HAMERSLEY IRON

A member of the Rio Tinto Group

Brockman Syncline 4 Iron Ore Project

PUBLIC ENVIRONMENTAL REVIEW

August 2005

HAMERSLEY IRON PTY. LIMITED

Brockman Syncline 4 Iron Ore Project

PUBLIC ENVIRONMENTAL REVIEW

- Final
- 5 August 2005

This document was prepared by Hamersley Iron with contribution from Sinclair Knight Merz and Environ.

Front cover shows the Brockman Syncline 4 Project area, looking south to dolerite hills towards Mt Wall.

Invitation to Make a Submission

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

Hamersley Iron Pty Limited proposes to develop an iron ore mine and 35 km rail spur approximately 60 km west-north-west of Tom Price, in the Pilbara Region of Western Australia. In accordance with the Environmental Protection Act 1986, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 4 weeks from Monday **8 August 2005, closing on Monday 5 September 2005**.

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

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

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

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

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

- Clearly state your point of view;
- Indicate the source of your information or argument if this is applicable; and,
- Suggest recommendations, safeguards or alternatives.

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

- Attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- Refer each point to the appropriate section, chapter or recommendation in the PER;

- If you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering; and,
- Attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- Your name;
- Address;
- Date; and,
- Whether and the reason why you want your submission to be confidential.

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

The closing date for submissions is: Monday 5 September 2005

Submissions should ideally be emailed to:

nyomi.bowers@environment.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822
PERTH
WA 6842

OR

Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: **Nyomi Bowers**

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Executive Summary

Introduction

Hamersley Iron Pty Limited (Hamersley Iron) (a Rio Tinto subsidiary) is one of the world's largest exporters of iron ore. The Company operates seven iron ore mine sites in the Pilbara region of Western Australia, together with a dedicated railway and port facility in Dampier. The mine sites include Mt Tom Price, Paraburdoo, Channar, Brockman 2, Marandoo, Yandicoogina and Eastern Range.

Hamersley Iron proposes to increase production in response to increased world demand for iron ore, with part of this increased production proposed to come from the development of a new operation, the Brockman Syncline 4 (BS4) Iron Ore Project.

Location

The BS4 Project is located in the Central Pilbara region of Western Australia, approximately 300 km south-east of Dampier and 60 km north-west of Tom Price. The Project's proposed infrastructure and mine are contained within the Shire of Ashburton. The Project is covered by Mining Leases and other mining tenements, with approximately 80 % of the mining area held under the Iron Ore (Hamersley Range) Agreement Act 1963 area AML 70/4 Sections 123, 124 and 125.

The Proposal

This document is a Public Environmental Review (PER) that has been prepared in accordance with Administrative Procedures prescribed under the Environmental Protection Act 1986. The PER describes the BS4 Project, and provides details of the measures to be implemented to manage the likely environmental impacts.

The BS4 Project will see the mining of a bedded haematite/goethite ore body along a 14 km ridge, marking the southern side of the Brockman Syncline. The Life of Mine is approximately 30 years with the major components comprising:

- Three new mine pits, referred to as the Western, Central and Eastern Lenses ;
- A dry processing plant with a nominal capacity of 20 Mtpa;
- Associated mine infrastructure (e.g. waste dumps, topsoil and low-grade stockpiles haul roads);
- An extension of the existing Brockman 2 rail spur to BS4 (approximately 35 km in length); and,
- Associated infrastructure, including village (operations), contractor's camp (construction), mine access roads, mine offices, airstrip, mine and camp bore fields, power transmission line, warehouse, bulk fuel storage, various workshops and wastewater treatment plant.

Stakeholder Consultation

Hamersley Iron initiated a Stakeholder Consultation Programme for the BS4 Project in mid 2004. Key agencies that have been actively consulted during the preparation of the PER have included the Environmental Protection Authority (EPA) Service Unit, Department of Environment (DoE), Department of Conservation and Land Management (CALM) and Department of Industry and

Resources (DoIR). Non-government organisations consulted have been the Conservation Council of Western Australia, Wildflower Society, the Guruma Aboriginal Corporation, the Puutu Kunti Kurrama and Pinikura people, as well as representatives of pastoral stations who operate in the proposed Project area, namely Rocklea, Hamersley and Wyloo Stations.

