *Ptilotus obovatus* var. *obovatus* and *Goodenia tenuiloba* on shallow granitic outcrops.	1.76	-	1.76
A5	Low Open Woodland of *Acacia aneura* var. *aneura, Acacia rhodophloia, Acacia xiphophylla* over *Eremophila margarethae* over *Solanum lasiophyllum, Senna* species, *Ptilotus obovatus* var. *obovatus, Goodenia tenuiloba* and *Aristida contorta* on shallow quartz and gravel flats.	99.3	0.05	99.35
***Triodia* Hummock Grassland Communities**				
T1	Hummock Grassland of *Triodia melvillei* with emergent *Acacia aneura* var. *major, Acacia rhodophloia, Acacia xiphophylla* over *Eremophila margarethae, Philotheca brucei* subsp. *cinerea, Hibiscus sturtii* var. *forrestii*, *Ptilotus obovatus* var. *obovatus, Eriachne pulchella* subsp. *pulchella* and *Goodenia tenuiloba* on upper slopes and rocky ridges of main ranges.	128.68	4.98	133.66
T2	Hummock Grassland of *Triodia melvillei* with denser pockets emergent species including *Acacia aneura* var. *major, Acacia ramulosa* subsp. *linophylla, Acacia xiphophylla, Grevillea berryana, Eremophila margarethae* and *Philotheca brucei* subsp. *cinerea* over *Hibiscus sturtii* var. *forrestii, Ptilotus obovatus* var. *obovatus, Eriachne pulchella* subsp. *pulchella* and *Goodenia tenuiloba* on upper slopes and rocky ridges of main ranges.	32.74	0.06	32.80
T3	Hummock Grassland of *Triodia melvillei* with denser pockets emergent species including *Acacia cockertoniana* (ms) over dense *Eremophila margarethae* over *Ptilotus obovatus* var. *obovatus, Eriachne pulchella* subsp. *pulchella* and *Goodenia tenuiloba* on upper slopes and rocky ridges of main ranges.	9.79	0.13	9.92

Community	Description	Currently Undisturbed (ha)	Previously Disturbed (ha – Outside of Operational Footprint)	Total Area in Exploration Lease (ha)
T4	Hummock Grassland of *Triodia melvillei* with denser pockets of *Acacia ramulosa* subsp. *ramulosa, Acacia cockertoniana* (ms), *Grevillea berryana* and *Acacia pruinocarpa, Psydrax latifolia* over *Tribulus suberosus, Ptilotus obovatus* var. *obovatus, Eriachne pulchella* subsp. *pulchella, Halgania gustafsenii* var. *gustafsenii* and *Goodenia tenuiloba* on upper slopes and rocky ridges of main ranges.	11.24	1.33	12.57
Breakaways				
B1	Low Open Woodland of *Acacia aneura* var. *aneura, Acacia ramulosa* var. *linophylla, Acacia ramulosa* var. *ramulosa, Acacia pruinocarpa* over *Thryptomene decussata, Eremophila margarethae* over *Solanum lasiophyllum, Senna* species, *Ptilotus obovatus* var. *obovatus, Goodenia tenuiloba* and *Aristida contorta* on breakaways.	215.00	0.48	215.48
***Ptilotus* Dominated Communities**				
P1	Low Open Woodland of *Acacia aneura* var. *aneura, Acacia ramulosa* var. *linophylla, Acacia ramulosa* var. *ramulosa, Acacia xiphophylla, Acacia cuthbertsonii* subsp. *cuthbertsonii, Acacia pruinocarpa* over *Aluta aspera* subsp. *hesperia, Thryptomene decussata, Eremophila margarethae* over *Solanum lasiophyllum, Senna* species, *Ptilotus obovatus* var. *obovatus, Goodenia tenuiloba* and *Aristida contorta* on shallow gravelly slopes.	174.68	0.47	175.15
P2	Low Woodland of *Acacia ramulosa* var. *linophylla, Acacia ramulosa* var. *ramulosa, Acacia xiphophylla, Acacia demissa, Psydrax suaveolons, Grevillea berryana* over *Eremophila margarethae, Philotheca brucei* subsp. *cinerea, Dodonaea petiolaris, Thryptomene decussata, Eremophila margarethae* over *Solanum lasiophyllum, Senna* species, *Ptilotus obovatus* var. *obovatus, Goodenia tenuiloba* on shallow gravelly slopes.	240.33	0.98	241.31

Of these plant communities, the restricted communities on the Jack Hills Ranges are the

most significant in the local and regional context. The *Triodia melvillei* communities (T1 and T2) were located on the mid and upper slopes of Mt Gould, 25 kilometres north-east of the Jack Hills Range. The aerial extent of these communities was not calculated for the Mt Gould and Robinson Ranges, as aerial photographic maps were not available at the time of the survey work. The spinifex communities on the Robinson Ranges are different from those on the Jack Hills and Mt Gould ironstone areas. The latter appears to largely relate to the differences in the geology and resulting soils on these respective areas.

None of the plant communities within the survey area are currently listed as Threatened Ecological Communities pursuant to Schedule 2 of the *EPBC Act 1999*. None of the plant communities within the survey are currently listed as Threatened Ecological Communities on the databases managed by CALM (CALM 2005b).

The plant communities have been extensively modified on the flats and plains within the project area mainly by grazing pressures (largely due to goats). Discussions held with local pastoralists indicate that regular goat culling is undertaken. During the survey work, groups of goats were seen on the project lease areas. Furthermore, the plant growth reflected some grazing pressure on the shrubs and trees. Despite these grazing pressures and the impacts of seasonal drought conditions, the condition of the vegetation on the project area is very good to excellent (based on criteria as developed by Keighery 1994).

4.9.5 Flora of Conservation Significance

4.9.5.1 Rare and Priority Flora

A threatened flora species search was undertaken of the area by CALM on 11 October 2004 defined by the coordinates 26.4023 – 25.6599°S and 116.849 – 117.596°E. An EPBC protected matters search defined by the coordinate 26.01703°S, 117.28308°E (20 kilometre buffer) was also undertaken. The search results are provided in Appendix 2.2 of this report.

The CALM database search highlighted the potential occurrence of five Rare, seven Priority 1, seven Priority 2, 15 Priority 3 and two Priority 4 species near the project area. The EPBC database search highlighted the potential nationally listed vulnerable species – *Pityrodia angustensis* (Mt Augustus foxglove). This species was not located during the recent surveys in 2004 and 2005.

On the basis of the surveys undertaken to date in the Jack Hills survey area, no plant taxon recorded in the surveys is gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act 1950*. No plant taxon listed as Threatened pursuant to Schedule 1 of the *EPBC Act 1999* were recorded in the surveyed area.

A total of three Priority flora species were recorded in the surveyed area (Figures 11a and 11b). There were two Priority 1 flora species and one Priority 3 flora species [*Calytrix verruculosa* (Priority 1), *Gunniopsis divisa* (Priority 1) and *Verticordia jamiesonii* (Priority 3)]. Of these the *Gunniopsis* is the most poorly known. The March 2006 targeted survey of the proposed haul road from the Jack Hills to the Beringarra-Cue Road was conducted to identify the population sizes and locations of *Gunniopsis divisa* and *Calytrix verruculosa*. The survey was conducted by vehicular and foot traverse of the Miscellaneous Licence area from the Beringarra-Cue Road to the proposed mine area.

The locations and significance of the Priority species are further outlined as follows:

- *Calytrix verruculosa* (Priority 1) is a shrub restricted to the Murchison Region. During the October 2005 survey, one population was located near the haul road and another population 1.5 kilometres from the proposed mining site. A further seven populations were found during the March 2006 survey, with a total 358 individual plants along the route. This species has been recorded previously within the foothills of Mt Hale and is known from nine records at the State Herbarium.
- *Gunniopsis divisa* (Priority 1) is an annual herb and was originally collected from two sites on the proposed haul road in October, 2005. This species is known from three records at the State Herbarium (Western Australian Herbarium, 2006) from further west. The targeted search conducted in March 2006 failed to locate any individuals along the proposed route despite the recent substantial rainfall in the region. Information contained on the *Florabase* web site indicates that *Gunniopsis divisa* flowers between August and October and it may be that germination responds only to winter rains, which would explain the species' absence during the March 2006 survey.
- *Verticordia jamiesonii* (Priority 3) was recorded at three locations in October 2005. Two of these locations occurred on the mining lease area, but outside the proposed mining and infrastructure area, whilst the other one occurred just outside the lease area. This species has been previously recorded on sandy-clay soils and lateritic breakaways and is known from 16 records at the State Herbarium.

These Priority species are all perennial (long-lived) species that could be located throughout the year.

4.9.5.2 Range Extensions of Flora

Several species were recognised as being significant, as they were range extensions or disjunct outliers. The most significant of these appeared to be the *Lobelia heterophylla* subsp. *pilbarensis* and the A*cacia cockertoniana* (ms) (Figures 11a and 11b). Both of these taxa have been recorded outside the proposed clearing areas for the project:

- *Lobelia heterophylla* subsp. *pilbarensis* was recorded during the October 2005 survey at only one location within the proposed pit area within the mining lease area. This taxon was sent to Neville Walsh at the Melbourne Royal Botanic Gardens to confirm its classification. This taxon has been recorded during a recent survey by CALM in a small population on the ranges south of the Jack Hills project area, as well as to the north and north-west on Mt Augustus, Brockman Station (north-west of Tom Price, near Wittenoom), Mt James Station (via Carnarvon and just west of Barlee Range Nature Reserve. A search for *Lobelia heterophylla* subsp. *pilbarensis* was also conducted during the March 2006 survey but no more individuals were located. On the basis of current information, it appears that the plant specimen collected during the Mattiske 2005 survey on the Jack Hills project area and the collection by CALM south of the Jack Hills project area are outlier populations from a range of sites in the Pilbara and near Mt Augustus.
- *Acacia cockertoniana* (ms), a perennial (long-lived) species, was recorded during the October 2005 survey at 21 sites both within the proposed pit area and within the mining lease area. This taxon was confirmed by Dr Bruce Maslin at the State Herbarium and is well known from a similar environment on the relictual ironstone ranges at Windarling near Southern Cross. This species is known from 26 records at the State Herbarium. This species extends beyond the proposed clearing areas.

A targeted search during the March 2006 survey of the proposed pit area on the Jack Hills to determine the population size of *Acacia cockertoniana* (ms) in each of the potentially affected communities. The communities surveyed were the *Triodia* communities T1, T2, T3 and T4 and the breakaway community B1. Surveys were conducted for each community both within the proposed pit area and outside of the impacted area, but restricted to the main range of the Jack Hills. The population estimates are for the area approximately between Mt Hale and Mt Matthew and the slopes either side of this area. For each survey, at least three transects (except for community T4 within the pit area) 50 metres in length were surveyed and all individuals of *Acacia cockertoniana* (ms) counted up to 5 metres either side of the transect line. Only a small area of community T4 occurs within the pit area and thus only two transects could be surveyed. The estimated densities and population sizes of *Acacia cockertoniana* (ms) are shown in Table 4.5.

Table 4.5: Densities and estimated population sizes (±SE) of *Acacia cockertoniana* (ms) (P1) for both within and outside of the proposed mine pit impact area on the main range of the Jack Hills

Community	Density Within Pit (plants/ha ±SE)	Estimated Total Population Within Pit Area (±SE)	Estimated Total Population of Haul Rd (±SE)	Density Outside Pit (plants/ha (±SE)	Estimated Total Population Outside Pit Area (±SE)
T1	(n=4) 55.0 ± 22.2	544.7 ± 219.6	6.55 ± 3.30	(n=3) 100.0 ± 50.3	5688.5 ± 2863.1
T2	(n=3) 200.0 ± 41.6	343.9 ± 71.6	7.50 ± 3.9	(n=3) 80.0 ± 41.6	874.3 ± 455.0
T3	(n=3) 153.3 ± 92.6	954.6 ± 576.6		(n=3) 246.7 ± 81.9	903.9 ± 300.2
T4	(n=2) 0.00 ± 0.00	0.0 ± 0.0		(n=4) 305.0 ± 99.5	3275.7 ± 1068.2
B1	(n=3) 93.3 ± 74.2	336.6 ± 267.7	3.21 ± 1.02	(n=3) 366.7 ± 116.8	8940.5 ± 2848.2

- *Amaranthus interruptus* was recorded from one site that is not located within the proposed mining or infrastructure area. This species is known from nine records at the State Herbarium.
- *Calandrinia pleiopetala* occurs as a range extension from areas north and north-east of the proposed mining. This species was recorded at eleven sites located on the proposed haul road, airstrip (airstrip site no longer included in proposal) and campsite options. This taxon is not restricted to these areas. This species is known from six records at the State Herbarium.

Table 4.6 summarises the proportion of plants in the communities on the main Jack Hills Range, both inside and outside the proposed operational areas and the potential impact of the proposed operational activities.

Table 4.6: Review of Impact of Proposed Operations on Significant Flora in the Jack Hills Project Area

Significant Flora Taxon	Total No. Recorded Sites in Survey Area	No. of Recorded Survey Sites Outside any Proposed Operational Areas	No. of Recorded Survey Sites in or near Proposed Operational Areas

Acacia cockertoniana (ms)	25	17	8 (mining and pit areas)
Gunniopsis divisa (P1)	2	-	2 (haul road)
Verticordia jamiesonii (P3)	4	4	-
Calytrix verruculosa (P1)	9	1	8 (haul road)
Lobelia heterophylla subsp. *pilbarensis*	1	-	1 (mining and pit area)
Amaranthus interruptus	1	1	-
Calandrinia pleiopetala	11	1^^	10 (camp, haul road)
Eremophila pendulina	1	1	-

Note – ^^ this taxon was recorded in an area selected for an airstrip, however this site has since been modified and therefore this site will not be disturbed by the proposed operations.

4.9.6 Weeds

Weed species that have been recorded in the Jack Hills area include *C*uscuta planiflora*. This species is not aggressive and vehicle hygiene measures should minimise the spread of this species.

Several more aggressive species are known from the Murchison area. Of these, Ruby Dock (**Acetosa vesicaria*) is known to occur in the Meekatharra area on disturbed sites. This species was not observed or recorded during the recent surveys on the Jack Hills area.

4.10 FAUNA

4.10.1 Background and Survey Methodology

The fauna of the Jack Hills project area has been described and recorded during a reconnaissance level survey undertaken by Western Wildlife in October 2004 and two detailed surveys with trapping undertaken by MBS Environmental in September 2005 and Western Wildlife in March 2006.

The reconnaissance level survey as specified in EPA Guidance Statement No. 56 of the Jack Hills project area for vertebrate fauna was undertaken by Dr Robert Davis of Western Wildlife from 18 to 22 October 2004. The survey included bird surveys, spotlighting, hand foraging and opportunistic observations, searches of State and Commonwealth legislation and databases for fauna species of conservation significance, a description of the habitats and preparation of lists of species likely to occur within the project area. The results of this survey are provided in a report titled "Vegetation and Fauna Assessment, Jack Hills Iron Ore Project" (August 2005) prepared by MBS Environmental (Appendix 2.3).

The detailed spring and autumn fauna surveys were undertaken in accordance with EPA Guidance Statement No. 56 to provide supporting information for the reconnaissance level survey. The spring survey was undertaken from 14 to 20 September 2005 and comprised nine trap sites located on the different habitats over which the mining infrastructure and haul road will occur: four on the plain, three on the *Triodia* upland area, one on the lower scree slopes and one on a granite outcrop. With the exception of the granite trap site, each of the trap sites comprised five pipes and five buckets deployed up to 50 metres apart. Each individual pit had an aluminium fence line 30 centimetres high and six metres long. Cages and Elliot traps were located within the vicinity of the trap lines. Funnel traps were deployed at each pitline. The autumn survey was undertaken from 14 to 9 March 2006 and comprised the nine trap sites established during the spring survey, plus an additional trap (R1) established on the lower scree slopes.

Other activities undertaken during the fauna surveys included hand foraging for reptiles, bird inventories, spotlighting, scat and track searching and recording of microbat ultrasonic echolocation signals. An invertebrate trap filled with glycol was deployed at each pitline during the September 2005 survey. Harp traps were used to capture bats during the March 2006 survey.

The trapping results were compared with the reconnaissance survey results and species recorded from the October 2004, September 2005 and March 2006 surveys combined. Mr Mike Bamford of Bamford Consulting Ecologists undertook a peer review of the October 2004 and September 2005 results. The results of the September 2005 survey are provided in a report titled "A Vertebrate Fauna Survey of the Jack Hills Project Area, Murchison Region, Western Australia" (November 2005) prepared by MBS Environmental (Appendix 2.3, Volume 2) The location of the fauna trap sites shown in Figures 12a and 12b, results of the March 2006 survey are provided in a report titled "Jack Hills Project Area: 2006 Fauna Survey" (March 2006) prepared by Western Wildlife (Appendix 2.3, Volume 2).

4.10.2 Survey Effort and Coverage

The reconnaissance survey was undertaken in mid spring (October 2004) during a period of hot weather and the detailed surveys in early spring (September 2005) when temperatures were cooler and early autumn (March 2006), when temperatures were warm to hot, following heavy rain associated with Cyclone Emma.

Species accumulation curves developed from the pooled data from the September 2005 and March 2006 surveys indicate that the majority of the "trappable" species have been caught on the plains sites (P1, P2, P4 and P5) and the scree slope sites (R1 and R2) for the seasons sampled. The species accumulation curves for the rocky *Triodia* uplands sites (R3, R4 and R5) and the granite outcrop site (G) were still increasing. For the granite outcrop site, this probably reflects the low number of individuals caught. On the rocky *Triodia* upland sites it indicates that, while the overall number of individuals trapped is reasonable, a higher proportion of the species in the reptile assemblage were trapped only once or twice.

The survey work undertaken to date describes the fauna expected to occur within the study area and recorded over 60% of these fauna within the habitats and landform types that will be impacted by the project on the range and on the plains.

4.10.3 Habitats

Habitats of the Jack Hills project area and haul road route include:

- Plains
  - Stony plain of *Acacia rhodophloia* shrubland.
  - *Acacia rhodophloia* dominated drainage line.
  - Alluvial plain of *Acacia ramulosa* subsp. *linophylla* and *Acacia cuthbertsonii* subsp *cuthbertsonii* dominated shrubland.
  - Quartz plain.
- *Triodia* Uplands
  - Hummock grassland of *Triodia melvillei* on upper slopes and rocky ridges of main ranges.
- Scree Slope
  - Mixed low open *Acacia aneura* and *Acacia grasbyi/Acacia rhodophloia* shrubland over *Ptilotus obovatus* heathland lower scree slopes.
- Granite Outcrop
  - Exfoliating granite outcrop of *Acacia rhodophloia* open shrubland over *Eremophila fraseri* subsp. *galeata* and *Ptilotus obovatus* shrubland.

4.10.4 Vertebrate Fauna

A diversity of mammals is expected to occur in the region, although a large number of these are presumed extinct. A similar number of native rodent species and small carnivorous species are represented. Few medium sized mammals have survived changed burning regimes and feral predators. The reptile fauna of arid areas is typically rich and diverse.

The reconnaissance level survey established that the project area could support eight frog, 66 reptile, 110 bird and 28 mammal species. Nine of the mammal species are bats and five species are introduced. The September 2005 fauna survey recorded no frog, 24 reptile, 44 bird and 13 mammal species. Two mammal species (*Sminthopsis longicaudata and Scotorepens greyii*) and one of the reptile species (*Cyclodomorphus melanops elongatus*) were found in addition to the species listed as expected to occur. This is 39% of possible species recorded during the 2005 survey. The March 2006 fauna survey recorded four frog, 30 reptile, 54 bird and 13 mammal species. This is 47% of possible species recorded during the 2006 survey.

By combining the results of the October 2004, September 2005 and March 2006 surveys, a total of four frog, 20 mammal, 33 reptile and 72 bird species have been recorded from the Jack Hills project area. This brings the percentage of species recorded up to 60% of possible species. A full species list of fauna recorded during the surveys is given in Table 4.7.