The main issues raised by stakeholders related to:

- Water and closure management;
- Vegetation and flora disturbance (particularly Priority flora); and,
- Disturbance of Aboriginal heritage sites.

Existing Environment

Physical Environment

The BS4 Project is located in the central Pilbara area of Western Australia, which experiences an arid tropical climate.

The topography consists of moderate to steep slopes bordering the mine pits on the north side and mild to moderate slopes within the Project area. The Brockman Syncline lies within the Hamersley Province of the Pilbara Craton. The syncline encloses the proposed rail loop and mining area, which would be located on a large floodplain area.

There are no major river systems or permanent water bodies passing through the BS4 mining area. The mining area is located in the Boolgeeda Catchment, which covers an area of approximately 400 km^2. Surface drainage is dominated by a number of small ephemeral drainage lines that flow only for a short period during significant rainfall events.

Aquifers are generally confined, with the water table in the region of the orebody being between 30 m and 100 m below the surface. Water quality is fresh to slightly brackish.

Biological Environment

The vegetation of the BS4 Project area includes hummock grasslands of *Triodia* species (mainly *T. wiseana*) with a variable shrub overstorey on low stony hills; tall shrublands of mixed species, usually with an overstorey of *Eucalyptus* or *Corymbia*, in creeklines; open woodlands of Coolibah *Eucalyptus victrix* over herblands in the gravelly bed of Boolgeeda Creek; and Mulga *Acacia aneura* and Snakewood *A. xiphophylla* tall shrublands over spinifex on plains.

A total of 367 taxa of native vascular flora from 149 genera, belonging to 52 families have been recorded from the BS4 Project area. No Declared Rare Flora and six Priority flora species have been recorded, with the most significant being the Priority 1 species, *Ptilotus* sp Brockman.

Fauna surveys recorded 159 taxa of terrestrial vertebrate fauna belonging to 54 families in the BS4 Project area, comprising two frogs, 54 reptiles, 83 birds, seven bats and 13 non-flying mammals (comprising 8 native and five introduced mammal species). Four Priority 4 listed fauna species were recorded within the BS4 Project area. A further three Scheduled fauna species and four Priority listed fauna species have either been historically recorded from, or have the potential to occur, in the BS4

Project area. One additional fauna species, while not listed as threatened at the State level, is listed as 'Endangered' at the Federal level.

Fauna surveys also documented three key groups of invertebrates potentially supporting narrow range taxa, namely:

- Pulmonata (land snails);
- Diplopoda (millipedes); and,
- Mygalomorphae (trapdoor spiders).

Social Environment

The BS4 Project is located mostly within Rocklea Station, which borders Hamersley Station. Hamersley Station homestead, which is approximately 55 km from the Project area, is the closest residential premise.

The Project area lies within two native title claims, with the western area claimed by the Puutu Kunti Kurrama and Pinikura people, and the eastern half by the Eastern Guruma group. A number of Aboriginal heritage archaeological sites have been identified within the BS4 Project area.

Environmental Impact Assessment and Management

The potential impacts of the BS4 Project have been assessed in the PER, and the proposed management measures to be instigated by Hamersley Iron are described. **Table ES-1** summarises the Project's potential environmental impacts, Hamersley Iron's proposed management of these potential impacts and the predicted outcome.

Hamersley Iron operates under an ISO14001 accredited Environmental Management System (EMS). The key elements of ISO14001 include: assessing environmental risk and legal requirements, developing objectives and targets for improvement, training, operational control, communication, emergency response, corrective actions, audits and review. Hamersley Iron sites gained certification to ISO14001 in 2003. The BS4 Project would also operate under the Hamersley Iron EMS.

To ensure that environmental impacts are addressed, and that the activities associated with Project construction are managed to minimise these impacts, a Construction Environmental Management Plan (CEMP) will be developed prior to the Project commencing. This will then be replaced by an Operational Environmental Management Plan (OEMP).

Hamersley Iron has extensive experience in managing the development and operation of projects similar to the BS4 Project. This experience will greatly assist Hamersley Iron to ensure that the BS4 Project is managed in an environmentally sound manner.

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- **Table ES-10-1 Environmental factors, potential impacts and proposed management for the BS4 Project**

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Biophysical					
Flora - Vegetation Communities	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 by improvement in knowledge.	Typical central Pilbara vegetation. The vegetation includes hummock grasslands with a variable shrub overstorey on low stony hills; tall shrublands of mixed species, usually with an overstorey of Eucalyptus or Corymbia, in creeklines; open woodlands over herblands in the gravelly bed of Boolgeeda Creek; and Mulga tall shrublands over spinifex on plains. A total of 367 taxa of native vascular flora from 149 genera belonging to 52 families have been recorded in the Project area, as well as six species of introduced flora.	Approximately 2,470 ha of vegetation is required to be cleared for the construction/operation of the following components of the BS4 Project: mine pits, haul roads, waste dumps, stockpiles, processing plant, rail spur, camp, access roads and supporting infrastructure. Other impacts may include off-road vehicle impacts, erosion, impact on vegetation from dust, disruption to surface hydrology, groundwater drawdown, increased risk of fire and introduction of weeds.	Clearing of vegetation will be minimised where practicable, particularly in areas of high conservation significance. Prepare a CEMP and OEMP that includes: • Weed Management in consultation with CALM. • Topsoil Management and Rehabilitation in liaison with CALM, DoE and DoIR, • Fire Management to minimise the risk of unplanned fires. • Dust Management. Avoid disturbance to surface drainage features wherever practicable, and, where not practicable, include culverts to maintain surface water flow. Monitor phreatic vegetation in areas where groundwater level has declined. Monitor vegetation health in dusty areas. Rehabilitate areas not required for operations on completion of construction, and conduct progressive rehabilitation where possible.	Minimal clearing within the constraints of the Project. No significant increase of weeds in the Project area as a consequence of the BS4 Project. Rehabilitation progressive and sustainable.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Flora – Declared Rare and Priority flora; flora of conservation significance.	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.	No Declared Rare Flora (DRF) encountered in surveys. Six Priority species were located: Priority 1 • *Ptilotus* sp Brockman. Priority 3 • *Abutilon trudgenii* ms. • *Phyllanthus aridus* • *Sida* sp Wittenoom (W.R. Barker 1962) Priority 4 • *Eremophila magnifica* subsp *magnifica* • *Goodenia stellata*	A population of the *Ptilotus* sp Brockman is located in close proximity to the mining area. *Eremophila magnifica* subsp *magnifica* is located within the proposed pit area and will be impacted.	Relocate facilities where practicable to avoid disturbance of Priority flora, and other flora species of conservation significance. Fencing off of individuals/populations of *Ptilotus* sp Brockman adjacent to the mining area to avoid disturbance during Project construction and operation. Ongoing flora surveys will be carried out to identify any additional significant species in the vicinity of the Project area. Conduct research into the reestablishment of Priority species in rehabilitated areas. Harvesting of seed from Priority species where practicable to use in the rehabilitation seed mix Implement an environmental awareness training programme.	The conservation status of Priority flora and other flora of conservation significance will not be adversely impacted upon by the BS4 Project.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	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.	Typical central Pilbara vertebrate fauna. Two species of frogs, 54 reptiles, eight terrestrial native mammals and five introduced mammals, seven species of bats and 83 species of birds. In addition, greater than 100 invertebrate taxa have been located in the BS4 Project area, including land snails (e.g. *Rhagada* sp "Mt Brockman"). Key fauna habitats in the BS4 Project area comprise habitats that support taxa with potentially narrow distributions e.g. mulga woodland and calcareous outcrops and soils.	Loss or modification of fauna habitat, loss of fauna as a result of activities, isolation or fragmentation of populations as a result of physical barriers or changes to surface water availability, noise and blasting impacts, altered fire regimes, spread of weeds, groundwater drawdown and dust. The primary fauna habitat that would be impacted is the *Triodia* hilltop habitat, which is widespread in the Project area.	Minimise disturbance to fauna habitats where practicable. Avoid disturbance to surface drainage features where possible and install culverts where practicable when disturbance unavoidable. Implement an Environmental Awareness training programme. Record fauna sightings and fauna deaths or injury during Project operations. Prepare a CEMP and OEMP that includes: • Weed Management in consultation with CALM. • Topsoil Management and Rehabilitation in liaison with CALM, DoE and DoIR. • Fire Management to minimise the risk of unplanned fires. • Dust Management.	Fauna populations and fauna habitats will not be adversely impacted upon by the BS4 Project.