Table 4.7: Fauna Species Recorded during Surveys of the Jack Hills Project Area

Species Name	Common Name
AMPHIBIANS	
Myobatrachidae (burrowing frogs)	
Limnodynastes spenceri	
Hylidae (tree frogs)	
Litoria rubella	Desert Tree Frog
Cyclorana maini	Main's Frog
Cyclorana platycephala	Water-holding Frog
MAMMALS	
Tachyglossidae (echidnas)	
Tachyglossus aculeatus	Echidna
Dasyuridae (carnivorous marsupials)	
Pseudantechinus woolleyae	Woolley's False Antechinus
Sminthopsis longicaudata	Long-tailed Dunnart
Sminthopsis macroura	Stripe-faced Dunnart
Macropodidae (kangaroos and wallabies)	
Macropus robustus	
Macropus rufus	Red Kangaroo, Marlu
Muridae (rodents)	
Mus musculus	House Mouse
Notomys alexis	Spinifex Hopping-mouse
Pseudomys hermannsburgensis	Sandy Inland Mouse
Emballonuridae (sheathtail bats)	
Taphozous hilli	Hill's Sheathtail Bat
Vespertilionidae (evening bats)	
Chalinolobus gouldii	Gould's Wattled Bat
Nyctophilus geoffroyi	Lesser Long-eared Bat

Species Name	Common Name
Scotorepens balstoni	Inland Broad-nosed Bat
Scotorepens greyii	Little Broad-nosed Bat
Vespadelus finlaysoni	Finlayson's Cave Bat
Molossidae (freetail bats)	
Tadarida australis	White-striped Freetail-bat
Canidae (dogs and foxes)	
Vulpes vulpes	Red Fox
Bovidae (horned ruminants)	
Capra hircus	Goat
REPTILES	
Typhlopidae (blind -snakes)	
Ramphotyphlops hamatus	
Elapidae (front-fanged snakes)	
Brachyurophis approximans	Northwest Shovel-nosed Snake
Gekkonidae (geckoes)	
Diplodactylus conspicillatus	
Diplodactylus pulcher	
Diplodactylus stenodactylus	
Gehyra punctata	
Gehyra variegata	Tree Dtella
Heteronotia binoei	Bynoe's Gecko
Oedura marmorata	
Rhynchoedura ornata	Beaked Gecko
Strophurus strophurus	
Pygopodidae (legless-lizards)	
Delma butleri	
Agamidae (dragon lizards)	
Ctenophorus scutulatus	Lozenge-marked Dragon
Ctenophorus caudicinctus	Ring-tailed Dragon
Ctenophorus nuchalis	
Ctenophorus reticulatus	Western Netted Dragon
Lophognathus longirostris	
Pogona minor	Western Bearded Dragon
Tympanocryptus cephala	
Scincidae (skink lizards)	
Cryptoblepharus plagiocephalus	Fence Skink
Ctenotus leonhardii	
Ctenotus schomburgkii	
Ctenotus severus	

Species Name	Common Name
Cyclodomorphus melanops elongatus	
Eremiascinus richardsonii	Narrow-banded Sand-swimmer
Lerista muelleri (rhodonoides)	
Menetia greyii	Grey's Skink
Varanidae (monitor-lizards)	
Varanus giganteus	Perentie
Varanus gouldii	Gould's Monitor
Varanus tristis	Black-tailed Tree Monitor
Varanus caudolineatus	
Varanus panoptes	
Boidae (pythons)	
Antaresia perthensis	Pygmy Python
BIRDS	
Dromaius novaehollandiae	Emu
Accipiter fasciatus	Brown Goshawk
Hamirostra melanosternon	Black-breasted Buzzard
Aquila audax	Wedge-tailed Eagle
Falco cenchroides	Nankeen Kestrel
Falco peregrinus	Peregrine Falcon
Falco longipennis	Australian Hobby
Burhinus grallarius	Bush Stone-curlew
Phaps chalcoptera	Common Bronzewing
Ocyphaps lophotes	Crested Pigeon
Geopelia cuneata	Diamond Dove
Cacatua roseicapilla	Galah
Psephotus varius	Mulga Parrot
Barnardius zonarius	Australian Ringneck
Neophema bourkii	Bourke's Parrot
Haliastur sphenurus	Whistling Kite
Cuculus pallidus	Pallid Cuckoo
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo
Eurostopodus argus	Spotted Nightjar
Todiramphus pyrrhopygia	Red-backed Kingfisher
Malurus splendens	Splendid Fairy-wren
Pyrrholaemus brunneus	Redthroat
Gerygone fusca	Western Gerygone
Acanthiza uropygialis	Chestnut-rumped Thornbill
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Paralotus striatus	Striated Pardalote

Species Name	Common Name
Acanthiza apicalis	Inland Thornbill
Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Manorina flavigula	Yellow-throated Miner
Lichenostomus virescens	Singing Honeyeater
Lichmera indistincta	Brown Honeyeater
Petroica goodenovii	Red-capped Robin
Microeca leucophaea	Jacky Winter
Pomatostomus temporalis	Grey-crowned Babbler
Pomatostomus superciliosus	White-browed Babbler
Cincloramphus mathewsi	Rufous Songlark
Psophodes occidentalis	Chiming Wedgebill
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush
Daphoenositta chrysoptera	Varied Sittella
Oreoica gutturalis	Crested Bellbird
Pachycephala rufiventris	Rufous Whistler
Colluricincla harmonica	Grey Shrike-thrush
Rhipidura leucophrys	Willie Wagtail
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Artamus cinereus	Black-faced Woodswallow
Artamus minor	Little Woodswallow
Hirundo neoxena	Welcome Swallow
Cheramoeca leucosternus	White-backed Swallow
Cracticus torquatus	Grey Butcherbird
Cracticus nigrogularis	Pied Butcherbird
Gymnorhina tibicen	Australian Magpie
Corvus orru	Torresian Crow
Corvus sp.	Crow species
Anthus novaeseelandiae	Richard's Pipit
Taeniopygia guttata	Zebra Finch
Hirundo nigricans	Tree Martin

The fauna survey also allowed for some comparisons of the fauna between landform types. Interesting reptile records were gained from the *Triodia* uplands sites: *Cyclodomorphus melanops elongatus* and *Delma butleri* are both *Triodia* associated species (Storr *et al.* 1999). These two species were not found on any of the plain sites suggesting that the two species are associated with the Jack Hills Range, which is substantially larger than the project area surveyed. In addition, some bird species such as the Little Woodswallow and Grey-crowned Babbler favour the ranges, and the Long-tailed Dunnart would favour rocky areas on the range.

4.10.4.1 Results of Fauna Surveys

The fauna survey served to confirm the presence of some species and was notable for

records of several species of conservation significance. Species recorded were generally common arid zone species with the exception of the Schedule 4 listed species Peregrine Falcon (*Falco peregrinus*), the Priority 4 CALM listed species Long-tailed Dunnart (*Sminthopsis longicaudata*) and Bush Stone-curlew (*Burhinus grallarius*) and the locally significant Black-breasted Buzzard (*Hamirostra melanosternon*). The Rainbow Bee-eater was also recorded and is classified as a migratory species by the EPBC, but it is common and widespread. A further 20 species of conservation significance were identified as potentially occurring in the area, though none were observed during the survey. A southerly range extension was the record of the Little Broad-nosed Bat (*Scotorepens greyii*). The Western Australian Museum Faunabase Records show the Little Broad-nosed Bat as occurring throughout the Kimberley and west to central Pilbara (Western Australian Museum, 2005).

4.10.4.2 Fauna of Conservation Significance

A threatened fauna species search was undertaken by CALM on 11 October 2004 of the area defined by the coordinates 26.4023 – 25.6599°S and 116.849 – 117.596°E. An EPBC protected matters search defined by the coordinate 26.01703°S, 117.28308°E (20 kilometre buffer) was also undertaken. The search results are provided in Appendix 2.2 of this report (Volume 2) and fauna species of conservation value are listed in Table 4.8.

Table 4.8: Results from CALM and EPBC Database Searches for Fauna Species of Conservation Value

Species	Common Name	Conservation Category
CALM Search		
Macrotis lagotis	Bilby	Schedule 1
Falco peregrinus	Peregrine Falcon	Schedule 4
Pseudomys chapmani	Western Pebble Mound Mouse	Priority 4
EPBC Search		
Acanthiza iredalei	Slender Billed Thornbill	Vulnerable
Charadrius veredus	Oriental Plover	Migratory Wetland Species
Apus pacificus	Fork-tailed Swift	Migratory (overfly marine areas)
Adea alba	Great Egret	Migratory (overfly marine areas)
Merops ornatus	Rainbow Bee-eater	Migratory (overfly marine areas)

Source: CALM (2004), Department of the Environment and Heritage (2004)

Table 4.9 lists the species of conservation significance recorded or potentially occurring in the region and the likely occurrence of threatened species and species of conservation concern are discussed below.

Table 4.9: Fauna of Conservation Significance (Maxwell *et al)*

Species	Common Name	Comment
MAMMALS		
Threatened Species (TS)		
Macrotis lagotis	Bilby	The Greater Bilby is listed as Vulnerable under the *Wildlife Conservation Act 1950* and the *EPBC Act 1999*.
Petrogale lateralis	Black-flanked Rock Wallaby	This rock-wallaby is listed as Vulnerable under the *Wildlife Conservation Act 1950* and the *EPBC Act 1999*.
Conservation Concern (CC)		
Sminthopsis longicaudata	Long-tailed Dunnart	This dunnart is listed as Priority 4 by CALM
Pseudomys chapmani	Western Pebble-mound Mouse	This mouse is listed as Priority 4 by CALM
Local Significance (LS)		
Antechinomys laniger	Kultarr	The Kultarr is listed as data deficient by Maxwell *et al*. (1996).
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	This species is at the southern edge of its range in the region.
AMPHIBIANS		
Local Significance (LS)		
Neobatrachus centralis	Desert Trilling Frog	This frog is only known with certainty from one locality 21km south-west of Mount Magnet.
Neobatrachus sutor	Shoemaker Frog	This frog is at the western edge of its range in the Jack Hills area.
Pseudophryne occidentalis	Western Toadlet	This frog may be at the northern edge of its range in the Jack Hills area.
REPTILES		
Conservation Concern (CC)		
Lerista eupoda	Skink	This skink is listed as Priority 1 by CALM
Egernia stokeii badia	Western Spiny-tailed Skink	This skink is listed as Vulnerable under the *Wildlife Conservation Act 1950.*
Locally Significant (LS)		
Diplodactylus wellingtonae	Gecko	This spiny-tailed gecko may be at the western edge of its range.
Lerista uniduo	Skink	This skink may be at the eastern edge of its range in the Jack Hills area.

Species	Common Name	Comment
Ctenophorus ornatus	Ornate Crevice Dragon	This dragon may be at the north-western edge of its range.
BIRDS		
Threatened Species (TS)		
Falco peregrinus	Peregrine Falcon	This falcon is listed as 'other specially protected fauna' under the *Wildlife Conservation Act 1950*.
Cacatua leadbeateri	Major Mitchell's Cockatoo	This cockatoo is listed as 'other specially protected fauna' under the *Wildlife Conservation Act 1950*.
Migratory Species (Mig.)		
Merops ornatus	Rainbow Bee-eater	Listed under JAMBA and as such are protected under the *EPBC Act 1999*.
Apus pacificus	Fork-tailed Swift	Listed under JAMBA and CAMBA, and as such are protected under the *EPBC Act 1999*.
Adea alba	Great Egret	Listed Marine Species under the *EPBC Act 1999*.
Charadrius veredus	Oriental Plover	Listed under the *EPBC Act 1999* as Migratory Wetland Species.
Conservation Concern (CC)		
Burhinus grallarius	Bush Stone-curlew	This species is listed as Priority 4 by CALM and as 'near threatened' by Garnett and Crowley (2000).
Ardeotis australis	Australian Bustard	The bustard is listed as Priority 4 by CALM and as 'near threatened' by Garnett and Crowley (2000).
Falco hypoleucos	Grey Falcon	This rare falcon is listed as Priority 4 according to CALM and classified as 'near threatened' by Garnett and Crowley (2000).
Local Significance (LS)		
Hamirostra melanosternon	Black-breasted Buzzard	The Black-breasted Buzzard was observed opportunistically on the plain. These species have undergone a possible 20 percent decline in the Murchison region, according to Barrett *et al.* (2003).
Conopophila whitei	Grey Honeyeater	Under-surveyed species. Although it has no formal conservation listing, this species is always scarce and may be under-surveyed.

Species	Common Name	Comment
Aphelocephala nigricincta	Banded Whiteface	Under-surveyed species. Records of this species in the Murchison are rare and it may be at the western edge of its range in this region (Barrett *et al.* 2003).
Neophema splendida	Scarlet-chested Parrot	Under-surveyed species. This species is irruptive in good years and may occur in the study area as a rare visitor.
Charadrius australis	Inland Dotterel	Under-surveyed species. Highly under-reported in WA (Barrett *et al.* 2003) with recent records in the Murchison.

a) Vulnerable (Commonwealth *EPBC Act 1999*) and Schedule One Listings (Western Australian *Wildlife Act 1950*)

Bilby (*Macrotis lagotis*)

Although listed as extinct, there is a confirmed record of the Bilby from the region on the CALM Threatened Fauna Database in 1961 near the study area at Mileura Station. This species has suffered an epidemic decline in distribution and abundance in the last 50 years and is now regarded as extinct in the Murchison region.

Black-flanked Rock Wallaby (*Petrogale lateralis)*

The Black-flanked Rock Wallaby is patchily distributed in Western Australia, where it is associated with breakaways and ranges, particularly those containing large boulders. Although not recorded from the study area, the Jack Hills range represents ideal habitat for this species and commentary from CALM (C. Freegard pers. comm.) indicates that there have been recent records of populations from the broader area. The Black-flanked Rock Wallaby is unlikely to be found on the plains of the haul road due to the absence of breakaways and ranges but may occur on the high slopes of the Jack Hills Range.

Slender-billed Thornbill (*Acanthiza iredalei*)

Listed on the Environment Protection and Biodiversity Conservation (EPBC) Protected Matters database as potentially occurring, this species inhabits samphire particularly around salt lakes. This habitat is not present on the project area.

b) Priority Taxa

Western Pebble Mound Mouse (*Pseudomys chapmani)*

The Western Pebble Mound Mouse is listed as a Priority 4 species by CALM. A key characteristic of the Western Pebble Mound Mouse is its construction of mounds of pebbles up to nine square metres in area. Mounds are usually situated on rocky scree slopes on the many ranges of iron ore country of the arid Pilbara region. This species may occur in the project area although no mounds have been sighted to date.

Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Long-tailed Dunnart is listed as Priority 4 by CALM. This species is mainly found among rocky hills and breakaways in the western arid zone, typically vegetated by a sparse mulga shrubland (Burbidge *et al* in Strahan, 1998). The Long-tailed Dunnart is not as rare as was once believed and they occur on almost every stony substrate in the

Murchison with more than 60 individuals caught over the last couple of years (Mark Cowan pers comm).

Lerista eupoda
No threatened species of reptile are known from the region, although the Priority 1 species *Lerista eupoda* may occur in the area.

c) Other Specially Protected Fauna (Western Australian *Wildlife Act 1950)*
Peregrine Falcon (*Falco peregrinus*)
The Peregrine Falcon is a wide-ranging bird of prey; therefore the study area may support a pair of these birds. This species has been recorded from the area by Birds Australia and was recorded on the plains during the March 2006 survey. The Peregrine Falcon nests on cliffs and in large trees. The proposed mine may locally impact on this species however ample breeding habitat is available on Mount Hale and other locations within the greater area.

Major Mitchell's Cockatoo (*Cacatua leadbeateri)*
This species has been recorded from the area by Birds Australia. This species is scarce and patchily distributed in Western Australia and has a core range in the arid woodlands of Western Australia. Major Mitchell's Cockatoos nest in large tree hollows. The proposed project could impact upon this species if large trees with breeding hollows are disturbed.

d) Migratory Species (Commonwealth *EPBC Act 1999*)
Rainbow Bee-eater (*Merops ornatus*)
The Rainbow Bee-eater is classified as a migratory species by the *EPBC Act 1999*, but it is common and widespread. The Rainbow Bee-eater is likely to be a common breeding visitor to the site. This species breeds in the south in summer, in burrows in sandy banks. There is scant information on breeding in the Murchison, but it may breed in the study area where sand is exposed. Due to the widespread habitat of this species it is unlikely that the proposed project will to impact upon the conservation status of this species.

Fork-tailed Swift *(Apus pacificus*)
The Fork-tailed Swift is protected under the *EPBC Act 1999* and international conventions. It is a largely aerial species, and unlikely to be impacted by the proposed mine and haul road construction.

Great Egret (*Ardea alba*)
The Great Egret (*Ardea alba*) inhabits terrestrial wetlands, estuarine and littorial habitats and moist grasslands. It prefers permanent waterbodies on floodplains and the shallows of deep permanent lakes (Marchant and Higgins 1993). The intermittent creek lines in the project area are unlikely to provide extensive feeding habitat for the species and impacts from the proposed action on the species can thus reasonably be considered minimal. Given that the land systems affected by the project are also represented widely on a regional scale, it is unlikely a highly localised disturbance such as the proposed mining project would impact on the conservation status of the Great Egret.

Oriental Plover (*Charadrius veredus*)
The Oriental Plover was also listed on the EPBC database search but is considered highly unlikely to occur in the study area, as there are no wetlands.

e) Conservation Concern
Australian Bustard (*Ardeotis australis*)
The Australian Bustard listed as Priority 4 by CALM is threatened by hunting and habitat

degradation in the region. Bustards were recorded from the area by Birds Australia and may be impacted by the haul road and village infrastructure, as it is largely a plain-dwelling species.

Bush Stone-curlew (*Burhinus grallarius*)
This species, listed as Priority 4 by CALM has been recorded from the project area by Birds Australia and it may be present where there is open ground such as along tracks and woodland areas. Three Bush Stone-curlews were observed on the plain close to the Beringarra turn off during the trap establishment in August 2005. The main threats to the Bush Stone-curlew are foxes, habitat clearing for agriculture, habitat degradation by pastoralism and removal of leaf litter and fallen timber debris from habitat remnants (Johnson and Baker-Gabb 1994). This species may be impacted by the haul road and village infrastructure, as it is largely a plain-dwelling species.

Grey Falcon (*Falco hypoleucos*)
The Grey Falcon, listed as Priority 4 by CALM, could be present anywhere within the study area. Garnett and Crowley (2000) note that it favours plains with acacia shrubland and tree-lined watercourses. This species breeds in the nests of other bird species in tall trees along watercourses (Garnett and Crowley 2000) but is unlikely to breed in the region. Although not recorded from the area by Birds Australia, Storr (1985) describes the species as a rare visitor to the region.

f) Local Significance
Yellow-bellied Sheath-tailed Bat *(Scaccolaimus flaviventris)*
The Yellow-bellied Sheath-tailed Bat is largely found in the tropics, but may extend south to the project area. On the project area it may roost in tree hollows or in the burrows of terrestrial mammals (Menkhorst and Knight 2001) and may be impacted upon by the proposed mine, haul road and airstrip.

Kultarr (*Antechinomys laniger)*
The small marsupial the Kultarr is scarcely recorded throughout its range in WA and is listed as data deficient in the Action Plan for Australian Marsupials and Monotremes (Maxwell *et al.* 1996). This species is known to occur in the study region with records from Mileura station by the Western Australian Museum. Clearing for the minesite, haul road and airstrip and may impact upon local populations of Kultarr if they inhabit the area. Secondary impacts such as an increase of fox and cat numbers to the area may also impact on local populations.

Birds listed as being of local significance (LS) have all been recorded as experiencing a greater than 20 percent decline by Barrett *et al*. (2003). These species will be further impacted by habitat loss in the region. Four species of bird have been listed for which there is little known and any records are rare. The Grey Honeyeater (*Lacustroica whitei*) is a scarcely recorded bird of the arid mulga described by Storr (1985) as scarce and patchily distributed. The Banded Whiteface (*Aphelocephala nigricincta*) has been recorded recently from the area (C Elliott pers. comm.) and there are very few records in the Murchison in Barrett *et al*. (2003). Storr (1985) records this species as generally scarce, but locally common in good years. It prefers stony country such as that found throughout the area. The Scarlet-chested Parrot (*Neophema splendida*) is an irruptive species with a core range further to the east. Storr (1985) describes it as a rare vagrant with historical records in the region.

There were similarly few records of the Inland Dotterel (*Peltohyas australis*) from the study region in Barrett *et al*. (2003). Storr (1985) describes this species as uncommon and occurring in small numbers on sparsely vegetated plains or stony flats. This species has

been recorded close to the study area (C Elliott pers. comm.). Inland Dotterels construct concealed nests on the ground and could be impacted by vehicle traffic and clearing of the haul road.

4.10.5 Invertebrate Fauna

4.10.5.1 Short Range Endemic Species

A meeting was held on 31 October 2005 between Dr Mark Harvey of Western Australian Museum, Mr Frank Sibbel of Murchison Metals Ltd and Mr Lance Bosch of MBS Environmental to discuss the proposed Jack Hills iron ore project and the potential impacts to short range endemic (SRE) invertebrate fauna species that may occur on the Jack Hills range. The scope and extent of the project was presented on aerial photographs and the results of Western Australian Museum identifications of invertebrate specimens collected by Murchison Metals Ltd in September 2005 were also discussed.

These discussions established that:

- SRE invertebrate fauna are likely to occur on the Jack Hills Range and that they are unlikely to be restricted to the Jack Hills project area.
- Native millipedes, snails and trapdoor spiders are the SRE invertebrate fauna likely to be of most importance.
- SRE invertebrate fauna prefer the southern and south-eastern facing aspects of the range and be located in dissected and protected areas which provide refuges, suitable habitat and food source. SRE invertebrate fauna are expected to occur over the entire range within suitable refuges usually with southern and south-eastern aspects.
- The project will have minimal impact on these preferred areas and more interesting areas are located outside of the project area.
- It was not considered necessary for a SRE invertebrate fauna to be surveyed or described for the Jack Hills project as proposed.

Dr Harvey advised in a letter of 14 November 2005 to MBS Environmental (Appendix 1.1, Volume 1) that "Given the location of proposed development in relation to suspected SRE habitat, it is probably not necessary to conduct surveys for SRE's at this time."

It was concluded with Dr Harvey that should Murchison Metals Ltd propose expanding the project in the future such that potential SRE habitat could be impacted, then Western Australian Museum would recommend a series of winter sampling programmes be undertaken in order to assess potential impacts to SRE invertebrate fauna. Extensive hand foraging is considered by Western Australian Museum to be highly effective, while pitfall trapping could augment results.

In an email dated 1 December 2005 Mr Daniel Coffey advised that CALM had no further comments on short range endemics.

4.10.5.2 Subterranean Fauna

No carbonate rocks or rock types with cavities forming positive permanent contact to the surface are expected within the Jack Hills Range. The locations of "perched" water lenses discovered by drilling appear, from the geological context, to be controlled by lack

of porosity and permeability in immediately underlying rocks. In adjacent holes, indications of "perched water level" differs by several or even tens of metres, yet recorded wet samples rarely exceeded two metres. The lack of porosity continuity and absence of permanent groundwater does not provide habitats likely to support stygofaunal life forms within the Jack Hills Range.

Discussions with Dr Harvey of WAM indicate there is the potential for troglofauna to occur within many different subterranean environments where there are voids or cavities which may have had previous connection to the surface that remain or have since become disconnected. During the recent drilling programmes within the Jack Hills exploration lease, no caves have been discovered and only small (less than 10 to 15 centimetres) cavities have been recorded in iron ore occurrences elsewhere. Dr Harvey was of the opinion that if troglofauna were to occur within any potential subterranean habitats of the Jack Hills range, then such invertebrate fauna are likely to be widespread where linkages remain between similar habitats. The homogeneity and subvertical layering of the BIF geological formations within the project area and throughout much of the range is likely to provide such linkage and continuity should any subterranean cavities exist. Consequently, it is unlikely any short range endemism of troglofaunal life forms would be restricted to small parts of the range, should they occur.

The weathered granitoids are generally impermeable and groundwater is associated with structural features associated with jointing, fractures and faulting which do not contain significant voids or vugs or provide habitats that support stygofaunal life forms. Shallow calcrete aquifers underlying the alluvial plains and the possibility of deeper palaeochannels associated with the Murchison River could provide habitat that may support stygofaunal life forms, subject to water quality being fresh to brackish. The alluvial plains and drainage systems within the Murchison are extensive.

4.11 SOCIAL ENVIRONMENT

4.11.1 Land Use

The project area is mostly located in the Shire of Meekatharra with only the very northern portion of M20/506 falling within the Shire of Murchison. The mine haul road is mostly located within the Shire of Murchison. The Cue to Beringarra public road is located in both the Shires of Murchison and Cue.

The region is sparsely populated. The Australian Bureau of Statistics (2005) provides estimated 2003 population figures for the Shire of Meekatharra of 1,488, the Shire of Murchison of 162 and the Shire of Cue of 370. Mining, pastoral and tourism activities are the principal economic activities in the area.

The main transport routes through the region are the Great Northern Highway and the Geraldton to Mt Magnet Road.

The closest dwelling is the Mt Hale station 30 kilometres east of the project area.

A Radio Astronomy Park (RAP) site is proposed 96 kilometres north of Cue and 71 kilometres south of the Jack Hills minesite. The area selected is reliant on its remoteness and absence of radio frequency interference. The RAP is a joint venture of the CSIRO, WA and Commonwealth Governments.

With the establishment of the truck infrastructure and the creation of employment in the town of Cue the Cue Shire is very supportive of the project.

4.11.2 Aboriginal Heritage

MML has entered into an Aboriginal Heritage Protection Agreement with the Native Title Parties and their Representative Body the Yamatji Land and Sea Council to ensure that its exploration activities do not disturb any places of heritage significance to the claimants. Under this Agreement a number of heritage surveys have been undertaken over the project area where ground disturbing activities were proposed.

A search of the Register of Aboriginal Sites maintained by the Department of Indigenous Affairs reveal that there are no registered Aboriginal sites that would be impacted by the project. No sites of cultural significance to the representatives of the Wajarri Yamatji Claimant Group were located along the haul road. A minor isolated artefact was recorded 20 metres off the centreline of the haul road and will not be disturbed. This does not constitute an Aboriginal site.

A heritage survey of the minesite conducted on 21 to 22 March 2006 by the Yamatji Land and Sea Council and seven representatives of the Warraji Yamatji Claimant group found no sites of cultural significance as detailed in a letter of 5 April 2006 (Appendix 2.6, Volume 2). Ethnographic heritage clearance was given for the mining proposal. An archaeological survey of the minesite was conducted by archaeologist Wayne Glendenning on 21 to 22 March 2006 recorded one archaeological site. The site is a low density artefact scatter located within the pit layout (524329 E, 711857 N). The Warraji Yamatji representatives discussed the site with the archaeologist and agreed that the site was of low significance and it was suggested that once permission was obtained from the Minister for Indigenous Affairs, to disturb the site that representatives of the Warraji Yamatji assist in the salvage and relocation of the artefacts. The archaeological report is provided in Appendix 2.6 of Volume 2.

In addition to the Aboriginal Heritage Protection Agreement, MML has also agreed to apply an Aboriginal Heritage Protocol to any ground disturbing activities relating to the proposed mining operations. This Protocol forms part of the Mining Project Agreement with the Native Title Parties. It provides for surveys to be carried out with the appropriate traditional owners selected by the Native Title Parties.

5. WASTE CHARACTERISATION

The physical and chemical properties of some waste fractions often have the potential to cause environmental contamination and to adversely affect the success of rehabilitation. This applies especially to fractions which have the potential to produce acid, have heavy metals in concentrations which may be environmentally harmful or become harmful under acidic conditions, have dispersive clays, form surface crusts and are generally inherently unstable.

In July 2004 a waste characterisation study was undertaken by Geochemist Dr Ian Martin of MBS Environmental from drill samples provided by MML. Wastes will consist primarily of five groups of oxidised and fresh rock, which are defined in Appendix 2.5 (Volume 2). The predominant materials will be low iron grade iron oxide – quartz rocks (magnetite – hematite quartzite, banded iron formation); inter-laminated banded iron formation and (quartz) – chlorite schist; with lesser amounts of argillite, granitoid and pegmatitic intrusives and thick chlorite/talc-chlorite schist which are derived from mafic rocks of both sedimentary and possibly intrusive affinities.

Eighteen samples mainly consisting of six metre drill hole composites, representing all rock types from the proposed first open pit were microscopically examined. Only four of these samples contained trace amounts of microscopically visible sulphide. No samples reacted with hot 1N hydrochloric acid. No apatite or other phosphate minerals were recorded and all samples were free of radioactive minerals.

On the basis of the microscopic examination, these samples have been submitted for acid digestion and circum-neutral leaching procedures for 18 elements, pH and Electrical Conductivity. The results and a geochemical interpretation are included as Appendix 2.5 (Volume 2). Table 5.1 lists the pH, EC, soluble arsenic, bismuth, cadmium, cobalt, copper, lead, molybdenum, nickel, zinc, and total sulphur values, the latter indicating clearly, that there is no likelihood of any acid generation from the wastes.

Based on Dr Martins' examination, none of these wastes have chemical properties that may cause heavy metal toxicities or environmental pollution. They also have no capacity to generate acid in volumes and concentrations that will give rise to environmental concern. The same will apply to wastes generated from other iron resource areas within the tenements.

Problems with waste rock stockpile erosion have been recorded at existing iron ore mines in the Pilbara and at Tallering in the Yalgoo Mineral Field. The Jack Hills and Weld Range iron ore horizons differ significantly in their degree of weathering, geological and topographic settings from these other mines and a similar situation is unlikely to occur.

Most waste rock stockpiles in iron ore mines elsewhere in Western Australia have been constructed using the standard 'bottom-up' construction methodology. With this mode of construction, rehabilitation of most or all of the waste rock stockpile is undertaken at mine closure, resulting in erosion from top to bottom where significant rainfall events occur prior to substantial vegetation establishment. With the 'top-down' procedure rehabilitation can commence early and proceed throughout the mine cycle.

In specific cases where iron ore is interbedded with shale, the common situation with the Brockman, Marra Mamba Formation iron ores, a high proportion of waste appears benign when placed on waste rock stockpiles then rapidly degrades to dispersive easily eroded clays. At some mines, large quantities of black pyritic shale waste occur. This can

acidify as well as degrading to dispersive clay and requires careful waste rock stockpile placement.

At the Tallering Mine near Mullewa, lateritic alteration has developed a wide, deep kaolin zone above the water table from chloritic schists and ankerite-bearing magnetite schists enclosing the iron ore. As a result, a high proportion of early mined waste is pale creamy-pink to pinkish-brown dispersive clay. This is likely to create short term erosional problems in the waste rock stockpiles. With deeper mining operations and after reaching the water table, fresher waste rock will be considerably less dispersive and improve the long term erosional scenario.

At Jack Hills, the waste rock enclosing ore will be approximately 40 percent moderately fresh, semi-massive banded iron formation, 50 percent slightly to moderately weathered chloritic schist and 10 percent of ankerite-bearing argillic magnetite/quartz/minnesotaite schist with at least one narrow mafic sill. Waste rock types are similar to those at Tallering but with only one to two metres of slightly weathered overburden above basically fresh rock. Argillic (clay-bearing) rock will be less than five percent of the total waste and should report entirely during the initial phase of stockpile construction. This material will be dispersive, a distinctive cream to light tan colour and can be encapsulated at the base of the waste rock stockpile, taking care to avoid the 'under drain' location.

It is anticipated that 60 percent of the waste will be rock fragments exceeding 50 millimetres in at least one dimension with a low content of material finer than 10 millimetres. The waste should be highly resistant to erosion.

Table 5.1: Location and Geological Details, Total Sulphur, pH and Electrical Conductivity plus Potentially Toxic Element Contents

Sample No.	Zone	Reduced Level	Potentially Toxic Elements plus Sulphur, pH and EC											
Short Description	Data by MML	Upper to Lower Levels												
Element			**pH**	**EC**	**As**	**Bi**	**Cd**	**Co**	**Cu**	**Mo**	**Ni**	**Pb**	**Total - S**	**Zn**
Units			NONE	µS/cm	µg/kg	µg/kg	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	percent	mg/kg
Detection Limit			0.1	5	0.1	0.01	0.02	0.05	0.05	0.05	0.05	0.5	0.001	0.05
Analytical Method			W/MTR	W/MTR	W/MS	W/MS	W/MS	W/OES	W/OES	W/MS	W/OES	W/MS	Aqua Regia	W/OES
017 030-036 Magnetite Quartzite	**1**	520.7 - 515.1m	9.4	72	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.13	<0.5	0.02	<0.05
020 054-060 Argillite & BIF	**1**	480.4-474.3m	9.2	46	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.05	<0.5	0.02	<0.05
019 062-068 BIF & Mafic sediment	**1**	479.9 - 474.7m	9.7	131	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.06	<0.5	0.06	0.10
018 022-028 Mafic schist	**2**	516.6 - 511.4m	9.4	85	<0.1	<0.01	<0.02	<0.05	0.18	<0.05	0.09	<0.5	0.05	<0.05
003 051-057 Argillaceous and Chloritic schist, BIF	**2**	488.9 - 483.7m	8.4	46	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.10	<0.5	0.03	<0.05
017 061-063 Mafic schist & BIF	**2**	491.6 - 489.7m	9.8	170	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	<0.05	<0.5	0.03	<0.05
022 096-102 BIF & argillite interbeds	**2**	466.2 - 461.0m	8.7	41	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	<0.05	<0.5	0.01	<0.05
021 070-076 BIF & mafic schist	**2**	458.9 - 453.0m	9.9	181	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.13	<0.5	0.01	<0.05
016 062-068 BIF	**BIF**	507.5 - 502.3m	8.1	40	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.05	<0.5	0.02	<0.05

Sample No.	Zone	Reduced Level	Potentially Toxic Elements plus Sulphur, pH and EC											
Short Description	Data by MML	Upper to Lower Levels												
007 070-076 Chloritic BIF	**BIF**	488.6 - 482.6m	9.6	109	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	<0.05	<0.5	0.04	<0.05
003 070-076 Chloritic BIF	**BIF**	492.5 - 487.3m	9.2	69	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.06	<0.5	0.01	<0.05
005 080-086 BIF	**[3]**	483.1 - 474.4m	9.3	55	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.06	<0.5	0.03	<0.05
022 060-066 Mafic (dolerite) schist	**3**	497.4 - 492.2m	9.2	59	<0.1	<0.01	<0.02	<0.05	0.19	<0.05	0.07	<0.5	0.02	<0.5
016 090-096 Mafic schist	**3**	486.2 - 481.0m	8.6	37	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.10	<0.5	0.01	<0.05
007 106-110 Mafic schist	**3**	452.7 - 448.8m	8.7	32	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	<0.05	<0.5	0.03	<0.05
026 106-112 Chlorite & Talc-Chlorite Schist	**3**	458.4 - 452.4m	9.3	63	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.10	<0.5	0.01	<0.05
003 103-109 BIF	**[3]**	452.1 - 446.5m	8.9	44	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.10	<0.5	0.04	<0.05
003 110-116 BIF	**FW Ore Zone**	445.6 - 439.9m	9.5	124	<0.1	<0.01	<0.02	<0.05	<0.05	<0.05	0.06	<0.5	0.01	<0.05

Reference Data

022 096-102	Drill Hole 022, sampled from 96.0m to 102.0m depth.
Geological Description	Description from microscope examination, not from drill logs.
Zone 2	See open pit sketch geological cross-section in Appendix 2.5 (Volume 2).
Reduced Levels	Actual vertical interval covered by the sample.
Total - S percent	Total sulphur in sample. Values < 0.3 percent S will not produce environmentally significant sulphuric acid upon oxidation.
[3]	Marginal material to BIF lens between Zones 2 and 3 or to Footwall Ore. Treated as portion of Waste Zone 3.

6. REHABILITATION, DECOMMISSIONING AND CLOSURE

6.1 GUIDELINES

Key government and industry guidelines for mine closure are listed in Table 6.1.

Table 6.1: Key Government and Industry Guidelines for Mine Closure

Guideline	Purpose
Australian Minerals Industry (AMI) Code for Environmental Management (MCA, 2000).	Framework including consultation, progressive rehabilitation and reporting.
Strategic Framework for Mine Closure (ANZMEC/MCA, 2000) (a joint government and industry guideline).	Framework including upfront planning for closure, consultation, progressive rehabilitation and reporting.
Guideline Safety Bund Walls Around Abandoned Open Pit Mines. Department of Minerals and Energy of Western Australia (1997).	Design of abandonment bunds around open pits to prevent vehicular access.
Mine Closure Guideline for Mineral Operations in Western Australia (Chamber of Minerals and Energy WA Inc. 2000).	Framework including consultation, progressive rehabilitation and reporting.
Mine Closure Policy (MCA, 1999).	Policy on mine closure.
Mine Rehabilitation Handbook (MCA, 1998).	Stakeholder consultation and financial provisioning.
Assessment Levels for Soil, Sediment and Water (DoE, V3 Nov 2003).	Threshold levels for contaminated soils.
ANZECC/ARMCANZ: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.	Establishing water quality criteria using previous monitoring data and site specific factors, to establish standards to be achieved at closure.
The Commonwealth Environmental Protection Agency series 'Best Practice Environmental Management in Mining'.	Industry examples of mining practices.
Guidance for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems. Draft No. 6 (EPA 2006)	Closure strategy and description of objectives, targets and review during mine operation.

Decommissioning and closure will include the following provisions:

- The pit will be decommissioned by extending the safety bund across the entry ramp, constructing an abandonment bund to DoIR standards and erecting signs.
- Rehabilitation of the Waste Rock Stockpile.
- All surfaces to be rehabilitated within the project area that were compacted by mining related activities will be ripped to create conditions which will enhance the establishment of self sustaining native vegetation.
- Prior to shutdown, clean up the process facilities and process any materials, including the run-of-mine ore pad.

- Identify bores, pipelines, power supply and accommodation infrastructure required to remain operational during closure activities.
- Identify and prepare a list of all equipment that can be donated to neighbouring communities, sold or recycled.
- Salvage pumps and other equipment.
- Identify and remove for disposal, hazardous materials, machinery and equipment.
- Demolish remaining buildings and other infrastructure, and dispose of the demolition waste in the onsite landfill.
- Decommission bores, seal and plug below ground.
- Ensure that, once infrastructure is no longer required for closure activities, it is removed.
- Decommission non-essential roads including the re-establishment of natural drainage, lines by removing culverts, trenching, and revegetating.

6.2 GENERAL PROCEDURES

6.2.1 Minimising Erosion

The Jack Hills project is located within a climatic zone characterised by high intensity rainfall events. Therefore, the prevention and management of erosion is important. MML will reduce the potential for erosion by:

- Restricting clearing and disturbance to the minimum required for safe and efficient operations.
- Undertaking rehabilitation progressively where possible.
- Ensuring surface runoff diversion structures discharge into well-vegetated or rock-armoured points in natural drainages.
- Siting infrastructure to reduce the potential for erosion (e.g. establishing roads along the contour of the land where possible).
- Minimising alteration to natural drainage patterns.

6.2.2 Clearing of Vegetation

All vegetation cleared from the site will be retained for use during rehabilitation. Vegetation returned to disturbed areas provides:

- A source of seed and organic matter.
- Physical protection against erosion.
- Habitat for fauna.

Cleared vegetation will be respread immediately, if possible, or will be stored on top of the topsoil stockpile areas. It will then be respread as part of the rehabilitation programme within the same habitat and vegetation type from which it was cleared.

6.2.3 Seed Collection

A seed collection programme will be established and implemented during the life of the project so that local seed sources are used in the rehabilitation programme. This programme will be undertaken on a seasonal basis by a seed merchant or local personnel under the direction of MML.

The species selected for the revegetation programme will depend on the site conditions specific to each area to be rehabilitated (e.g. slope, drainage and soil characteristics). In the event that insufficient quantities of seed are available from the project area (e.g. due to poor seasons, loss through bushfire, or poor viability of seed collected) then seed of local provenance will be sourced. If local seed is unavailable, alternative sources will be selected in consultation with DoIR and CALM. Direct seeding will be undertaken immediately prior to the expected onset of seasonal rains.

6.2.4 Topsoil Management

Topsoil stockpiles will be located to minimise the potential for their erosion. The soils will be stripped in a dry state to preserve soil structure and during relatively still wind conditions.

The dimensions of the topsoil stockpiles will not exceed two metres in height and 50 metres in length. This is to prevent topsoil from becoming anaerobic and deteriorating in soil structure, organic matter, nutrients, seed resource and populations of beneficial soil micro-organisms. Stockpiles will be located sufficiently distant from mining operations so that they will not be disturbed prior to being used in rehabilitation.

6.2.5 Rehabilitation

The objective of the rehabilitation programme is to minimise erosion potential and ensure local native plant species are re-established. It is anticipated that the rehabilitation programme will result in establishment of a self-sustaining vegetation complex into which local fauna will be able to return.

The mechanism for determining rehabilitation completion criteria will be the application of an Ecosystem Function Analysis (EFA). The EFA will be implemented throughout the life of the project and the outcomes will be incorporated into subsequent reviews of the Decommissioning and Closure Plan (DCP) (Appendix 1.8, Volume 1). The EFA is a multi-factorial assessment method, conducted on both vegetation and soil criteria. The assessment is conducted on both undisturbed locations (analogue sites) and rehabilitated areas. For soil, various indices are derived from a list of assessment criteria and can be compared against the analogue sites. The indices include soil stability, infiltration/runoff and nutrient cycling status. Other criteria assessed as part of the EFA process include habitat complexity and erosion. The DCP establishes the site closure processes and describes the assessment process for EFA.

Progressive rehabilitation undertaken over the project area will be guided by the following principles:

- Locate and design landforms to be rehabilitated to optimise blending with the surrounding topography.
- Minimise soil erosion; particularly on the batters of the waste rock stockpile.
- Stockpile vegetative material and topsoil for later use.
- Minimise length of stockpiling of vegetation and topsoil.
- Rehabilitate completed areas as soon as practicable.
- Seed and plant using stockpiled vegetative material and topsoil, and seed/plant material from local native plant species.
- Fence waste stockpiles to minimise grazing impact.

To assist with ongoing review of the rehabilitation and environmental management at the site, the proponent will submit an Annual Environmental Report (AER) to DoIR and to DoE.

The waste material comprises a significant proportion of rocky materials that if used to cover the outer surface of the waste rock stockpile, provide increased erosion control. The arid climate of the project area is characterised by short duration, high intensity rainfall events, with extended dry periods. The average annual evaporation rate exceeds the precipitation rate by a factor of 10 to 1. This has implications for rehabilitation in constructing erosion control features and also maximising the water retention capacity of the waste rock stockpile, to maximise the water available for plant establishment.

There are many mining companies operating within the arid climatic zone of Western Australia that have collectively established a significant history of rehabilitation techniques. Adoption of best practice methods will be implemented for rehabilitation of the project area.

Within the Murchison region the experience gained from other mine closure/rehabilitation activities has identified the following as key elements that require consideration:

- The region has intermittent and highly variable rainfall (it is common to experience extended periods of drought and significant flood events). This places logistical constraints on the planning and implementation for rehabilitation seeding/planting programmes as well having implications for erosion control. Previous means of addressing these logistical constraints have been focussed on planning and preparedness for the mobilisation of seeding/planting programmes to take advantage of rainfall events. Erosion control is also a key factor in the siting and design of the waste rock stockpile. The small catchment area on the ranges upslope of the waste rock stockpile minimises the volume of water flowing onto the stockpile during a rain event. The design elements include insloping lifts to the ranges and coarse rock filling the natural drainage lines which allows the waste rock stockpile to be internally draining, rather than shedding water down the external faces of the stockpile. Further details on the location, design and construction of the waste rock stockpile is described in Sections 3.2.1 and 3.6 of this EPS report and in the DCP.
- There is a strong recognition within the region of the importance of the local community to assist in the logistical requirements associated with implementing

seeding/planting programmes. In a site closure sense, there has also been some recognition of the need to provide community sponsorship to enable some post-closure community activity of the rehabilitation programmes.