Fauna - Specially Protected (Threatened) and Priority 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.	There are four Priority 4 listed fauna species within the BS4 Project area. A further three Scheduled species and four Priority listed species have either been historically recorded from, or have the potential to occur, in the BS4 Project area. One additional fauna species, while not listed as threatened at the State level, is listed as 'Endangered' at the Federal level.	Specially Protected and Priority fauna species may be impacted upon through habitat loss, individual animal deaths and isolation/fragmentation of populations.	Minimise disturbance to vegetation within the BS4 Project area. Feral animal control. Report death or injury of significant fauna to CALM.	The conservation status of Specially Protected and Priority fauna will not be adversely impacted upon by the BS4 Project.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Fauna - Stygofauna	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.	Two phases of sampling for stygofauna in the BS4 Project area recorded a single bathynellid specimen. This animal was collected from a bore that is outside the predicted dewatering impact area for the Project.	Changes to habitat as a result of changes to groundwater levels, death of individuals during groundwater extraction/sampling and pollution of groundwater.	Maintain stygofauna monitoring and reporting as appropriate. Monitor groundwater production, depth to water table and aquifer recharge. Prevent groundwater pollution.	The conservation status of any stygofauna that may be present in the Project area is unlikely to be changed as a result of the BS4 Project.
Groundwater Quantity	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance are protected.	There are no existing groundwater users in the Project area, with the exception of water extraction on Rocklea Station for stock watering. Nearest bore is approximately 15 km from the proposed mining area. Aquifers are generally confined, with the water table being between 30 m and 100 m below the surface near the orebody.	Decline in groundwater levels around the mine and water supply borefields, and a reduction in groundwater outflow to adjacent areas.	Monitor groundwater drawdown and recharge in the groundwater supply areas. Implement water conservation measures to minimise groundwater abstraction. Strategies for sustainable management of the borefields will be included in a Borefield Management Plan. Backfill mine pits to above water table to minimise evaporation.	Groundwater reserves will not be adversely impacted upon by the Project.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water Quality - Groundwater	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.	Aquifers are generally confined, with the water table being between 30 m and 100 m below the surface near the orebody. Groundwater in the BS4 area is of an intermediate chemical type with no dominant cations or anions, with pH between 7.6 – 8.5 and Total Dissolved Solids 400 – 2,400 mg/L.	Pollution of groundwater from chemicals, hydrocarbon materials and wastewater streams. Increases in salinity caused by the concentration of salts, by evaporation, of water in mined-out pit voids.	Monitor groundwater quality. Backfilling mined out pits to above pre-mine water table levels to prevent long-term salination of groundwater. Hazardous materials to be stored in accordance with Australian Standards and Licence conditions. Storage of hazardous substances incorporated into the CEMP and OEMP. Prevention of groundwater pollution and contamination through appropriate waste management practices. A spill management plan will be developed for the BS4 Project and incorporated into the BS4 CEMP and OEMP. Environmental awareness training and spill response training will be provided. Treatment of contaminated wastewater prior to discharge to the surrounding environment.	No unacceptable adverse impacts to groundwater quality.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Pollution Management					