- Fencing of rehabilitation areas as a means of grazing control has also proven to be an important element in successful establishment and growth of rehabilitated areas. This is usually carried out in conjunction with the local pastoralist.

MML will incorporate the above knowledge gained within the local region, in the Jack Hills Project proposed rehabilitation programme.

6.3 PROJECT SPECIFIC AREAS

6.3.1 Borrow Pits

Borrow pits will be battered and contoured to a safe and stable angle of less than 20 degrees, allowing the egress of fauna. When available, topsoil and subsoil will be spread over the base of the pits to a depth of 10 centimetres and ripped along the contours to a depth of 20 centimetres. The rehabilitation areas will be seeded with locally occurring native species. Diverted drainage will be maintained around the pits to prevent down stream reduction in flow or erosion of the pit embankments.

6.3.2 Open Cut Pit

On completion of mining the open pit will have an abandonment bund constructed to specifications required by DoIR.

6.3.3 Waste Rock Stockpile

Design and rehabilitation of the Waste Rock Stockpile is based on waste characterisation and geotechnical conditions and will comply with existing DoIR guidelines. The final surface of the Waste Rock Stockpile will be shaped by a bulldozer. The need for reshaping will be kept to a minimum by adopting an appropriate dumping schedule.

The Waste Rock Stockpile will be designed to reduce the need to construct and maintain a comprehensive drainage system for the entire stockpile **(Management Action 6.3.3)**. This will include the following measures:

- To prevent water from the top of the stockpile eroding the batters, the upper surface of the Waste Rock Stockpile will be concave to provide an inward draining surface.
- The upper surface of the Waste Rock Stockpile will also be compartmentalised with windrows to 0.5 metre to prevent water from collecting in a single area on the top of the stockpile.
- The perimeter crest of the top of the stockpile and the leading edge of each berm will have a one metre bund pushed up to prevent water draining down the face of the stockpile.

- If available, rocky material and topsoil will be stripped from the advancing stockpile footprint and directly returned to a depth of about 150 millimetres over the shaped Waste Rock Stockpile.
- The waste characterisation assessment (Appendix 2.5, Volume 2) has identified that dark green mafic schists and the browner BIF waste will blend well with the general landscape while also armouring the slopes and batters.
- All topsoiled surfaces will be scarified on the contour to a depth of about 300 millimetres. The first rip line between berms will be surveyed to ensure that it is horizontal.
- The Waste Rock Stockpile will be seeded with local native species, with a preference for local provenances, when available.

6.3.4 Infrastructure

All infrastructure, including the crushing plant, offices and workshops, power cables and bore equipment, will be removed. All concrete foundations will be broken up and buried.

Approval is to be obtained by the Pastoral Lands Board and the Company for any infrastructure to be left on site at the end of operations that is required by the pastoralist.

All items that cannot be sold, recycled or used off-site will be removed and buried in the on-site industrial landfill (located within the waste rock stockpile).

The original ground level of all roads and disturbed areas will be restored as far as is practicable. Culverts will be removed and natural drainage reinstated. Barriers may be installed at various points to prevent unauthorised access.

All areas will be contoured, covered with topsoil, ripped and seeded. Highly compacted areas will be deep-ripped to approximately 500 millimetres in depth.

6.3.5 Bioremediation of Hydrocarbon Spills

Small scale hydrocarbon spills will be remediated in-situ using bioremediation absorbents. Larger scale contaminated soil will receive an application of bioremediation absorbents and then be excavated and disposed of at the project's industrial waste landfill (located within the waste rock stockpile) or as otherwise directed by regulatory authorities.

6.3.6 Landfill Site

Filling of the landfill site will occur progressively over the life of the project. As part of the decommissioning and closure phase of the project, the waste at the landfill site will be capped with a clay layer (or other suitably low permeability material) to approximately 300 millimetres in depth and contoured to encourage runoff away from the waste. Material excavated in the construction of the landfill will be placed over the clay capping and contoured to blend in with the natural contours of the local area. The surface will be spread with topsoil, ripped and seeded. Seeding with deep-rooted species will be avoided on the landfill site, as deep roots may provide pathways for surface water to infiltrate the waste.

6.4 MONITORING AND MAINTENANCE

Rehabilitated areas will be monitored to ensure the success of the rehabilitation programme. Monitoring will be carried out on a regular basis to assess:

- The physical stability of the landform of rehabilitated areas.
- The characteristics of the vegetation in rehabilitated areas.
- The establishment of self-sustaining ecosystems.
- Water drainage from the site.
- Any public safety aspects.

Monitoring the rehabilitated areas will ensure that any areas requiring remedial work are identified. Maintenance procedures will be carried out where necessary and may include:

- Replanting areas that may not have regenerated.
- Repairing any erosion problems.
- Weed control.
- Amelioration of soil.
- Fire management.

The frequency of monitoring will decrease as rehabilitation progresses and will cease when the rehabilitation objectives and completion criteria have been achieved. The results of these management and monitoring activities will be described in the AER to be submitted to the DoIR and DoE.

6.5 DOCUMENTATION

Records of the planning and implementation of all rehabilitation and closure works will be maintained for each rehabilitated area and will include:

- Data on the analogue sites of the pre-disturbance condition of each area (to provide a baseline against which the rehabilitation can be assessed).
- Information on the vegetation, topsoil and subsoil removal, handling and storage techniques utilised.
- The extent and timing of each disturbance.
- Details on the rehabilitation treatment(s), including:
    - The rehabilitation earthworks.
    - Seed bed preparation.
    - The species used in the seeding programme.
    - Seed pre-treatment and seeding methods.

- The results of the rehabilitation monitoring programme.
- The scope of any remedial work (such as re-ripping, re-seeding and weed control).

6.6 PRELIMINARY DECOMMISSIONING AND CLOSURE PLAN

A preliminary DCP has been prepared and is included as Appendix 1.8 (Volume 1). The Plan will be reviewed regularly through the operation to ensure it remains current and it will be implemented at the end of the mine life, which at present is estimated to be approximately five years. A timeframe for completion criteria will be developed in the subsequent version, within two years of project commencement **(Management Action 6.6)**.

7. COMMUNITY AND GOVERNMENT CONSULTATION

7.1 BACKGROUND

The EPA requires evidence of a satisfactory consultation mechanism that demonstrates consultation has been undertaken and that relevant environmental concerns have been addressed in the design and management of the proposed Jack Hills Iron Ore project.

A public consultation programme was undertaken to consult with:

- State Government departments, agencies and organisations.
- Local and Shire authorities.
- Pastoralists.
- Special interest groups.

The public consultation programme was designed to:

- Inform the public about the proposed development of the mine.
- Record potential concerns, issues and recommendations.
- Aid in preparing the design and management of the proposed mine, ensuring that public concerns are addressed.
- Provide feedback to stakeholders.
- Establish meaningful and ongoing dialogue.

The public consultation included:

- Establishment of a list of all relevant stakeholders.
- Meetings with government authorities/agencies.
- Meetings with pastoralists.
- Meetings, site visits and surveys with Aboriginal Groups.
- Newspaper notice that the EPA intends to formally assess the project at EPS level.
- Information letter mail-out (emailed) to stakeholders.
- Provision of information pack of supporting reports and surveys for the project.
- Follow up phone calls to all those who received the information mail out and information pack.
- Issue of Draft EPS for comment.
- Presentation of project to stakeholders (where requested).
- Regulatory authority site visit on 14 March 2006.
- Discussions and correspondence with stakeholders who had further questions or concerns following the presentation and provision of additional information.

7.2 RECORD OF PUBLIC CONSULTATION

A detailed list of the individuals, organisations, groups and agencies that were consulted is given in Appendix 2.1 (Volume 2) and summarised in Table 7.1.

Table 7.1: Stakeholders Consulted about the Proposed Development of the Jack Hills Iron Ore Project

Stakeholder Sector	Organisations/Individuals
State Government and Regulatory Authorities	• Environmental Protection Authority Service Unit • Department of Environment - Perth Office - Geraldton Office • Department of Conservation and Land Management - Perth Office - Geraldton Office • Department of Industry and Resources • Department of Indigenous Affairs • Main Roads Western Australia • Western Australian Museum
Pastoralists	• Mt Hale • Mileura • Beringarra
Local Authorities/ Agencies	• Shire of Meekatharra • Shire of Cue • Shire of Murchison
Special Interest Groups	• Conservation Council of Western Australia Inc. • Wildflower Society of Western Australia • Wilderness Society • Western Australia Naturalists Club
Indigenous Groups	• Yamatji Land Sea and Council • Ngoonooru Wadjari • Wajarri Elders
Other	• Australian SKA Planning Office

7.2.1 Preliminary Consultations with Regulatory Authorities, DoIR, EPA, CALM, WAM

7.2.1.1 Regulatory Authority Meetings and Correspondence

Further to the submission of the NOI a number of meetings and consultations were held as follows:

- Meeting of 2 September 2005 between proponent, EPA Service Unit, CALM and DoIR to discuss the proposed Jack Hills project as contained in the NOI.
- Email correspondence of 19 September 2005 from Daniel Coffey (CALM) providing advice on vegetation and fauna assessment contained in the NOI. CALM requested:
    - Further information on how variable the upland *Triodia* community is, how much of it will be impacted by the proposal and where else in the region has it been recorded from.
    - A detailed spring flora survey of the project infrastructure areas to adequately assess the potential impacts to flora.
    - Information on short range endemics which may be found in the area.
- Meeting of 31 October 2005 with Mark Harvey of Western Australian Museum to discuss short range endemics and a letter of 14 November 2005 received from Western Australian Museum (Appendix 2.1).
- Meeting of 17 November 2005 with Daniel Coffey, Norm Caporn and Neil Gibson of CALM to discuss interim results of October 2005 spring flora survey undertaken by Mattiske Consulting Pty Ltd.
- Emails of 1 December and 5 December 2005 from Daniel Coffey of CALM providing advice on short range endemic and vertebrate fauna survey report (MBS Environmental, November 2005), respectively (Appendix 2.1).
- Meeting of 16 December 2005 with Ray Claudius (EPA Service Unit) and Mark Cannon (DoIR) to provide project background and discuss preparation and timing requirements for the EPA Referral.

7.2.1.2 EPA Meetings

On 8 February 2006 MML met with the EPA chairman and representatives of the EPA Service Unit to discuss the Jack Hills mining proposal, environmental issues associated with the project and likely assessment and approval process. The EPA Chairman, after considering the information presented to him, advised that he considered a formal assessment set at the level of an EPS would be appropriate for the scale of such a project and environmental factors involved.

7.2.1.3 Consultation with WAM and CALM Regarding Short Range Endemic (SRE) Species

A meeting was held on 31 October 2005 between Dr Mark Harvey of Western Australian Museum, Mr Frank Sibbel of Murchison Metals Ltd and Mr Lance Bosch of MBS Environmental to discuss the proposed Jack Hills iron ore project and the potential impacts to short range endemic (SRE) invertebrate fauna species that may occur on the Jack Hills range. The scope and extent of the project was presented on aerial photographs and the results of Western Australian Museum identifications of invertebrate specimens collected by Murchison Metals Ltd in September 2005 were also discussed.

Dr Harvey advised in a letter of 14 November 2005 to MBS Environmental that "Given the location of proposed development in relation to suspected SRE habitat, it is probably not necessary to conduct surveys for SRE's at this time."

It was concluded with Dr Harvey that should Murchison Metals Ltd propose expanding the project in the future such that potential SRE habitat could be impacted, then Western Australian Museum would recommend a series of winter sampling programmes be undertaken in order to assess potential impacts to SRE invertebrate fauna. Extensive hand foraging is considered by Western Australian Museum to be highly effective, while pitfall trapping could augment results.

In an email dated 1 December 2005 Mr Daniel Coffey advised that CALM had no further comments on short range endemics.

7.2.2 Notification and Distribution of Information to Identified Stakeholders

The Conservation Council of Western Australia, Wildflower Society of WA, Western Australian Naturalists' Club (Inc.) and the Wilderness Society were identified as stakeholders having an interest in the key environmental factors associated with the Jack Hills project. During January 2006, each of these organisations was contacted by telephone and emailed introductory details of the project. An information pack, comprising copies of the NOI, EPA Referral, flora report (Mattiske Consulting Pty Ltd, 2005) and fauna reports (MBS Environmental, 2004; MBS Environmental, 2005), was issued to each of these organisations. Each of the organisations was requested to provide comments or concerns and was invited to discuss the project and/or attend a presentation given by MML.

At the request of the Conservation Council of Western Australia and Wildflower Society of WA, MML made presentations on 23 and 30 January 2006, respectively. No written comments were received from any of the organisations in response to the information provided and presentations given. MML advised each of these organisations that a draft EPS document would provide further detail on the environment, especially flora and fauna (based on the reports provided in the information packs), and the management and mitigation of impacts of the mining proposal.

A letter of 22 February 2006 was received from the Western Australia Naturalists' Club advising that they did not receive all the fauna reports and were not able to comment on the fauna aspects of the project. An email of 24 February 2006 was sent to the Western Australia Naturalists' Club clarifying that fauna information and reports were indeed included in the information pack. Correspondence is provided in Appendix 2.1.

7.2.3 Distribution and Comments on the Draft EPS

The draft EPS was distributed to the following organisations, as listed in Table 7.2.

Table 7.2: Draft EPS Distribution List

Organisation	Contact	Date Issued	Comments
Department of Conservation and Land Management	Anthony Desmond (Geraldton office) Daniel Coffey (Perth office)	21/02/2006	Email received on 9/03/2006. Combined comments from Geraldton and Perth offices.
Department of Environment	Paul Anderson (Geraldton office)	22/02/2006	EPA letter of 3/03/2006. Geraldton office comments incorporated into EPA letter.
Department of Indigenous Affairs	Madge Schwede	22/02/2006	No comments received. MML meeting to discuss comments.
Western Australian Museum	Director	22/02/2006	Letter of 2/03/2006.
Conservation Council of WA	Chris Tallentire	21/02/2006	Letter of 7/04/2006.
WA Naturalists' Club (Inc.)	Kate Creed	21/02/2006	Letter of 13/03/2006.
Wildflower Society of WA (Inc.)	Brian Moyle	21/02/2006	Letter of 3/03/2006.
Wilderness Society	Charles Roche (Perth office)	21/02/2006	No comments received.
Yamatji Land and Sea Council	Nathan Cammerman	28/02/2006	Email received on 2/03/2006.

Comments were received from organisations as listed in Table 7.2 and provided with responses from MML (Appendix 2.1). The Department of Indigenous Affairs did not provide a written response but did discuss with MML the need to complete archaeological surveys of the mining area to ensure the area was clear of heritage sites. The Wilderness Society did not respond to several requests from MML.

A revised Draft EPS, which incorporated the results of the March fauna survey and targeted flora survey of the mine site and haul road and the heritage survey of the minesite was distributed to the Wildflower Society, Conservation Council of WA and the WA Naturalists Club in mid April 2006. Comments have been received from the Wildflower Society (letter dated 16 April 2006).

7.2.4 EPA and CALM Meetings and Site Visit

Representatives for the EPA Board (Chairman Wally Cox and members Joan Payne and Denis Glennon), EPA Service Unit (Manager Tim Gentle and Environmental Officer Mark Brundrett), senior CALM botanist (Neil Gibson) and representatives for MML (Project Manager Frank Sibbel, consultants Lance Bosch and Libby Mattiske) attended a site visit on 14 March 2006. The proposed mine site and pit areas were inspected, with particular

emphasis on the range and environmental factors associated with the proposal. The project was discussed and the main environmental factors discussed and any outstanding issues identified with respect to EPA, CALM and comments received from the Wildflower Society of WA.

7.3 ISSUES RAISED DURING STAKEHOLDER CONSULTATIONS

The environmental issues raised during the stakeholder consultation programme are listed in Table 7.3.

Table 7.3: Environmental Issues Raised During Stakeholder Consultations

Issue and MML Response
General
Issue (Wildflower Society) The application of the Principles of Environmental Protection as set out in EPA Position Statement No. 7 (EPA August 2004) within the Jack Hills Iron Ore Project. **MML Response** A summary of the application of the EPA Principles of Environmental Protection is provided in Section 1.5. This summary details each of the principles, states their relevance to the project and provides direction to relevant sections within the EPS.
Issue (Wildflower Society, Conservation Council) The EPA should not be considering this project until the Section 16 advice requested by the Minister for Environment on the banded ironstones of the Mid West and Yilgarn has been completed and received. **MML Response** The EPA has advised MML that there is no Section 16e advice covering the area of the Jack Hills project. The environmental impact assessment of the project and this EPS has been developed utilising relevant technical information that is currently available. This is also a matter for the EPA to consider. In general, we are always dealing with gaps in knowledge and this needs to be recognised at a community level. Support for regional studies would overcome many of these aspects of knowledge gaps.
Issue (Wildflower Society) Eighty percent of the material mined will be waste and at least 34.5 ha of land will be cleared to accommodate it. We doubt this amount of waste is in line with the Iron Ore Industry average. The EPS should comment on this. **MML Response** The determined waste to ore ratio and ore grade has been assessed as a component of project feasibility and is considered economically viable.
Issue (Wildflower Society) Environmental Management Actions (listed in Section 1 and contained throughout EPS) – actions need to be written in such a way as to be auditable or backed up by a reference to an action in an auditable management plan. **MML Response** All proposed actions are auditable through the setting of EPA and DoIR conditions (which arise from the project's listed environmental management actions and commitments).

Issue and MML Response
Issue (Wildflower Society) There are large outcrops and boulders on the range but no comment has been made on the document about this. **MML Response** There are occasional large boulders some of these may reach three to four metres across and two to three metres high, plus a small number of low vegetation density outcrop areas ranging up to 10 to 12 metres in their maximum dimension in the Jack Hills Range. These features are not rock type specific. Similar size boulders and outcrop areas are found in virtually every range throughout the world, but mention of them in reports is only made where they represent a danger to human beings or form spectacular landscape features. This is not the case in the Jack Hills setting where such features are only visible at very close range. The majority of such sites relate to the vicinity of Mount Hale and Mount Matthew, neither of which will be impacted by the currently proposed mining venture (Section 8.12.2). Thus there is no reason to mention these features within Section 8.4 or elsewhere in the document. Neither Mount Hale nor Mount Matthew form spectacular features like Mount Gould, 50 kilometres to the north, which is a feature with a similar geological setting that bears recording and preservation. Within M20/506, some features of this type occur but the areas they are small, non-dangerous and of no significance. Since none are in locations where they can be considered dangerous nor form spectacular landscape features visible from some distance, there is no reason why they should be specifically recorded. There is no suggestion that they host endangered faunal or floral species, nor are they recorded as indigenous special sites.
Issue (Wildflower Society) There is no commitment to employ a full-time on-site environmental manager or any other professionally qualified environmental staff. **MML Response** MML will employ the services of suitably qualified personnel who will maintain a presence on site which is appropriate to the scale of the mining operation and different phases of implementation (see Table 1.5).
Flora and Vegetation
Issue (Wildflower Society) The EPS has not demonstrated that the flora and vegetation from the Jack Hills are well represented outside the proposed clearing area and the regional significance of the area planned to be mined has not been fully established. No comment has been provided on the representation of the project area vegetation within the conservation estate. **MML Response** It is difficult to assess the representation of flora and plant communities in the regional context when major gaps exist in our knowledge on specific taxa and plant communities in different areas of the State. This in part reflects the lack of support for regional studies in the State and the difficulty of comparing detailed studies with regional vegetation mapping units (as defined by Beard) and land system mapping as undertaken by the Department of Agriculture. The issue of representation in the conservation estate is a matter for the government, not a proponent.
Issue (Wildflower Society) It is apparent insufficient work was done prior to October 2005 and further work is still needed to classify the values of the area. This should be allowed to proceed prior to mining. **MML Response** The March 2006 flora survey addresses this issue.
Issue (Wildflower Society)

Issue and MML Response
At least two visits to the sites should be done to get an appropriate coverage. **MML Response** The October 2005 and March 2006 flora surveys address this issue.
Issue (Wildflower Society) The comment "clearing of vegetation will affect less than 0.7% of the BIF component of the range" is not telling the full story. The project is targeting the haematite and the majority of the vegetation on this geology will be cleared. This needs to be clarified and the level of clearing given a local context. **MML Response** The currently proposed clearing of vegetation will affect less than 0.7% of the BIF component of the Jack Hill Range, but a substantially higher proportion, close to 5% of that component within the mining lease. There is no preferred relationship of flora to either normal or enhanced iron haematitic BIF, so the higher percentages of clearing in the mining lease should not permanently impact on any specific floristic species within the Jack Hill Range (see Section 8.7).
Issue (Wildflower Society) The fact that no plant communities in the area are listed as Threatened Ecological Communities is possibly due to the fact the information is still being collected. **MML Response** The Mattiske Consulting Pty Ltd report provides a summary on the potential impact on the *Triodia* communities and the species highlighted during the assessment (see Appendix 3.1).

Issue and MML Response

Issue (CALM)

There needs to be discussion made of the impact that the proposal will have on the flora identified as having conservation significance. CALM requires a Flora Species Impact Table clearly outlining the predicted impact on each DRF, priority and range extension species that will be disturbed and the quantitative impacts on flora of conservation significance. In addition, available data on the remaining size and extent of affected and unaffected populations should also be included in the table.

MML Response

Occurrence of rare, Priority and range extension flora on the Jack Hills project area:

- *Acacia cockertoniana* (ms), a perennial (long-lived) species, was recorded at 25 sites both within the proposed pit area and within the mining lease area. Of these seventeen sites are outside the proposed impact areas, five are on the edge of the proposed impact areas and three are within the proposed impact areas. This taxon was recorded in variable numbers in eight plant communities (A1, A3, B1, P2, T1, T2, T3 and T4); however it is recognised that the relative numbers in the different communities will vary significantly. Several of the stands are on the lower ranges to the east of the main banded iron formation ridge. This taxon was confirmed by Dr Bruce Maslin at the State Herbarium and is well known from a similar environment on the relictual ironstone ranges at Windarling near Southern Cross. This species is known from 26 records at the State Herbarium (Western Australian Herbarium 2005a). This species extends beyond the proposed clearing areas.

  Action: The March 2006 survey estimated the population sizes in each of the affected communities and the results are shown in Table 4.5. This data indicates that Community T3 will be the most heavily impacted with a loss of about 50% of the population followed by Community T2 with a loss of around 30% of individuals. However, the overall loss of plants is likely to be about 10% of total population of the main range and it should be noted that these figures are for only the five communities likely to be impacted by the mining operations. *Acacia cockertoniana* (ms) has been recorded in the surveyed communities away from the main range as well as three other communities on the Jack Hills and it is likely that the total population is higher than is shown in Table 4.5.

- *Gunniopsis divisa* (Priority 1) was recorded from two locations on the proposed haul road in October 2005. This species is only known from further west. This species was recorded in one plant community (M2) within the proposed haul road. This species is known from three records at the State Herbarium (Western Australian Herbarium 2005a).

  Action: Although the March 2006 survey failed to locate any more populations of *Gunniopsis divisa*, the haul road has been re-aligned to avoid the areas where the species is known to occur and similar communities in which it may occur.

  Verticordia jamiesonii (Priority 3) was recorded at three locations in October 2005. This taxon was recorded at four sites by Mattiske Consulting Pty Ltd, within plant communities A1, C1 and T2), on the lower undulating hills and valleys to the east and south east of the proposed impact areas. As noted in MBS Environmental (2005), this taxon has been previously recorded on sandy-clay soils and lateritic breakaways. This species is known from 16 records at the State Herbarium (Western Australian Herbarium 2005a).

  Action: This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.

Issue and MML Response
• *Calytrix verruculosa (Priority* 1) was recorded near the haul road (within plant community M2 This taxon was recorded on a site 1.5km from the proposed mining site (MBS Environmental 2005). This species has been recorded previously within the foothills of Mt Hale. This species is known from nine records at the State Herbarium (Western Australian Herbarium 2005a). *Action:* The March 2006 survey identified seven additional populations of *Calytrix verruculosa* along the proposed haul road route and recorded a total of 358 individuals. The current alignment would have seen the loss of around 24% of the population. However, the haul road has been re-aligned which will limit the loss of plants to about 7%. • *Lobelia heterophylla* subsp. *pilbarensis* was recorded at only one location, in the T3 plant community, within the proposed pit area within the mining lease area (Hill 12). This taxon was sent to Neville Walsh at the Melbourne Royal Botanic Gardens. This taxon has been recorded in a small population on the ranges south of the Jack Hill project area (Meissner and Caruso collection Perth 07201354), as well as to the north and northwest on Mt Augustus, Brockman Station (northwest of Tom Price), near Wittenoom, Mt James Station (via Carnarvon and just west of Barlee Range Nature Reserve). On the basis of current information, it appears that the plant specimen collected by Chalwell on the Jack Hills project area and the collection by Meissner and Caruso to the south of the Jack Hill project area are outlier populations. *Action:* The March 2006 survey failed to find any more individuals in the communities on the main range around the impacted areas. This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project • *Amaranthus interruptus* was recorded from one site (SC8), which is located on the lower undulating hills to the east of the proposed impact area, with the plant community B1 as defined by Mattiske Consulting Pty Ltd (2005). As such it is not located within the proposed mining or infrastructure area. This species is known from nine records at the State Herbarium (Western Australian Herbarium 2005a). Action: This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project. • *Calandrinia pleiopetala* occurs as a range extension from areas to the north and northeast of the proposed mining. This species was recorded at eleven sites within four plant communities (A1, A5, M2 and C2) located on the proposed haul road, airstrip and campsite options. This taxon is not restricted to these areas. This species is known from six records at the State Herbarium (Western Australian Herbarium 2005a). Action: This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project. • *Eremophila pendulina* was recorded during the brief visit to the Robinson Ranges and occurs as a range extension to populations further north. This species is known from 14 records at the State Herbarium (Western Australian Herbarium 2005a). This taxon is not going to be directly impacted by any proposed operations and therefore is of general interest in the regional context. Action: This taxon occurs outside the Lease areas and will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project (see Section 8.7.5).

Issue and MML Response
Issue (CALM, Western Australian Naturalists' Club) The proposed haul route should be located away from populations of priority and significant flora. What steps have been taken to avoid impacts on Priority 1 species *Calytrix verruculosa* and *Gunniopsis divisa* that are located along the proposed route for the haul road? **MML Response** The miscellaneous licence is 100 metres wide and the road will be designed and aligned to avoid these species (see Section 8.7.4.2). The new proposed alignment will avoid areas where *Gunniopsis divisa* is known or is likely to occur and has been designed to limit the loss of *Calytrix verruculosa* to around 7% of the recorded population.
Issue (CALM) The proportion of the expected flora that was actually recorded during the surveys should be included in the EPS to support the statement that *"it is predicted that a significant part of the flora was collected"*. **MML Response** Multiple site visits were undertaken to ensure good seasonal coverage for the survey. This was the mechanism utilised to ensure that the flora surveying is comprehensive and addresses the key groupings of plant communities within the area (see Section 4.9.2). In addition further plant collecting is being undertaken during March 2006 to capture the recent response to rains.
Issue (CALM) What management strategies are Murchison Metals proposing to ensure the long term viability of the upland *Triodia* community, e.g. fire management plan, clearing controls, feral animal control. **MML Response** The management strategies which have relevance to ensuring the life of project viability of the upland *Triodia* community are within the following; • Dust Management Plan (Appendix 1.5). • Vegetation Management Plan – i.e. including vegetation clearing controls (Appendix 1.6). • Fire Management Plan (Appendix 1.9). • Feral animal control measures (Sections 8.8.5 and 8.13.5).
Issue (CALM) More information on the known distribution of the A4 community type within the Jack Hills range is required to determine the significance of the impact which the proposal will have on the A4 community type. **MML Response** The Low Open Woodland of *Acacia rhodophloia* (A4 community type) is associated with the granite outcrop. This community type occurs on other scattered granite outcrops within the region and the floristic composition of the A4 community type within the project area is not as significant as those which occur on the Jack Hills range (Section 8.7.4.1). Mattiske Consulting Pty Ltd has mapped similar communities on granite in the Murchison and Pilbara areas, and although confirmed in this project area, these communities are not regionally unique. The re-design of the waste dump shifted the impact from the *Triodia* communities to the A4 community. Low Open Woodland of *Acacia rhodophloia* over *Dodonaea petiolaris, Thryptomene decussata, Calytrix desolata, Eremophila latrobei* subsp. *latrobei* over *Ptilotus obovatus* var. *obovatus* and *Goodenia tenuiloba* on shallow granitic outcrops. *Acacia rhodophloia* and the associated species are not restricted to this project area and as such extend into the Pilbara.
Issue (CALM)

Issue and MML Response
It appears from associated maps in the draft EPS that approximately half the area occupied by the ironstone endemic, *Acacia cockertoniana* ms, will be impacted by the proposal. In consideration of this, CALM suggests that: • The extent of impact on the population is defined in a Flora Species Impact Table. • Subject to the information provided in point 1 above, further work may be required on the genetic and reproductive biology of *Acacia cockertoniana* ms to gain an understanding of the long term impacts of the mining proposal on this taxon. **MML Response** The Flora and Vegetation report (Appendix 3.1) has been updated to address this (see Appendix 3.1, Table 3) (EPS Section 4.9.5.2, Table 4.5).
Issue (CALM) The Explosives Magazine should be included as an area to monitor and manage for impacts on vegetation. **MML Response** The Vegetation Management Plan has been modified to include the Explosives Magazine as an area to monitor and manage for impacts on vegetation (Appendix 1.6).
Issue (CALM) A Fire Management Plan should be developed to manage fire, both as a hazard, and an environmental tool for managing the Spinifex community. **MML Response** A Fire Management Plan to manage fire hazards is provided in Appendix 1.9. The use of fire as an environmental tool for managing the Spinifex community will be reviewed in future studies but is not necessarily a matter to be undertaken by the proponent.
Issue (Western Australian Naturalists' Club) The report does not consider the effect of groundwater abstraction on local vegetation. **MML Response** The project's groundwater abstraction will mainly occur through the proposed groundwater production bores to be located within geological structures (faults, fractures and jointing) in the granites at the foothills of the range. There will be minimal dewatering required for the open pit as the permanent water table is well below the pit base (i.e. negligible groundwater abstraction). The groundwater drawdown for the production bores will be localised should not adversely effect the surrounding vegetation (see Section 3.8).
Issue (Conservation Council) The Company should make an upfront commitment to vehicle hygiene measures and adequate training of staff to allow for early detection and notification of any noxious weed outbreak. **MML Response** MML will employ the services of suitably qualified personnel who will maintain a presence on site which is appropriate to the scale of the mining operation and different phases of implementation (see Table 1.5). MML will implement vehicle hygiene measures and train the workforce in weed control (see Section 8.7.5 and Vegetation Management Plan Appendix 1.6, Volume 1).
Fauna and Fauna Habitats

Issue and MML Response
Issue (CALM) The Company should pursue feral animal eradication and control on their leases, including goats, foxes and cats. **MML Response** The proposed feral animal control measures for the project are detailed in Section 8.8.5 and 8.13.5. These measures comprise; • Refuse and the landfill site will be managed to prevent an increase in feral animals populations (i.e. covered by soil regularly to prevent access by animals); and • Implementing deterrent and/or eradication programmes in consultation with CALM, the Department of Agriculture and pastoralists.
Issue (Western Australian Naturalists' Club) The Company should monitor fauna presence before, during and after life of the project, to establish the effect the project has on local fauna, and the level and timing of fauna return to rehabilitated areas. **MML Response** Baseline fauna assessment has been completed and a post closure assessment of fauna return will be undertaken as a component of the site's post closure monitoring. During the project's operation, the monitoring focus will be on the extent and success of revegetation within rehabilitated areas (see Section 8.7.5).
Rehabilitation, Decommissioning and Closure
Issue (Wildflower Society, CALM) The statement that *"the Waste Rock Stockpile will be seeded with local species, with a preference for local provenances when available"* should be replaced with a commitment that has auditable completion criteria. The company should be held liable to see a self-sustaining plant community of local species was established. **MML Response** The nature of the local environment is such that not all flora species set seed annually. As such, the intent is to collect local provenance seed whenever it is available. In addition, waste rock stockpile rehabilitation completion criteria have as yet, not been set. The project's Preliminary Decommissioning and Closure Plan and subsequent reviews, will form the basis for the setting of project closure criteria. Rehabilitation completion criteria will be based on the rehabilitation process (as delineated in the Decommissioning and Closure Plan) and the stability of the landforms and progress of revegetation.
Issue (Wildflower Society) In view of the possible short life of the mine (5 years) the proponents needs to be able to (a) demonstrate if there has been successful rehabilitation in a similar area on such a harsh environment as a mine waste dump and (b) sufficient resources will be set aside to continue rehabilitation for years beyond the life of the mine. **MML Response** There are demonstrated examples within the Murchison region of successful rehabilitation of mine waste rock stockpile and key lessons have been learnt (see Section 6.2.5). Rehabilitation will occur progressively throughout the life of mine and at closure. DoIR bonds will be put in place and linked to the agreed closure/rehabilitation completion criteria.
Issue (Wildflower Society) The proposed site closure strategy infers that rehabilitation commences at closure. This is not current best

Issue and MML Response
practice which is progressive rehabilitation over the life of the mine. **MML Response** Rehabilitation will occur progressively throughout the life of mine as areas become available (see Section 6.2.5). There will also be a final site rehabilitation phase upon site decommissioning and closure.
Issue (CALM, Western Australian Naturalists' Club) More details are required on the location, size and containment of pollutants, and the vegetation proposed for re-establishment on the bioremediation pad. **MML Response** Small scale hydrocarbon spills will be remediated in-situ using bioremediation absorbents. Larger scale contaminated soils will have an application of bioremediation absorbents and then be excavated and disposed of at the project's industrial landfill (see Section 6.3.5).
Issue (CALM) The final species composition on the rehabilitated rock stockpile should aim to be representative of what was present prior to disturbance, rather than only using seeds of species that are not palatable to wildlife and stock. If grazing of seedlings is likely to be a problem options for exclusions of grazing fauna during establishment, such as fencing the area, should be considered. **MML Response** The preference is to use local provenance species and undertake seeding as required. The waste rock stockpile will be fenced to minimise grazing impacts (see Section 6.2.5).
Issue (CALM) In relation to the rehabilitation process it is CALM's view that a separate rehabilitation plan be developed and reported on annually through the annual environmental reporting process. The plan should include the objective to establish a native ecosystem that mirrors the attributes and function of pre-mining vegetation. **MML Response** All rehabilitation success criteria are included within the Vegetation Management Plan (see Appendix 1.6). The plan also states a commitment to monitor for these criteria and report the results as part of the AER process. It is considered that there no need to replicate this process within another management plan. The stated rehabilitation objective for the project area is to minimise erosion potential and ensure local plant species are re-established. It is envisaged that this will result in the establishment of a self-sustaining vegetation complex into which local fauna will be able to return and inhabit (Section 6.2.5).
Issue (Western Australian Naturalists' Club) The EPS states that vegetation will be stockpiled '"with topsoil for re-spreading over the areas during rehabilitation and that fertiliser will be used where necessary. The Naturalists' Club is of the opinion that using fertiliser with native species could adversely affect native flora growth and encourage exotic species as well as weedy colonizing native species. **MML Response** No fertiliser will be utilised to assist revegetation.
Issue (Western Australian Naturalists' Club) Stockpiling topsoil for more than six months drastically reduces the viability of any seeds present in the soil. Rehabilitation programme should include harvesting of native plant seeds for broadcasting on placed topsoil and the germination of local species for planting on the placed topsoil. **MML Response**

Issue and MML Response
The proposed topsoil stockpiles will not exceed 2m in height. This will ensure that any stockpile stored for a long term will remain ecologically functional. That is, regrowth will occur, which over time will result in seed setting and the provision of further additional seed resources (see Section 6.2.4).
Issue (Western Australian Naturalists' Club) The main report does not specify that rehabilitation works will be carried out for the exploration areas, but the Vegetation Plan does. **MML Response** The rehabilitation of the previously disturbed exploration areas is outside the scope of this EPS. This is currently being addressed through the existing DoIR process. However, it is intended that this will come under the overall site operational management upon project commissioning. As such, it has been included in the Vegetation Management Plan (see Appendix 1.6).
Issue (Conservation Council) The Company should give an upfront commitment, including funding reflected in the approved project budget, to ensure that the rehabilitation program reaches the goals outlined in Section 6.4 of the EPS, Monitoring and Maintenance. **MML Response** MML has established landform rehabilitation provisions for closure. The Decommissioning and Closure Plan (Appendix 1.8, Volume 1) will be updated during the operational phase to: • Confirm that a financial provision is in place and that it reflects the real cost of closure. • Confirm that accepted accounting standards were used for the basis of the financial provisioning. • Confirm that adequate securities will protect the community from closure liabilities.
Air Emissions – Greenhouse Gases
Issue (Wildflower Society, Conservation Council) Greenhouse gases are a global, not just a local or regional concern. Based on the CO_2 emission figures given in Section 8.9.3 of the EPS, the greenhouse gas per tonne of ore product will be high compared to other projects in Western Australia. There does not seem to be anything in the draft EPS to take account of the fact that 20ML or more than 12L of diesel per tonne of ore will be used to truck ore 550km to Geraldton. It would appear the EPA objective is not being met. **MML Response** The EPA objective for Greenhouse Gas emissions will be met through the following (see Sections 8.9.1 and 8.9.5): • There being no adverse effect from the project greenhouse gas emissions to environmental values, or the health, welfare and amenity of people and land uses; and • All haulage vehicles will be maintained to a high level to ensure optimum fuel use efficiency and the minimising of emissions.
Dust Management
Issue (Wildflower Society/CALM) Dust impacts to the BIF vegetation and other significant vegetation types and their management, has not been adequately addressed. **MML Response**

Issue and MML Response
MML acknowledge that potential dust impacts to surrounding vegetation are a significant issue and as such, the dust management measures are focussed to address this (see Section 8.10.5 and Dust Management Plan – Appendix 1.5).
Construction Environmental Management
Issue (Wildflower Society) We would question the fact that there will be no Fauna, Air emission, Waste Products, Fire Management, Heritage and Surrounding Land Use plans. There will need to be specific mention of all of these in any department of Environment Licence particularly in view of the comments in 'Environmental performance' below. **MML Response** The scope of Construction Environmental Management Plan (CEMP) is relevant to the small scale and short duration of the project's construction phase. The CEMP will also comply with all relevant legislative requirements, therefore the production of specific management plans for items mentioned are not warranted (see Appendix 1.7).
Social Issues
Issue (Wildflower Society) There is a proposal to possibly establish a Square Kilometre Array (SKA) in the area and monitoring of electromagnetic signals has or will soon commence. Any mining proposal is likely to have a major impact. **MML Response** MML is consulting with Australian SKA Planning Office on the potential sources of radio-frequency interference from the mining operation and their management. This consultation is continuing (see SKA Planning Office briefing memo and email – Appendix 2.1).
Environmental Performance
Issue (Wildflower Society, Conservation Council) We are concerned that the Company during exploration has very severely damaged the flora and vegetation across the top of the Jack Hills and it remains to be seen if this is irretrievable. There is no comment in the EPS about addressing this and also it means there can be no confidence about the ongoing environmental performance of the company. This is reinforced by the fact that the aerial photos used in the flora survey, reports by Mattiske (Mattiske December 2005), and in Figure 4 of the EPS show a different scene from that in the November Investor Road Show presentation on the Murchison Metals web site. **MML Response** Exploration is managed within the DoIR's GDA process which is outside of the scope of this EPS. The existing disturbance associated with the previous exploration is identified within the project's vegetation assessment (see Table 4.4, Section 4.9.4 and Table 8.3, Section 8.7).
Issue (Conservation Council) The standard of environmental performance and rehabilitation would be expected to be at least industry best practice. This has not as yet been demonstrated through the draft environmental protection statement. **MML Response** The EPS and supporting management plans provide extensive details on measures and procedures to be adopted in the design, operation and decommissioning of the project. DoIR, CALM and DoE have

Issue and MML Response
provided advice to MML in the development of the EPS which is considered to incorporate industry best practice.
Issue (Conservation Council) The proposed increase in mine capacity will likely have much greater effects on plant communities restricted to the BIF component of the range than outlined in the draft EPS. These communities will not be restored post mining due to the complete removal of their habitat. To show a genuine commitment to environmental performance MML should take the effects of the planned mine expansions into account at the beginning of the project. **MML Response** The proposal as described in the EPS is being formally assessed by the EPA**.** The environmental impact assessment of the project and this EPS has been developed utilising relevant technical information that is currently available. Any future expansions will be referred to the EPA.
Surface Water
Issue (CALM) Table 1.2 Summary of Environmental Factors (page 12) – There is a potential that the location of the waste rock dump will interfere with the surface water run-off into the creeks and subsequently have an impact on the riparian vegetation. The proponent will need to provide an environmental justification for the proposed location of the waste rock dump, and propose strategies to minimise/mitigate impacts to the creek system. **MML Response** The waste rock stockpile has been relocated specifically to take advantage of the existing topography and to ensure minimal upstream catchment. All surface run-off from within and upslope of the waste rock stockpile will be contained within the stockpile footprint (Section 8.6.5)
Waste Products
Issue (Western Australian Naturalists' Club) There is no commitment to identifying opportunities for the recycling of office and domestic wastes. **MML Response** Currently there are no viable opportunities for the broad recycling of office and domestic wastes, due to the remote nature of the site. However, MML will, throughout the life of project, actively identify and look to apply; any viable opportunities for the recycling of office and domestic wastes (see Section 8.13.5).
Issue (Western Australian Naturalists' Club) The waste rock stockpile should not be utilised for dumping of tyres and contaminated soil. **MML Response** The site's industrial waste landfill will be located within the waste rock stockpile. This is in line with relevant standards and legislation.
Dangerous and Hazardous Substances
Issue (Western Australian Naturalists' Club) The fuel storage log should include information on spill handling and reporting procedures. **MML Response** Spillages of fuels and other hazardous materials will be treated as incidents and responded to under the site's incident response procedure. All personnel will be inducted on this process and have access to the procedure within the respective work areas (see Section 8.14.5).

7.4 TRANSPORT CONSULTATION

MML has conducted an ongoing public consultation programme for the transport and haulage of ore product from the mine site to the Port of Geraldton. This has involved the Shires, Main Roads Western Australia, Geraldton Port Authority, Pastoralists and Midwest Infrastructure Development Group, radio and news stations, schools, police and education programmes. Details of public consultation are provided in Appendix 2.1 (Volume 2).