Watercourses and Surface Water Quality	To maintain the integrity, ecological functions and environmental values of watercourses and sheet flow. 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.	There are no major river systems or creeklines passing through the BS4 Project area. The closest major creekline is Boolgeeda Creek. Surface drainage from the mining area is to the west-south-west, and is dominated by a number of small ephemeral drainage lines.	The haul roads and rail spur will cross ephemeral drainage lines. The pits waste dumps and stockpiles have the potential to intercept natural drainage. Impacts to watercourses may include alteration of natural sheet flow, increased erosion and sediment deposition. Contamination of surface water from any accidental wastewater and/or hydrocarbons spills.	Culverts will be installed where practical to minimise diversion/obstruction of watercourses and sediment deposition on downstream vegetation. Sumps will be constructed immediately around ore processing and product stockpiling areas. All sumps will be constructed to fully contain a 1 in 5 year rainfall event. Treatment of any contaminated storm water runoff prior to discharge to the surrounding environment. Hazardous substances to be stored appropriately to minimise potential for surface water contamination. Spill management procedures will be developed, and environmental awareness training in spill management provided to personnel.	The natural functions and environmental value of watercourses and sheet flow within the Project area and further downstream will not be adversely affected by the BS4 Project. No significant impact to surface water quality.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Air Quality – Particulate dust emissions during construction and operations	To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of peoples and land uses by meeting statutory requirements and acceptable standards.	The Project area is an arid environment, which is subject to naturally high background dust levels.	Brockman ore is expected to be particularly dusty due to it having a low moisture content. Dust may be generated during construction, mining (drilling, blasting), ore handling (loading, unloading, transferring) ore processing and ore transport activities. Occupational Health and Safety impacts.	Implementation of dust suppression techniques, haul road watering and enclosed processing areas where dust emissions are significant. Primary, secondary and tertiary crushing plants will be fitted with a dry bag house type dust collection system. Maintaining appropriate moisture content of the ore where possible to minimise dust generation. Real time and high volume dust monitoring and sampling of TSP, PM_{10} and $PM_{2.5}$ particulate size fractions and review of data to assess compliance with allowable limits. Regular inspections to visually assess dust generation and to ensure correct functioning of dust suppression equipment. Minimising vegetation clearing. Conduct progressive rehabilitation where possible to minimise the total open area.	No unacceptable impacts to the environment or human health as a result of dust generation from the BS4 Project.
Greenhouse Gases	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	The Project area is currently used for pastoral grazing and is vegetated with spinifex, wattles and eucalypts.	The predicted level of CO_{2e} from the BS4 Project, assuming uniform CO_2 emissions over 30 years, is 5.59 kg CO_2 per tonne of ore per annum.	Greenhouse gas emissions will be estimated annually and reported to the Australian Greenhouse Office (AGO) through the Greenhouse Challenge Program. The BS4 Project will incorporate appropriate technology for minimising greenhouse gas emissions, particularly with heavy earthmoving equipment, light vehicles and ore processing equipment. Land clearing will be minimised and progressive rehabilitation will be conducted where possible. Abatement projects will be reported to the AGO.	Emissions of greenhouse gases from the BS4 Project will be kept as low as practicable.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Noise and Vibration	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.	There are no residences located in close proximity to the Project area. The closest noise sensitive premises are Hamersley Station (~55 km) and the Brockman 2 accommodation camp (~25 km). The BS4 camp will be approximately 10 km from the plant.	Noise and vibration impacts are expected to be negligible due to the remote location of the BS4 Project.	Noise Management included in the CEMP and OEMP. Noise management measures that may be considered include: • Purchase of heavy equipment with reduced Sound Pressure Levels; • Modification of blasting practices to reduce noise emissions; • Consideration of meteorological data during general operations and blasting; and, • Design and layout of the mine site (e.g. stockpile locations) to minimise/mitigate noise emissions.	No unacceptable impacts from noise generated during construction and operation of the BS4 Project.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Waste (general and hazardous waste)	Ensure that waste is contained and isolated from ground and surface water surrounds and treatment or collection does not result in long-term impacts on the surrounding environment.	The Project area is currently used for pastoral grazing.	Inappropriate waste management may lead to spills and contamination of soils, ground or surface water bodies, as well as increased risks to human health.	Application of the Hamersley Iron Company wide Waste Management Plan to the BS4 Project. Waste management based on 'Reduce, Reuse, Recycle' principle. Hydrocarbons and chemicals will be stored according to Australian Standards within impermeable, bunded enclosures, or in double-skinned tanks that do not require bunding. Hazardous waste removed from site. The vehicle washdown facility will incorporate a sediment trap and oily water treatment plant. Explosives will be stored in remote magazines in accordance with the Explosives and Dangerous Goods Act 1961. Non-hazardous and non-recyclable waste will be disposed of at an on-site landfill facility approved by the DoE. Sewage and grey water will be treated on-site using package sewage treatment plants.	