8. ENVIRONMENTAL ISSUES AND MANAGEMENT

8.1 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

An "environmental impact" is defined as a modification in the status of the environment by a proposed action. Environmental impacts may affect the natural or social components of the environment and may be positive (beneficial) or negative (adverse). They may occur either as a primary result (direct) or as a secondary result (indirect) of the action, and may be temporary/short duration (short term) or permanent/long lasting (long term). Impacts may vary in magnitude from no change or only a slight discernable change, to a significant change in the status of the environment.

The main environmental factors and impacts associated with the Jack Hills project were identified by MML in consultation with EPA, DoE, CALM and DoIR and through discussions with relevant stakeholders:

- Disturbance to flora and plant communities associated with BIF.
- Disturbance of fauna habitat and species.
- Dust generation during construction and operation and indirect impacts to vegetation and flora.

Other factors identified as potentially relevant include:

- Visual/landscape.
- Geoheritage.
- Weeds.
- Potential presence of invertebrate fauna (short range endemic fauna and subterranean fauna).
- Waste characterisation and potential for acid sterilisation.
- Geraldton Port (noise and dust).
- Haul road.
- Closure and rehabilitation.
- Proximity of mining operations and trucking to proposed Radio Astronomy Park

8.2 ENVIRONMENTAL MANAGEMENT

Environmental impacts from construction and operation of the Jack Hills project will be managed through a series of plans prepared specifically for the site to deal with issues raised on the project. The following management plans are provided:

- Construction Management Plan.
- Vegetation Management Plan (incorporating rehabilitation and weed management).
- Dust Management Plan.

- Preliminary Decommissioning and Closure Management Plan.
- Fire Management Plan.

All other impacts can be managed through the measures described in Section 8 of this report and procedures and management actions provided throughout this EPS and as listed in Table 1.4 of Section 1 of this report.

8.3 AREA OF DISTURBANCE

The estimated total area that will be disturbed as a result of the Jack Hills project is presented in Table 8.1.

Table 8.1: Total Areas of Disturbance

Disturbance	Area to be Cleared (ha)
Waste rock stockpile	52.6
Pit	25.4
Crusher and ROM	0.8
Workshop	0.2
Ore stockpile area	0.1
Fuel storage	0.04
Power house	Included in workshop/ administration area
Laydown	0.6
Administration area	0.2
Camp	2.8
Haul road (M20/506)	4.4
Site roads (M20/506 and L51/85)	3.9
Domestic landfill	0.2
Haul road (L20/47 and L20/53)	36.4
Airstrip	Upgrade existing Mt Hale airstrip – no new disturbance required
Explosives magazine	0.04
Sewage treatment	0.03
Total	**127.7**

8.4 GEOHERITAGE AND SIGNIFICANT GEOLOGICAL FEATURES

Other than Mt Hale and Mt Matthew, which will not be impacted by the project, there are no regionally significant geological features or landforms that are nearby to the project area. No caves will be impacted by the mining activities. The granite outcrop on the plain that will be

covered by the waste rock stockpile is well represented elsewhere as scattered outcrops throughout the region.

The EPA notes in its letter of 11 October 2005 to Murchison Metals Ltd that the Jack Hills area is understood to be of international geoheritage significance, as the range contains particles of the oldest rocks recorded on earth.

The iron ore deposits of the Jack Hills project occur in late Archaean Era meta-sedimentary and volcanic rocks of very low metamorphic grade, within a structurally defined west-south-westerly to east-north-easterly trending range known as the Jack Hills. An en-echelon range of substantially older, Hadean Era meta-sedimentary gneisses which do not include volcanic rocks or iron ore and are of much higher metamorphic grade, occur 35 kilometres south-west and offset by five to 10 kilometres northerly from the Jack Hills. This range is known as the Erawandoo Hills and the geological system stretches from Mount Narryer to Erawandoo Hill, a distance of about 70 kilometres.

Age dating commenced in the mid 1960s, identified rubidium/strontium age dates in excess of 3.8 billion years and zircons defined poor precision uranium/lead age dates ranging up to 4.3 billion years within samples collected from Mount Narryer. Recent high precision age dates of 4.4 billion years have been obtained from Erawandoo Hill. Despite publications in scientific journals, this occurrence is not in the Jack Hills. The Jack Hills are aged at approximately 2.6 billion years.

The 4.4 billion years age figure is the oldest found on Earth at this time and the site is of geological and geoheritage importance. The specific site is at about 26.18 degrees south, 116.95 degrees east. No impact on that site will occur as a result of the mining operation.

8.5 GROUNDWATER

8.5.1 EPA Objectives

- To maintain the quantity of groundwater 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.

8.5.2 Relevant Standards and Legislation

Standards

- ANZECC, ARMCANZ: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.
- NEPC: Contaminated Sites Management Series - Assessment Levels for Soil, Sediment and Water, November 2003.

- WRC, DME and DEP: Water Quality Protection Guidelines No 1-11, Mining and Mineral Processing, 2000.

Legislation

- *Environmental Protection Act 1986*.
- *Water and Rivers Commission Act 1995*.
- *Rights in Water and Irrigation Act 1914*.

8.5.3 Potential Issues

Up to 250,000 kilolitres of groundwater will be abstracted from bores drawing water from structural aquifers within the weathered fractured granitoids located within the foothills of the range for water supply. Upon cessation of mining, groundwater seepage and incident rain will accumulate in the pit void.

The proposed mining operations pose the following potential issues in regard to groundwater:

- Water draw from the mine bores may affect quality and quantity of groundwater supplies by other users.
- Development of a permanent water source in the mine pit void may create a surface water feature for native and introduced fauna that did not previously exist.
- Alteration of groundwater levels.
- Contamination of groundwater.

8.5.4 Impact Assessment

The proposal does not involve treatment of ores and the construction of facilities, such as tailings dams, that would have an impact on groundwater quantity, by the creation of groundwater mounds. Potential impacts to groundwater levels from the project are considered to be minimal and localised.

Groundwater will be abstracted for dust suppression and potable uses. Water for dust suppression will be obtained from bores located along the haul road route and nearby to the mine site and crushing plant. Drinking water will be obtained from bores.

MML will develop bores specifically for the project. Groundwater extraction for dust suppression, camp and office facilities will be licensed. A Licence to Construct or Alter Well CAW15813(1) has been issued for MML to explore for water resources.

The closest operational pastoral bore (Rainlover bore) to the project site is located approximately eight kilometres north-east of the proposed Jack Hills project. The construction and test pumping of bores will be undertaken, as part of licence CAW15813(1), to ensure minimal drawdown effect on neighbouring bores. The modest water requirement by the operation is not anticipated to cause any off site impacts.

The effects of any temporary lowering of water levels as a result of water abstraction from bores during the life of mining operations will be reported in aquifer reviews, as required by the site's Groundwater Licence Operating Strategy and water extraction licence condition (when issued).

Exploration drilling has not intercepted any significant aquifers in the elevated profile of the pit within the Jack Hills Range. There will be minimal dewatering of the pit as the permanent groundwater level is well below the pit base (i.e. the permanent water table is below 340 metres AHD while the pit base is at 460 metres AHD). Any water intercepted will be used for dust suppression. Due to the elevated nature of the pit on the range, perimeter bunds diverting surface flows from entering the pit and the arid climate providing minimal rainfall and maximum evaporation, it is anticipated the pit floor will not develop a permanent pit lake.

Waste characterisation indicates there is no potential for acid drainage. Minor concentrations of soluble contaminants that may occur within surface runoff and leachates from the waste rock stockpile will be ecologically acceptable.

Diesel will be the most significant hazardous chemical (by volume) on site. Storage and handling of diesel will be undertaken to AS 1949:2004 and site licence requirements. Spillages will be reported and remediated in line with Company Incident reporting procedures.

8.5.5 Management and Mitigation Measures

MML will endeavour to maintain groundwater quantity and quality and manage impacts of groundwater abstraction and dewatering so that they do not affect the environment or any other beneficial users.

A groundwater monitoring programme will be implemented by MML in accordance with a Groundwater Licence Operating Strategy **(Management Action 8.5.5a)** and will include:

- Fitting of flow meters to groundwater extraction bores to enable monitoring of extraction volumes.
- Monthly monitoring of groundwater levels.
- Collection of groundwater samples on a quarterly basis and analysis for the following:
    - Samples to be filtered before analysis.
    - pH.
    - Electrical conductivity.
    - Total dissolved solids (gravimetric and calculation).

- Ions – sodium, calcium, magnesium, chloride, potassium, bicarbonate, carbonate, sulphate, nitrate.
- Metals – aluminium, arsenic, barium, boron, chromium, copper, iron, manganese, lead, nickel and zinc.

Data from the water monitoring programme will be collected and reviewed. Water quality results will be compared with existing baseline data and concentrations and trends analysed. Should the rate of drawdown be higher than expected or if the groundwater levels in bores used by pastoralists are found to decline to below regional groundwater level values, MML will seek to reduce drawdown by using alternative water sources **(Management Action 8.5.5b)**.

Water level and quality information will be reported to the DoE annually **(Management Action 8.5.5c)**.

The monitoring and management of groundwater abstraction and dewatering will be addressed in the Groundwater Licence Operating Strategy and will be reviewed and updated annually **(Management Action 8.5.5d)**.

8.5.6 Environmental Outcome

Groundwater reserves within the region will not be significantly reduced. Water level drawdown from bores within the project area will be localised. On cessation of mining they will recover to pre-mining levels. Water supply to pastoral bores should remain unaffected.

It is not expected that the quality of the groundwater will be affected by the project.

- No chemicals are used during crushing and raw water used is of drinking water quality.
- Waste rock will not generate acid and leachates will contain negligible concentrations of contaminants.
- Spills of hazardous materials will be cleaned up and the site remediated.

The installation of monitoring bores and a monitoring programme will ensure that production bore abstraction has no adverse impacts to the groundwater quantity and quality of the region.

8.6 SURFACE WATER

8.6.1 EPA Objectives

- To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.
- To maintain the quality of water so that environment values or the health, welfare and amenity of people and land uses are protected, by meeting statutory requirements and acceptable standards.

8.6.2 Standards and Legislation

Standards

- ANZECC, ARMCANZ: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000.
- WRC, DME and DEP: Water Quality Protection Guidelines No 1-11, Mining and Mineral Processing, 2000.

Legislation

- *Environmental Protection Act 1986.*
- *Water and Rivers Commission Act 1995.*
- *Rights in Water and Irrigation Act 1914.*

8.6.3 Potential Issues

The intensity of rainfall events, usually associated with thunderstorms and cyclonic activity, results in high erosion potential that is increased with clearing of vegetation.

During the occasional periods of rainfall runoff, surface hydrology may be impacted by the diversion of existing water courses due to the construction of Waste rock stockpile, roads and other infrastructure.

The proposed mining and crushing operations and disposal of waste rock pose the following potential issues in regards to surface water quantity and quality:

- Erosion and deposition of sediments.
- Increased turbidity of runoff water as a result of construction and mining activities.
- Contamination of runoff water with fuels, oils or other chemicals.
- Mine, plant and drainage infrastructure may impact on the volumes and quality of local runoff discharges to a small degree and will have some effect on drainage lines in the immediate area of the pit, plant and associated infrastructure.

8.6.4 Impact Assessment

The rainfall events that will mainly impact on drainage protection for project infrastructure will be those for short duration events. The Northern Australian 4.5 hour rain event has been used to calculate flows from thunderstorm type events. The range of intensities associated with these events and flows generalised on the slope above the pit, the Waste Rock Stockpile and on the crusher plant site are provided on Table 8.2.

Table 8.2: Catchment Areas and Discharge Rate

Catchment A	Area (km^2)	Years	Average Rainfall Intensity (mm/hour)	Flow (m^3/sec)
Above pit area	0.20	2	5.80	0.16
		5	7.50	0.25
		10	9.50	0.37
		20	12.00	0.53
		50	16.00	0.80
Waste rock stockpile area	0.80	2	5.80	0.65
		5	7.50	1.00
		10	9.50	1.48
		20	12.00	2.15
		50	16.00	3.23
Crusher plant area	0.05	2	5.80	0.04
		5	7.50	0.06
		10	9.50	0.09
		20	12.00	0.13
		50	16.00	0.20

This information shows the magnitude of flows from events of two, five, 10, 20 and 50 year ARI's. These flows can be conducted in channels or earth bunds to sediment control structures prior to discharge to natural drainage lines.

Waste characterisation indicates that there is no potential for acid drainage. Very minor concentrations of soluble contaminants that may occur within surface runoff and leachates from waste rock and ore stockpiles will be ecologically acceptable.

The siting of the Waste Rock Stockpile against the ridge (see Figure 8) has occurred to take advantage of the existing topography and to ensure minimal upstream catchment.

8.6.5 Management and Mitigation Measures

Impacts on surface water quality will be minimised by constructing bunds around mine infrastructure areas which have the potential to contaminate surface water flows with fuels, oils, sediment or other contaminants **(Management Action 8.6.5a)**. Containment bunding, silt and oil traps will be established where necessary to remove sediments or pollutants from runoff before water enters local drainage **(Management Action 8.6.5b)**. Any spills of contaminants, such as oil or fuel, which occur outside of bunded areas will be cleaned up immediately where a risk of surface water contamination occurs **(Management Action 8.6.5c)**.

Surface water management structures will be designed and constructed to minimise erosion **(Management Action 8.6.5d)**. Diversion drains will be constructed to ensure water re-enters

natural drainage lines at a velocity and depth that can be accommodated by the natural stream line without increased scouring. Regular visual monitoring will be undertaken of the diversion channels and downstream drainage lines, and the condition of vegetation in the diversion channels **(Management Action 8.6.5e)**.

Should substantial erosion occur, the cause of the erosion will be identified, erosion/ deposition areas rehabilitated as appropriate, and measures implemented to prevent further erosion **(Management Action 8.6.5f)**.

During periods of heavy rainfall, the open pit will be closed to ensure the safety of workers and to prevent damage to pit ramps and roads.

At closure, disturbed areas will be stabilised and revegetated to minimise erosion potential **(Management Action 8.6.5g)**.

8.6.6 Environmental Outcome

Mining activities are not expected to have any significant impact on water flows or quality downstream of the mine site.

8.7 VEGETATION AND FLORA

Four vegetation and flora surveys have been undertaken within the Jack Hills project area by MBS Environmental (October 2004 and June 2005) and Mattiske Consulting Pty Ltd (October 2005 and March 2006), with comparative site visits to Mt Gould (October and November 2005) and Robinson Range (October 2005) by Mattiske Consulting Pty Ltd. The data collected by MBS Environmental and Mattiske Consulting Pty Ltd were merged and utilised by Mattiske Consulting Pty Ltd in the interpretation of the findings, presented in Mattiske Consulting Pty Ltd (December 2005; Appendix 3.1). The findings of the March 2006 targeted survey are incorporated into Sections 4.9 and 8.7 of this report. These surveys established that within the Jack Hills project area there are:

- No nationally significant plant communities.
- Flora and vegetation types on the adjoining plains are commonly represented in the region.
- Flora and vegetation of the Jack Hills Range is complex and restricted to relictual geological formations of the ironstone ridges.
- Three Priority flora species have been recorded.
- Several flora species are of scientific interest as outliers or poorly known taxon.
- Only one introduced species was recorded.

The Jack Hills project will require the clearing of 127.7 hectares of vegetation, of which 25.4 hectares occurs on the range (pit) and the remainder occurs on the adjoining plains north of the range, for the crushing plant, waste rock stockpile, camp, access roads and associated mining infrastructure. Included in the above is the haul road from the mine site to the Beringarra-Cue Road, which will require clearing .36.4 hectares of vegetation on the adjoining plains.

The currently proposed clearing of vegetation will affect less than 0.7% of the BIF component of the Jack Hills Range, but a substantially higher proportion, close to 5% of that component within the mining lease. There is no preferred relationship of flora to either normal or enhanced iron haematitic BIF, so the higher percentages of clearing in the mining lease should not permanently impact on any specific floristic species within the Jack Hill Range.

Table 8.3 summarises the extent of plant communities within the Jack Hills mine site area and the potential impact, as described in Mattiske Consulting Pty Ltd (December 2005). The plant communities have been disturbed by previous exploration drilling. The plant communities surveyed along the haul road route are common and extensive within the adjoining plains and the spatial extent is not included in Table 8.3.

Table 8.3: Spatial Extent of the Plant Communities in the Jack Hills Mine Site Area[1]

Plant Community Code	Total Area of Exploration Lease (ha)	Total Area in Mining and Infrastructure (ha)	Previous Exploration Disturbance (Outside of Operational Footprint) (ha)	(^% Potential Impact)
A1	1101.14	55.23	4.64	5.44%
A2	3.73	-	0.03	0.80%
A3	179.56	-	1.29	0.72%
A4	1.76	1.62	-	92.05%
A5	99.35	0.94	0.05	0.99%
B1	215.48	4.77	0.48	2.44%
C1	53.97	0.05	-	0.10%
C2	169.42	5.94	0.12	3.58%
C3	9.13	-	-	-
F1	20.19	-	-	-
M1	9.48	-	-	-
P1	175.15	1.8	0.47	1.30%
P2	241.31	-	0.98	0.41%
T1	133.66	10.02	4.98	11.22%
T2	32.8	2.2	0.06	6.89%
T3	9.92	6.24	0.13	64.21%
T4	12.57	0.66	1.33	15.83%

Extent and impact of project on plant communities surveyed along haul road route are not included in this table.

The baseline work undertaken to date provides the opportunity for longer-term monitoring of changes in species composition and community structure. The species recorded to date provide a sound basis for a rehabilitation programme on disturbed tracks, operational areas and mining areas.

8.7.1 EPA Objectives

- 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.
- Protect declared rare and priority flora, consistent with the provisions of the *Wildlife Conservation Act 1950* and the *EPBC Act 1999.*
- Protect other flora species of conservation significance.

8.7.2 Standards and Legislation

- *Environmental Protection Act 1986.*
- *Wildlife Conservation Act 1950.*
- *EPBC Act 1999.*
- EPA Guidance Statement No. 51 (Terrestrial Flora).

8.7.3 Potential Issues

Clearing of 127.7 hectares within the mine site and haul road will involve the temporary or permanent loss of native vegetation, which may result in the loss of protected flora species, plant communities with limited knowledge of their distribution or threatened ecological communities.

The *Triodia* communities, restricted to the BIF component of the range, will be impacted by the pit and ramp. Several Priority or significant flora species recorded in the Jack Hills project area will be impacted by the pit, mining infrastructure and haul road.

The waste dump, relocated to avoid the *Triodia* communities, will impact a small granite outcrop plant community.

Activities associated with the project have the potential to cause:

- The introduction of weed species not already present in the project area.
- The spread of weed species that may already be present in the project area.
- Fire.

8.7.4 Impact Assessment

8.7.4.1 Plant Communities

Eleven of the 18 communities as defined will be impacted by the proposed mining and associated infrastructures.

The mining proposal will impact on 19.12 hectares of *Triodia melvillei* Hummock Grassland Community and the previous disturbance associated with exploration drilling, located outside the mining operational footprint, has impacted on a further 6.5 hectares. The project combined with previous exploration drilling disturbance will impact on approximately 13.56% of the *Triodia melvillei* Hummock Grassland Community and individually T1, T2, T3 and T4 by 11.22%, 6.89%, 64.21% and 15.83%, respectively. The isolated granite outcrop, comprising of a Low Open Woodland of *Acacia rhodophloia* (A4), will be impacted by 92.05%. The project will impact less than 7.5% of any of the remaining plant communities surveyed within the Jack Hills range and adjoining plains. These communities are more widely distributed outside the study area and have not been surveyed.

The waste dump will impact on a small hill at the foothills of the range that comprises a granite outcrop. The Low Open Woodland of *Acacia rhodophloia* (A4) associated with the granite outcrop occurs on other scattered outcrops within the region and the floristic composition of this area is not as significant as those on the Jack Hills range.

The pit and ramp will impact less than 20 hectares of the *Triodia melvillei* Hummock Grasslands Community (T1, T2, T3 and T4), which covers an area of approximately 189 hectares on the Jack Hills range within the study area. This community was also observed on similar ironstone ridges at Mt Gould, at which time the T1 and T2 plant communities were recorded. The extent of *Triodia melvillei* Hummock Grasslands Communities on Mt Gould was not able to be mapped in the time available and photographic maps were not available at the time of the survey. The relative regional impact on the *Triodia melvillei* Hummock Grassland Community, especially the T1 and T2 plant communities, will be less as a result of this regional representation.

Of the *Triodia* communities defined, the T3 appears to be the one that will be influenced most markedly by the proposed pit. Approximately 6.24 hectares (63%) of the *Triodia melvillei* Hummock Grasslands Community (T3) will be impacted by the pit. The remainder of the T3 plant community is located immediately north-east of the pit, of which 0.13 hectare (1.31%) is disturbed by previous exploration drilling. At this stage, no additional T3 plant community has been recorded, but additional areas may be located with more detailed mapping along the north-east portions of the range away from the project area. The T3 plant community differs from the remaining *Triodia* communities mainly through the differences in proportional contribution of the different shrub species; including increased abundance (numbers and plant cover) of *Acacia cockertoniana* (ms) and *Eremophila margarethae*. None of the species within this community are restricted to the proposed clearing area.

The remaining plant communities that will be impacted by the project are associated with the drainages and flats on the adjoining plain that are widely represented in the region.

None of the plant communities within the survey area are currently listed as Threatened Ecological Communities pursuant to Schedule 2 of the *EPBC Act 1999*.

8.7.4.2 Significant Flora

No Declared Rare or Threatened Flora was recorded within the Jack Hills project area. The three Priority species (*Calytrix verruculosa*, *Gunniopsis divisa* and *Verticordia jamiesonii*) recorded on the mining lease and along the haul road alignment are expected to occur outside the areas of disturbance and are known to occur elsewhere in the region. Several species were significant as they are outliers from previously known locations. The most significant of these are the *Lobelia heterophylla* subsp. *pilbarensis* and the A*cacia cockertoniana* (ms) as these species occur on the proposed mining area. Both of these taxa have been recorded outside the proposed clearing areas for the project.

The haul road route has been re-aligned to avoid the Priority species *Gunniopsis divisa* and minimise the impact on Priority species *Calytrix verruculosa* to 24 individuals lost (6.7% of total). The originally proposed central pegged alignment of the Miscellaneous Licence would have destroyed 86 plants (24% of the total). This has necessitated aligning part of the road outside the current Miscellaneous Licence. Table 8.4 shows the impacts on plant numbers along the original and re-aligned routes.

Table 8.4: Size of *Calytrix verruculosa* populations and potential impact on proposed re-aligned haul road on the Jack Hills project Area

Site	Easting (GDA)	Northing (GDA)	Population Size	Loss of Plants on Original Alignment	Potential Loss of Plants on Re-alignment	Recommendation
1	509140	7108600	80	8	1	Align road through 509172/7108607 + 509205/7108690 + 509246/7108792
2	510021	7109785	20	3	3	Maintain alignment through centre of corridor
3	510036	7109749	54	20	6	Move north through 510021/7109785 + 510092/7109851: would lose 20 plants on original alignment
4	510607	7110128	15	10	0	Move road north to between pegged alignment and fence
5	512042	7111068	30	11	11	Keep pegged alignment
6	518632	7116730	8	8	0	Move road 100m north should avoid most plants
7	518820	7116858	77	10	0	Move road 100m to the north to avoid population; current alignment would destroy 10 plants
8	519034	7117006	74	16	3	Move road north 150m (through 518892/7117055); keeping current alignment will lose 16 plants

Site	Easting (GDA)	Northing (GDA)	Population Size	Loss of Plants on Original Alignment	Potential Loss of Plants on Re-alignment	Recommendation
		Total	**358**	**86**	**24**	

The pit and ramp will result in the potential loss of about 10% of the estimated population of *Acacia cockertoniana* on the main range. The greatest potential loss of plants is in Community T3 where 50% of plants could be lost, followed by Community T2 with a potential loss of 30% of the total population. However, if *Acacia cockertoniana* (ms) densities are similar in the surveyed communities throughout the lease area, then the total population will be higher and the total loss would be more in the region of 2-3%. It should also be noted that *Acacia cockertoniana* (ms) has been recorded in three additional communities to the five surveyed in March, 2006.

8.7.4.3 Long Term Impacts

The long-term impact of clearing on vegetation and flora for mine development and operation, with the exception of the pit, is expected to be minor, with the temporary loss of 102.3 hectares, which will be rehabilitated with native species either progressively during mining life or on cessation of mining operations. This will not result in a significant loss of biodiversity as all of the vegetation types occurring on the adjoining plains area are commonly represented in the region.

There will be a permanent loss of 25.4 hectares of *Triodia* community vegetation within the pit perimeter, of which 64% of survey extent of T3 will be impacted.

The other *Triodia* sub-communities (T1, T2 and T4) are either represented elsewhere on the Jack Hills Range or other BIF ranges and are impacted by less than 16% of their known surveyed extent.

8.7.4.4 Weeds

The spread of weeds is influenced by:

- Proximity to settlements and other disturbed sites where the weeds currently occur.
- Past and current land use.
- Movement of people, livestock and vehicles.
- Ruby Dock (*Acetosa vesicaria*) is known to be spreading within the Murchison region and there is the potential for this and other introduced species to establish in the area.

8.7.5 Management and Mitigation Measures

MML will implement the following measures during the project to minimise the impact on vegetation and maximise the conservation of the botanical values in the project area **(Management Action 8.7.5a)**, namely:

- The project layout has been designed to minimise the clearing of vegetation and clearing will be limited to that which is necessary for the completion of the first stage of the project. Any expansion will require further detailed investigations and approval.
- Existing access tracks and transport routes have been used where possible.
- New transport routes have been located away from areas of environmental sensitivity such as the range, granite outcrops and drainages as much as possible.
- Pockets or strips of vegetation will be left undisturbed within areas cleared for infrastructure where the risk of fire, impacts on road safety or interference with mining operations is low.
- As an alternative to clearing vegetation, areas of low shrub will be clearly marked out for laydown areas where this use is temporary only, and does not increase the risk of fire.
- Areas to be cleared will be clearly defined on maps and the ground, and clearing activities will be supervised.
- Vehicles and machinery are to be parked in designated areas.
- Dust control measures will be implemented.
- Access to the range, other than the pit area, will be restricted as follows:
    - Only for MML personnel conducting environmental monitoring and exploration.
    - MML induction will prohibit personnel from access to the range other than for monitoring, mining and exploration purposes.
    - Signage prohibiting access on the entry points will be erected and maintained.
- Conduct additional follow-up botanical surveys to include:
    - Searches for Rare and Priority Flora will continue during the operational phase of the project.
    - Searches for flora that are restricted or occur as range extensions will be investigated further in the field during the operational phase of the project, including additional targeted searching should be undertaken for species that occur as outliers and the three Priority species.
    - Additional detailed on-ground studies to clearly define the extent of the various Spinifex communities on Jack Hills, the Robinson Ranges and Mt Gould during the operational phase of the project. The definition of the outer extent of Triodia communities was undertaken on the Jack Hills in October 2005.
    - Undertake further integrated regional studies, in conjunction with CALM, to investigate and define the extent of the communities on the Jack Hills Ranges during the operational phase of the project.
    - Establish permanent vegetation plots and monitor before, during, and after mining activities.
- Management actions specific to the occurrence of rare, Priority and range extension flora are:
    - *Acacia cockertoniana* (ms) – Undertake additional investigations into relative numbers in the different plant communities (as mapped) in order to clarify the potential impact of the proposed operations on this taxon at Jack Hills.

- *Verticordia jamiesonii* (Priority 3) – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
- *Lobelia heterophylla* subsp. *pilbarensis* –This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
- *Amaranthus interruptus* – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
- *Calandrinia pleiopetala* – This taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.
- *Eremophila pendulina* – Although located outside the lease area, this taxon will be investigated as the opportunity arises in more detailed native vegetation studies during the operational phase of the project.

- Implement rehabilitation procedures using data from mining activities in similar environments. Investigate the likely success for revegetation, addressing the issues of water relations, weed invasion, changes in topography and soil structure.
- Topsoil, rootstock and cleared vegetation will be retained in designated areas for use in rehabilitation.
- Disturbed areas will be progressively rehabilitated with native species and monitored.
- Respread topsoil over disturbed areas as soon as possible after clearing and stockpiling for short periods if direct return of topsoil is not feasible.
- Further collections of flora will be undertaken after higher seasonal rainfall events
- An environmental induction and awareness programme will be developed to raise the workforce awareness of conservation issues.
- Review other options for conserving the communities in the Jack Hills lease areas.

Weeds will be controlled through prevention, monitoring and early eradication **(Management Action 8.7.5b)** as follows:

- Avoiding or minimising disturbance to areas with, or vulnerable to, weed infestation where practicable.
- Inspecting vehicles and machinery for soil and seeds when entering the site and washing them in designated areas if required.
- Inspecting disturbed and rehabilitated areas for weeds (particularly after rainfall events) and consulting with CALM and the Department of Agriculture as to the treating of infested areas.
- Raising awareness of the workforce in weed control.
- Rehabilitating disturbed areas progressively to discourage weed establishment.

Weed prevention, management and monitoring measures will be implemented in accordance with a Vegetation Management Plan **(Management Action 8.7.5c)** [Appendix 1.6 of this report (Volume 1)].

Fire management will be implemented in accordance with a Fire Management Plan **(Management Action 8.7.5d)** [Appendix 1.9 of this report (Volume 1)].

8.7.6 Environmental Outcome

The flora and vegetation within the Jack Hills project area are represented outside the proposed clearing area associated with the proposal. The proposed clearing activities will modify the degree of representation of some species and plant communities in a local context. Additional studies proposed during the operational phase of the project on the flora and vegetation will assist in establishing the further extent of community distributions.

These additional botanical studies, weed control programmes and rehabilitation methods will assist in mitigating the impacts on flora and vegetation.

8.8 FAUNA

Three fauna surveys have been undertaken within the Jack Hills project area by Western Wildlife (October 2004 and March 2006) and MBS Environmental (September 2005). These surveys established that within the greater project area:

- A cumulative total of 129 vertebrate, of a possible 212 species expected to occur in the region, were recorded within the habitats of the project area, comprising four frogs, 20 mammals, 33 reptiles and 72 birds.
- Twenty-four species of conservation significance were identified as potentially occurring within the Jack Hills project area and comprise six mammals, three amphibians, five reptiles and 10 birds. Of these, one mammal and three birds have been recorded in the project area to date. Additionally, four trans-equatorial or migratory birds listed on international treaties have been recorded in the greater Jack Hills project area. Highly localised disturbance is unlikely to impact on the conservation status of these significant species.
- The Jack Hills Range supports a faunal assemblage that is distinct from that of the adjoining plains.
- Five introduced species were recorded.

Species recorded were generally common arid zone species with the exception of the Schedule 4 Listed species Peregrine Falcon (*Falco peregrinus*), the Priority 4 CALM listed species Long-tailed Dunnart (*Sminthopsis longicaudata*) and Bush Stone-curlew (*Burhinus grallarius*).

A southerly range extension was the record of the Little Broad-nosed Bat (*Scotorepens greyii*). The Western Australian Museum Faunabase Records show the Little Broad-nosed Bat as occurring throughout the Kimberley and west to central Pilbara (WA Museum, 2005).

Interesting reptile records were gained from the *Triodia* uplands sites: *Cyclodomorphus melanops elongatus* and *Delma butleri* are both *Triodia* associated species (Storr *et al.* 1999). These two species were not found on any of the plain sites suggesting that the two species are associated with the Jack Hills Range.

Consultations with Western Australian Museum have established that short range endemic (SRE) invertebrate species are likely to occur on the southern and south-eastern facing hillsides of the ranges and SRE habitat is not expected to occur, or be impacted, in the Jack Hills project area.

The geology of the Jack Hills range and the absence of groundwater does not provide subterranean habitat to support stygofaunal life forms and is not unique in terms of habitat for potential troglofaunal life forms that may occur on the range. The geology and hydrogeology of weathered granitoids and structurally controlled aquifers located within the foothills of the range does not contain voids and cavities which may support subterranean fauna. The shallow aquifers on the extensive plains may provide habitat for stygofaunal life forms.

8.8.1 EPA Objectives

- 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.
- Protect Specially Protected (Threatened) and Priority fauna and their habitats consistent with the provisions of the *Wildlife Conservation Act 1950* and the *EPBC Act 1999.*

8.8.2 Standards and Legislation

- *Environmental Protection Act 1986*.
- *Wildlife Conservation Act 1950.*
- *EPBC Act 1999*.
- EPA Guidance Statement No. 56 (Terrestrial Fauna).

8.8.3 Potential Issues

Clearing of 127.7 hectares within the mine site and haul road will involve the temporary or permanent loss of habitat, which may result in the loss of rare, threatened or vulnerable fauna species. Potential impacts on fauna include:

- Disturbance of fauna habitat and fauna species.
- Death on haul road due to increased vehicle traffic.
- Attraction of feral animals to project area such as putrescible waste facility.

8.8.4 Impact Assessment

The Jack Hills Range supports a faunal assemblage that is distinct from that of the adjoining plains. The pit (25.4 hectares in area) will impact approximately 19.12 hectares (10.12%) of the *Triodia* Upland community, which covers an area of approximately 189 hectares, as mapped by Mattiske Consulting (November 2005). An additional 3.44% of the *Triodia* Upland community is impacted by previous exploration drilling programmes.

The impact on the BIF component of the Jack Hills range, which is an area of 3,900 hectares, is less than 0.7%. These habitats are well represented outside the area of mining impact. The habitat of the scree slopes and adjoining plains within which most of the mining infrastructure and haul road occur is extensive within and without the study area. The granite outcrop, which will be impacted by the waste dump, is well represented elsewhere as scattered outcrops throughout the region.

Based on the size, extent and nature of activities, the construction and operation of the Jack Hills project is unlikely to have a significant impact on the diversity and population of vertebrate fauna species including those of conservation significance that are expected to occur in the immediate vicinity of the project area and of the region.

The impact of clearing on habitat is expected to be minor, with permanent loss of 25.4 hectares within the pit and ramp layout and temporary loss of 102.3 hectares that will be rehabilitated with native flora species. Recolonisation of disturbed areas will occur as vegetation is progressively re-established and as the site is decommissioned on cessation of activities.

All of the fauna habitats that will be impacted as a result of the project are well represented on the Jack Hills Range and on the adjoining plains. The development of the project will not reduce the conservation value of these habitats. The majority of the birds and larger fauna species are highly mobile and any individuals residing in these areas are likely to naturally move away from the areas of increased human activity and relocate to adjacent areas.

Minimal impact on fauna species of conservation significance is predicted as the habitat suitable for most of the species identified as existing or potentially existing in the project area is widely represented on a regional scale.

On the basis of limited extent and location of the mining proposal, the Jack Hills project will not have any adverse impacts on short range endemic invertebrate fauna species that may be associated with the range. Mining and water abstraction will have minimal or no adverse impact on subterranean fauna.

8.8.5 Management and Mitigation Measures

The following measures will be implemented during the project to minimise the impact on fauna **(Management Action 8.8.5)**:

- Clearing of vegetation will be restricted to the minimum necessary to implement the project. This will be achieved using the Murchison Metals Ltd internal "Permit to clear" procedures.

- An egress will be provided at one end of pits and trenches to enable trapped wildlife to escape.
- Drill hole capping will be regularly checked to ensure the integrity of the capping is maintained.
- Open holes and trenches without egress will be inspected prior to 10:00am daily for trapped fauna. Trapped individuals will be released.
- The environmental induction programme and ongoing provision of information will raise the awareness of the workforce about the conservation of fauna (particularly rare, threatened or vulnerable fauna) and their habitats.
- Direct contact with fauna will be avoided whenever possible.
- Vehicles and machinery will be parked in designated locations only to minimise habitat damage.
- Refuse and the landfill site will be managed to prevent an increase in feral animal populations.
- Feral animal deterrent measures and/or eradication programmes will be implemented in consultation with CALM, the Department of Agriculture and pastoralists.
- Restricting traffic to established roads and parking areas.

Other initiatives will be trialled in an effort to minimise impact on fauna. For example, undertaking clearing using a "from the inside out" approach may increase the ability of animals to move beyond the clearing envelope.

8.8.6 Environmental Outcome

The habitats within the Jack Hills project area are well represented within the range and on the adjoining plains are common and widespread throughout the region. The fauna recorded or expected to occur within the project area are unlikely to be significantly impacted by clearing and temporary removal of these habitats. Consequently, the impact of the proposed Jack Hills project on fauna and habitat will be negligible in a regional conservation context. Clearing measures, mining and exploration procedures, feral animal programmes and rehabilitation methods will assist in mitigating the impacts on fauna and habitats.

8.9 AIR EMISSIONS

8.9.1 EPA Objectives

Air Quality
To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

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

8.9.2 Relevant Standards and Legislation

Standards

- World Health Organisation Guidelines for Air Quality 2000.

Legislation

- *Environmental Protection Act 1986*.
- National Environmental Protection Measures (NEPMs) outlined in the *National Environment Protection Council (Western Australia) Act 1996*. These are:
  - Ambient Air Quality NEPM.
  - Diesel Vehicle Emissions NEPM.
  - National Pollutant Inventory NEPM.

8.9.3 Potential Issues

Gaseous emissions will result from burning of fuels for the diesel powered generators, engine exhausts of earth moving equipment and mine vehicles and trucking of ore to Geraldton. This includes carbon monoxide, carbon dioxide and nitrous oxides. An estimated four megalitres per annum of fuel is expected to be burnt at the Jack Hills project and 20 megalitres per annum used for the trucking to Geraldton.

Greenhouse gases will also be released from vegetation clearing by burning, natural decay and soil carbon release.

The Greenhouse Challenge spreadsheet obtained from the Australian Government Greenhouse Office was used to estimate the amount of carbon dioxide that will be emitted as a result of the Jack Hills operations, while the National Pollutant Inventory (NPI) *Emission Estimation Technique Manual* for Combustion Engines (Environment Australia, 2002) was used to estimate emissions of carbon monoxide and oxides of nitrogen. Based on fuel consumption of four megalitres per annum, emissions of 10,000 tonnes of CO_2, 56 tonnes of CO and 125 tonnes of NO_X are estimated for the Jack Hills project. Based on fuel consumption of 20 megalitres per annum, emissions of 50,000 tonnes of CO_2, 280 tonnes of CO and 624 tonnes of NO_X are estimated for the trucking of ore to Geraldton.
Reporting of up to 90 substances to the NPI will potentially be required based on the quantity of substances that are used, consumed and/or emitted from the Jack Hills operations. The NPI is a database designed to provide the community, industry and government with information on the types and amounts of certain substances being emitted to the air, land and water. Statutory reporting of substances depends on the exceedence of category thresholds, and based on the estimated annual fuel use only, at least 21 substances will need to be reported.

8.9.4 Impact Assessment

Greenhouse gas emissions will result from onsite generation of power for the operation and from exhausts of vehicles and mobile equipment. Given the remoteness of the project and

trucking route, it is not anticipated that the additional greenhouse gas emissions resulting from this project will have an adverse impact on local or regional air quality.

Clearing associated with the project will result in the permanent loss of 25.4 hectares and the temporary loss of 102.3 hectares. The rehabilitation and re-establishment of native vegetation over the mining area, excluding the pit, will result in restoration of more than 75% of the carbon sink function of the current vegetated area over a period of 10 to 20 years.

8.9.5 Management and Mitigation Measures

The following management and mitigation measures will be implemented to minimise and control air emissions **(Management Action 8.9.5)**:

- Vehicles and power generating equipment will be regularly maintained and serviced to manufacturer's specifications to ensure efficient running of equipment and optimum fuel consumption, thereby minimising exhaust emissions.
- Rehabilitation will, where possible, be progressive and involve careful topsoil management and re-introduction of endemic species such that a self-sustaining vegetation complex is established.
- Emissions will be reported as part of the National Pollutant Inventory.

8.9.6 Environmental Outcome

Greenhouse gas emissions from power generation and mobile plant will be minimised by regular maintenance and efficient use of plant, vehicles and equipment. Vegetation clearing will result in mostly a temporary loss in the carbon sink and in the release of CO_2 over a five-year mining life.

8.10 DUST

8.10.1 EPA Objectives

To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land use by meeting statutory requirements and acceptable standards.

8.10.2 Relevant Standards and Legislation

Standards

- World Health Organisation Guidelines for Air Quality 2000.
- *Mines Safety and Inspection Regulations 1995*.

Legislation

- *Environmental Protection Act 1986*.
- The following National Environmental Protection Measures (NEPMs) outlined in the *National Environment Protection Council (Western Australia) Act 1996*:
  - Ambient Air Quality NEPM.
  - National Pollutant Inventory NEPM.
- *Mines Safety and Inspection Act 1994*.

8.10.3 Potential Issues

Dust may be generated from the following:

- Earthworks undertaken during the construction and operation of the project.
- Topsoil stripping.
- The mining and loading of ore onto haul trucks.
- Blasting activities
- The movement of vehicles.
- Wind erosion of exposed surfaces such as the pit, waste rock stockpile, stockpiles, the ROM area and roads.

8.10.4 Impact Assessment

Fugitive dust will be generated from mining activities, vehicular movement and wind erosion. The extent of dust generated is expected to be minor and localised. Dust suppression using water sprays will mitigate dust effects from these sources.

Generation of dust from blasting activities cannot be mitigated using water sprays. Dust generated from blasting in the pit will potentially impact on vegetation downwind of the pit at the time of the prevailing wind when blasting occurs. For most of the year, the prevailing

winds of the project area will be from the east and south-east. Vegetation on the leeward side of the pit within a 500 metres radius of the pit edge comprises vegetation as presented in Table 8.5. Approximately 72 hectares of vegetation occur within 500 metres of the leeward areas, of which 35.9 hectares are associated with range (uplands, breakaways and footslopes) vegetation and the remainder is on the plains. Vegetation more distant from the pit is almost entirely located on the plains.

Potential dust deposition on sensitive vegetation, especially the upland *Triodia* plant communities of the Jack Hills Range, in close proximity to the open pit will be up to 18.42 hectares. The T3 plant community, which will be impacted the most by the pit (proportionate to its representation on the range), will not be adversely affected by potential dust generated from prevailing winds with an estimated 0.4 hectare located on the northern edge of the pit.

Table 8.5: Vegetation Within 500 Metres of Western and North-Western Edge of the Pit

Plant Community	Total Area in Exploration Lease (ha)	Area to be Disturbed by Jack Hills Project (ha)	Area within 500m of NW/W Side of Pit (ha)
Near Creeklines and Drainage Lines			
C2	169.42	5.22	3.72
Open *Mulga* and *Acacia* Communities on Flats and Hills			
A1	1,101.14	54.23	31.48
A3	179.56	-	0.91
***Triodia* Hummock Grassland Communities**			
T1	133.66	10.02	8.76
T2	32.80	2.2	9.13
T3	9.92	6.24	0.4
T4	12.57	0.66	0.13
Breakaways			
B1	215.48	4.64	6.91
***Ptilotus* Dominated Communities**			
P1	175.15	0.88	10.57

8.10.5 Management and Mitigation Measures

Site personnel will visually monitor dust levels during construction and operation of the project. Dust suppression measures will be instituted using water trucks, spray bars and other means as necessary, in the event that high levels of dust are observed, and/or strong winds and dry conditions make dust generation likely **(Management Action 8.10.5a)**.

Site personnel will monitor dust deposition on the *Triodia* plant communities, and other vegetation communities visually and also using dust deposition gauges, to ensure there is no detrimental effect from dust **(Management Action 8.10.5b)**.

Prevailing wind information will be utilised to, where possible, undertake blasting when wind directions are blowing away from the remaining T3 plant community, which is located in close proximity east and north-east of the pit **(Management Action 8.10.5c)**.

The implementation of a progressive rehabilitation programme will also reduce the risk of dust generation.

Dust minimisation, management and monitoring measures will be implemented in accordance with a Dust Management Plan **(Management Action 8.10.5d)** [Appendix 1.5 of this report (Volume 1)].

8.10.6 Environmental Outcome

The potential for dust generation can be managed through standard dust suppression measures and by implementation of special procedures to be observed during blasting activities. There will be no off site impacts, as dust generation will be contained by the Jack Hills operations.

8.11 NOISE

8.11.1 EPA Objectives

To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

8.11.2 Relevant Standards and Legislation

Standards

- *Environmental Protection (Noise) Regulations 1997*.
- *Mines Safety and Inspection Regulations 1995*.

Legislation

- The noise provisions of the *Mines Safety and Inspection Regulations 1995* (Part 7: Division 1).
- *Environmental Protection (Noise) Regulations 1997*.

8.11.3 Potential Issues

Noise generated as a result of the project will be primarily due to:

- Power generation from generator sets.
- Blasting in the pit.
- Operation of earthmoving machinery, trucks and other mechanical equipment.

- Crushing and screening.
- Traffic along the transport routes.

8.11.4 Impact Assessment

The mining and crushing operations at Jack Hills will comply with legislation that governs occupational noise and noise emissions from premises.

The camp is 2.5 kilometres north-east of the project site and is unlikely to be affected by noise from the operations. The nearest local station is over 30 kilometres from the project area and should also not be affected by noise from the operation.

The haulage route bypasses the town of Cue. The truck assembly area is outside the Cue town boundary to minimise disruption to residents. On the public sections of the haulage route such as the Great Northern Highway, truck traffic is not subject to the noise regulations.

8.11.5 Management and Mitigation Measures

Noise emissions generated by the construction and operation of the project are expected to be localised and not create a nuisance beyond the boundary of the project area. MML will implement the following noise management measures **(Management Action 8.11.5)** to ensure that:

- Noise control equipment on stationary and mobile equipment is operating correctly.
- The noise emissions comply with the requirements of the *Environmental Protection (Noise) Regulations 1997* and the *Mining Act 1978*.

8.11.6 Environmental Outcome

As there are no noise sensitive premises in close proximity to the project area, noise impacts are expected to be minimal.

8.12 LANDSCAPE/VISUAL AMENITY

8.12.1 EPA Objectives

To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.

8.12.2 Visual Assessment

Within the vicinity of the project area Mt Hale and Mt Matthew are the highest points on the landscape, at heights of 697 and 655 metres AHD, respectively, while the most prominent section of the Jack Hills ridgeline ranges from 450 to 697 over a distance of 38 kilometres.

The visual impact of the Jack Hills project, following decommissioning of the mining operations, is shown in three-dimensional computer generated views based on an aerial photograph draped over the regional contours of the area (Visual Plates 1 to 3). Visual Plate 1 shows the location of four viewpoints of the Jack Hills project site. The range, as seen from the north-west, north-east, south-east and south-west, is shown in Viewpoints 1, 2, 3 and 4, respectively. Visual Plate 2 shows Viewpoints 1 and 2 and Visual Plate 3 shows Viewpoints 3 and 4.

The pit will be the only mining-related infrastructure located on the range, while the remainder will be located on the plain with the Waste Rock Stockpile, reaching a maximum height of 80 metres and abutting the range on the lower scree slopes (refer to Figures 8 and 9). The pit and the waste rock stockpile will be the only infrastructure that will remain after decommissioning of operations at the mine site. The pit is located on an approximately 25 hectare footprint on the north-west facing slopes of the range with the southern pit walls occurring at elevations from 400 to 520 metres AHD. These elevations are well below the north-east to south-west aligned ridgeline, which is located on the southern side of the pit.

The range skyline and Mt Hale and Mt Matthew will therefore not be lowered or altered.

The major portion of the pit, which will reach depths of up to 140 metres (i.e. on highest side of range), will be hidden by the hillside in the foreground when viewed from the north-west.

The upper walls on the south-eastern side of the pit will be visible when viewed from the north and north-west. At distances of more than 10 kilometres, up to 25 metres will be exposed. However, at such distances the impact of active mining will be minimal, as the nearest residence or public road is more than 30 kilometres north and north-west of the mine. The exposed portion of the pit wall will become less visible nearer to the mine until, at a distance of 1,500 metres, it will be hidden by the hillside in the foreground. The BIF rock is dark coloured and will blend into the natural colours of the range, becoming weathered over time, further enhancing the visual amenity.

The waste rock stockpile is located well below the ridgeline and will be more visible during the mining operation. The siting of the waste rock stockpile well below the ridgeline takes advantage of the existing topography to optimise the visual blending with the surrounding environment (see Figure 8). The final slope design of the waste rock stockpile (i.e. proposed 16 degrees slope – see Figure 9) also takes account the visual blending with the surrounding environment (i.e. while also addressing stability and drainage/erosion requirements). In addition, the dump will be rehabilitated with a final cover of oxidised waste rock to improve the visual amenity and will blend into the surrounding slopes as vegetation becomes established (i.e. dark green mafic schists and the browner BIF waste will blend well with the general landscape).

The main ridgeline shields the project area from view from the south-east, as shown in Viewpoint 3. From the south-west, Viewpoint 4 shows the view of the pit, which is located within undulating hills and valleys on the western side of the range.

8.13 WASTE PRODUCTS

8.13.1 EPA Objectives

Soil Quality
To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.

Water Quality
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.

8.13.2 Relevant Standards and Legislation

Standards

- Relevant standards and guidelines in regards to waste storage, transport, and management, include but are not limited to:
    - Guidelines for Controlled Waste Generators.
    - Guidelines for Controlled Waste Treatment and Disposal Sites.
    - Guidelines for Acceptance of Solid Waste to Landfill.

Legislation
The key legislation regarding waste management is administered by the Waste Management Branch and is contained within the *Environmental Protection Act 1986*. This includes the:

- *Environmental Protection Act 1986* – Part VIIA.
- *Environmental Protection Amendment Regulations (No. 2) 1998*.

The following legislation relates to the transport of waste that may cause environmental or health risk:

- *Environmental Protection (Controlled Waste) Regulations 2004*.
- *Health Act 1911*.

8.13.3 Potential Issues

Various wastes will be generated by the project. These include:

- General domestic and office refuse.
- Industrial wastes (e.g. tyres, packaging, infrastructure and machinery components).
- Hazardous wastes (e.g. oils, grease, lubricants).
- Sewage.

There is the potential for incorrect waste disposal to result in the contamination of soil, surface water and groundwater and for litter to be dispersed beyond the landfill perimeter.

8.13.4 Impact Assessment

General domestic and office waste and all industrial wastes can be disposed to separate landfill cells with minimal impact to the environment. Hazardous wastes will be disposed off site and will not present an environmental hazard.

Waste oils, grease and lubricants are collected and removed from site for disposal or recycling by an authorised contractor.

A waste treatment plant will treat sewage from the accommodation camp before being discharged via a sprinkler system to a fenced area of native vegetation. A septic tank sewerage system will be provided for the site office ablutions. The systems will be designed and operated in compliances with the health requirements of the Health Department of Western Australia and the relevant Shires of Meekatharra or Murchison.

The groundwater level beneath the pit on the Jack Hills Range is in excess of 140 metres and the permanent water table will not be intersected by mining. Landfills and sewerage treatment systems will be designed to depths such that the underlying water table will not be adversely impacted.

All used tyres will be buried within the Waste Rock Stockpile. A request for this disposal will be included in the application to DoE for an Environmental Operating Licence.

Records of tyre disposal will be kept and disposal sites within the waste rock stockpile will be selected on the following criteria:

- Nominated areas provide secure tyre disposal.
- Tyre disposal does not interfere with waste rock stockpiling.

8.13.5 Management and Mitigation Measures

MML will implement management measures **(Management Action 8.13.5)** to minimise the potential for contamination of the surrounding environment due to general waste disposal as follows:

- General domestic and office waste will be disposed of to an on-site landfill, located above the water table. Currently there are no viable opportunities for the broad recycling of office and domestic wastes, due to the remote nature of the site. However, MML will, throughout the life of project, actively identify and look to apply any viable opportunities for the recycling of office and domestic wastes.
- Industrial waste will be disposed of to an on-site landfill, located in the waste rock stockpile.
- Landfill cells will be located away from areas that may be subject to localised inundation and away from drainage lines. Surface water will be managed in the vicinity of the landfill cell to minimise runoff entering the cell.
- The industrial landfill site will be regularly covered with soil to prevent access by animals and the occurrence of wind-blown litter.

- The camp landfill site will be fenced and regularly covered with soil to prevent access by animals and the occurrence of wind-blown litter.
- Waste oils, solvents and other hazardous material will be collected in drums and stored in a bunded area. These will be removed from site for recycling or disposal to an approved waste disposal facility.
- Sewage generated during operations will be treated in approved systems and discharged to irrigation areas or leach drains.
- During closure of the project, the landfill will be capped with a clayey soil layer and rehabilitated.

8.13.6 Environmental Outcome

Through appropriate management measures in accordance with standard industry practices there is expected to be minimal impact on the environment through generation and on-site disposal of waste products.

8.14 DANGEROUS AND HAZARDOUS SUBSTANCES

8.14.1 EPA Objectives

Soil Quality
To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.

Water Quality
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.

8.14.2 Relevant Standards and Legislation

Standards
Relevant Australian standards in regards to the storage, handling, and management of dangerous and hazardous substances include, but are not limited to:

- AS 1940 - The storage and handling of flammable and combustible liquids.
- AS 1692 - Tanks for flammable and combustible liquids.

Legislation

- *Environmental Protection Act 1986.*
- *Environmental Protection (Controlled Waste) Regulations 2004.*
- *Environmental Protection (Liquid Waste) Regulations 1996.*

- *Explosives and Dangerous Goods Act 1961.*
- *Dangerous Goods (Transport) Act 1996.*

8.14.3 Potential Issues

High intensity rainfall events are characteristic of the climatic conditions of the Murchison region and caution needs to be taken in the storage of hazardous substances to ensure contaminants are not mobilised by runoff water.

There is the potential for incorrect storage of dangerous and hazardous substances to result in the contamination of soil, surface water and groundwater.

8.14.4 Impact Assessment

Crushing of the ore does not require chemicals. The greatest hazardous material on site, by volume, will be hydrocarbons (diesel, oils and grease), used in power generation and the mining equipment.

Other hazardous materials, to be used in small quantities and given in Table 8.6.

Table 8.6: Hazardous Materials

Class	Products	Use
Explosives	Bulk explosives and detonators	Mining
Gases	Oxy – acetylene	Maintenance workshops
	LPG	Camp
Corrosives	Acid	Batteries
	Caustic Soda	Cleaning products
Poisons	Cleaning products, herbicides, insecticides	Camp, environmental

8.14.5 Management and Mitigation Measures

MML will implement management measures to minimise the risk of contamination of soil, surface water and groundwater and harm to employees at the site **(Management Action 8.14.5)**:

- A register of all hazardous materials on site will be developed and maintained. This will document the hazardous material name, location, approximate volume, storage method and where applicable, disposal method for the substance and containers.
- Fuel storage areas and workshops will be bunded in accordance with the DoIR and DoE requirements.
- Runoff contaminated with hydrocarbons will be treated prior to discharge.
- Absorbents will kept on site for minor spills. Staff will be trained on the use of the absorbents.

- Oil spills in the workshop area will be directed to an oil-water separator.
- Hydrocarbon spills will be cleaned up and contaminated soil will be remediated on-site.
- Hazardous wastes generated by the operation will be transported offsite to licensed waste disposal facilities. This is likely to include waste oil, grease and heavy equipment fuel and oil filters.
- Hazardous materials will be brought to the site in bulk packaging wherever possible. This practice will minimise the number of containers and reduce the risk of spillage.
- All mobile equipment and light vehicle servicing activities including wash down will be conducted on impermeable surfaces.
- The heavy vehicle workshop facility shall contain a purpose built wash down facility incorporating a triple interceptor style sediment and oil/grease removal system.
- An explosives magazine will be constructed and operated in accordance with regulatory requirements.
- Crushing activities will be conducted in areas where surface drainage can be captured to ensure overflows, spillages or leaks can be contained.
- A Licence to Store Dangerous Goods will be obtained for the storage of all hazardous materials on site.
- Spillages of hazardous materials will require incident reporting according to company policy and procedures. The incident investigation will assess the severity of the spillage according to Table 8.7.

Table 8.7: Assessment of Spillage Severity

Consequence	Description	Action
Minor	Small spill (<5 litres). Very localised impact (<2m^2). Not in an environmentally sensitive area.	In situ "natural remediation". No further action. Report in AER.
Low	Spill <20 litres. Localised impact. Not in an environmentally sensitive area.	Remove contaminated soil to the Waste Rock Stockpile or treat in situ with absorbents. Report in AER.
High	Large spill. In environmentally sensitive area.	Contain spill. Remove contaminated soil to the landfill or bioremediation area. Further remedial actions as identified in the incident report. Report immediately to senior management and DoE/DoIR.

- All explosives will be transported by road from Perth or Geraldton and will be transported and stored in accordance with the *Mines Safety and Inspection Act 1994*, *Mines Safety and Inspection Regulations 1995* and *Explosives and Dangerous Goods Act 1961*.

8.14.6 Environmental Outcome

By implementing appropriate storage and handling measures in accordance with industry standards and practices, dangerous goods and hazardous substances used in the Jack Hills mining and crushing operations will not present a hazard or cause environmental harm.

9. SOCIAL ISSUES AND MANAGEMENT

9.1 SURROUNDING LAND USE

9.1.1 Potential Issues

Potential issues arising from the project on pastoral leases may include:

- Disturbance to stock and mustering activities.
- Temporary obstruction of tracks.
- Loss of grazing area.
- Risk of injury to stock posed by excavations and increased traffic.
- Quantity and quality of water for stock.
- Increased noise and dust.
- Damage to fences and gates.
- Radio frequency interference to proposed Radio Astronomy Park (RAP).

9.1.2 Impact Assessment

MML has consulted with all adjacent pastoralists during the planning of the Jack Hills project. This consultation is ongoing to ensure that both mining and pastoral activities can co-exist in the region.

The closest operational pastoral bore is located approximately eight kilometres north-west of the proposed Jack Hills mine. Groundwater monitoring will indicate if groundwater reserves, levels and quality are being adversely impacted by the project.

MML will implement noise and dust management measures to ensure that the operations do not adversely affect pastoral activities.

Australia may be selected as a Square Kilometre Array (SKA) site. If not selected then the RAP operations are likely to be smaller in scale. The proximity of RAP operations to the Jack Hills mining operations and haulage route along Cue-Beringarra Road may be affected by potential sources of radio frequency interferences (RFI) from upgrade works, blasting, mine communications, general RFI from mine camp, crushing operations and fly in fly out traffic movements. The location of the mining operations and haul road north of the Jack Hills range will provide topographic shielding to minimise RFI on the RAP.

9.1.3 Management

Any disturbance to stock and pastoral activities arising from the project's implementation will be minimised **(Management Action 9.1.3)** through the following measures:

- MML will liaise with the pastoralists throughout the life of the project.
- The mining operations will be fenced and unused test pits and drill holes will be backfilled.
- The site induction will instruct all personnel on pastoral lease activities around the project site and compliance with Company Policy requirements.
- Night driving outside the Jack Hills operational area will be minimised.
- The waste landfill site will be fenced and waste will be regularly covered to prevent stock entering and litter escaping.
- Water levels will be measured regularly in regional bores to monitor the impact of water abstraction from the water supply bores and whether pastoral water supplies will be affected.

MML is consulting with the Australian SKA (Square Kilometre Array) Planning Office regarding the management of potential RFI to the proposed RAP. This consultation is continuing (see Appendix 2.1).

Preliminary measures to minimise impacts that have been proposed by SKA include:

- Timing of Cue-Beringarra Road upgrade
- Adequate insulation on electrical connections (to minimise blasting effects)
- Use of low radio frequency for mine communications
- Use of cable instead of radio transmissions for phones, TV and radio
- Modifications to some mining/crushing equipment
- Avoid fly over radio telescopes
- Signage on Cue Beringarra Road
- Radio quietness controls for haulage tracks

9.1.4 Outcome

Consultation with pastoralists has indicated that through implementation of management measures there will be no negative impacts.

Initial consultation with the SKA Planning Office indicates that the potential impact of RFI on the RAP by mining operations can be managed and minimised

9.2 ABORIGINAL HERITAGE

9.2.1 EPA Objectives

To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

9.2.2 Relevant Standards and Legislation

- *National Environment Protection Council (Western Australia) Act 1996*.
- *Aboriginal Heritage Act 1972*.
- *Heritage of Western Australia Act 1990*.
- EPA Guidance Statement No. 41, Assessment of Aboriginal Heritage.

9.2.3 Potential Issues

Development and operation of the Jack Hills project may adversely impact on sites of archaeological or cultural significance to Aboriginal people.

9.2.4 Impact Assessment

Ethnological and Aboriginal heritage surveys of the project area were conducted with the traditional owners during 2004, 2005 and 2006, in which no sites of cultural significance were identified within the project area where ground disturbing activities are proposed. A minor isolated artefact was located within the proposed haul road route and will be avoided. No objections or concerns were raised regarding the project. An archaeological site of low significance recorded within the proposed pit layout will be salvaged and relocated once permission is obtained from the Minister of Indigenous Affairs to disturb the site.

MML has established an Aboriginal Heritage Protocol with the Native Title parties and the Yamatji Land and Sea Council that provides for surveys to be carried out with the appropriate traditional owners selected by the Native Title parties.

9.2.5 Management and Mitigation Measures

MML will avoid any unnecessary disturbance to any identified Aboriginal heritage sites **(Management Action 9.2.5)**. Management and mitigation measures that will be implemented to achieve this will include:

- The general site induction will include information regarding the importance of cultural sensitivity, respect for land and protection of items of heritage significance. All employees and contractors will be required to participate in this induction.
- Raising workforce awareness on Aboriginal heritage issues, including measures for protecting Aboriginal sites identified during Aboriginal surveys or discovered during operations.
- All employees and contractors will be advised of the correct procedure to be followed in the case of any items of potential heritage significance being discovered during mining.
- Comply with the requirements of the *Aboriginal Heritage Act 1972* and will seek advice from the Department of Indigenous Affairs in the event that any Aboriginal heritage sites are identified during the life of the project.

9.2.6 Environmental Outcome

The heritage values of the Jack Hills project area and region have been identified through appropriate survey and consultation that will be ongoing during the project. The proposed Jack Hills project has been designed, and is expected, to have no impact on any Aboriginal cultural or heritage sites of significance.

10. REFERENCES

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11. ABBREVIATIONS

4WD	Four Wheel Drive
AHC	Australian Heritage Council
ANZECC	Australian and New Zealand Environment and Conservation Council
ARD	Acid Rock Drainage
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CALM	Department of Conservation and Land Management
DEH	Department of the Environment and Heritage
DoE	Department of Environment
DoIR	Department of Industry and Resources
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
EPS	Environmental Protection Statement
FIFO	Fly-in, fly-out
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measures
NHMRC	National Health and Medical Research Council
NPI	National Pollutant Inventory
ROM	Run of Mine
WAM	Western Australian Museum

FIGURES

COMPUTER GENERATED VIEWS

APPENDICES

APPENDIX 1.1

Correspondence from Regulatory Authorities

APPENDIX 1.2

MML Licences

APPENDIX 1.3

MML Works Approvals (Geraldton Port)

APPENDIX 1.4

MML Policies

APPENDIX 1.5

Dust Management Plan

APPENDIX 1.6

Vegetation Management Plan

APPENDIX 1.7

Construction Management Plan

APPENDIX 1.8

Decommissioning and Closure Plan

APPENDIX 1.9

Fire Management Plan

APPENDICES

APPENDIX 2.1

Record of Public Consultation

APPENDIX 2.2

Records of Flora and Fauna Searches

APPENDIX 2.3

Fauna Reports (MBS Environmental, August 2005 and November 2005, Western Wildlife, March 2006)

Fauna Report (MBS Environmental, August 2005)

Fauna Report (MBS Environmental, November 2005)

Fauna Report (Western Wildlife, March 2006)

APPENDIX 2.4

Hydrological Report

APPENDIX 2.5

Waste Characterisation Report

APPENDIX 2.6

Heritage and Archaeological Survey Reports

APPENDICES

APPENDIX 3.1

Flora and Vegetation on the Jack Hills Project Area (Mattiske Consulting, December 2005)