Appropriate management of waste resulting in no long-term impacts on the surrounding environment.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Waste (overburden, waste rock) and Acid Rock Drainage	Ensure that waste is contained and isolated from ground and surface water surrounds and treatment or collection does not result in long-term impacts on the surrounding environment. To clearly identify potentially acid forming material, selectively handle this material, and store the material so that leachate is not generated.	BS4 is a typical high phosphorus Brockman martite-goethite type deposit.	Overburden and waste rock, if not appropriately managed, could result in unstable landforms and erosion. The orebody contains a section of pyritic black shale on the southern boundary. This material extends the length of the proposed pits, and is approximately 14 m thick and has potential to generate acid rock drainage.	Waste rock and overburden contained in a purpose built waste dump and backfilled (to above water table levels) as space becomes available in pits. Waste dumps will be constructed to industry standards, and will be stable and non-eroding, contoured to blend in with the surrounding topography and rehabilitated. If encountered, acid-generating waste rock will be encapsulated in segregated dumps.	Overburden and waste dumps will be safe, stable and non-polluting. No adverse impacts to soil, surface water or groundwater quality as a result of acid rock drainage.
Social Surrounds					
Aboriginal and European Heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	A total of 27 archaeological sites have been located to date within the BS4 Project area. The majority of these sites are rock shelters, but there are also artefact scatters, water sources and scarred trees. There are no sites of European heritage significance located within the BS4 Project area.	Identified Aboriginal heritage sites may need to be either disturbed or actively managed in order for the BS4 Project to proceed. It is not anticipated that the Project will adversely impact on any areas of ethnographic significance. It is not expected that BS4 Project will affect any sites of European heritage significance.	Conduct further Aboriginal heritage surveys in the rail spur corridor, power/water corridor, transport corridor, and airstrip, camp, water bore and plant areas during 2005. The alignment of the rail spur and location of mining infrastructure will take into consideration Aboriginal heritage sites. Consultation with Native Title claimant groups on the management of Aboriginal heritage sites within the BS4 Project area. Obtaining of approval from the Minister of Indigenous Affairs prior to disturbing any Aboriginal heritage sites. Aboriginal heritage and cultural sensitivity issues will be addressed in all site Inductions, and will be addressed in the CEMP and OEMP.	Subject to receiving the necessary approvals, some Aboriginal heritage sites will be disturbed following appropriate consultation. No impact to European heritage.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Economic and Social Impacts	Ensure that there is a net social and economic benefit from the BS4 Project.	The Project is relatively isolated. The nearest homestead (Hamersley Station) and the nearest town (Tom Price) are located 55 and 65 km from the Project area respectively.	There is unlikely to be any significant adverse social or economic impacts due to the isolated location of the BS4 Project. Local services/businesses may be strained as a result of increased mining development in the Pilbara region over the next few years.	Continuation of the community consultation program to ensure a communicative relationship is maintained between Hamersley Iron and local communities. Hamersley Iron will work with local communities to identify opportunities for participatory support for regional development within the Shire of Ashburton.	Positive contribution to the social and economic status of the region.
Visual Amenity, Landscape and Geoheritage	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape to as low as reasonably practicable. To maintain and protect any significant landscape and geoheritage values and maintain the integrity, ecological functions and environmental values of the soil and landform	The topography consists of moderate to steep slopes bordering the proposed mine pits (located on 14 km of ridgeline) on the north side and mild to moderate slopes within the Project area. The area to the north consists of a large floodplain area. The Project area has been disturbed as a result of pastoral grazing over the last 100 years. There are no sites of landscape or geoheritage significance located within the BS4 Project area.	Earthworks, including removing topsoil, overburden and ore during mining, will create voids in the landscape and waste dumps, the latter of which will form new raised landforms. Adverse impacts to visual amenity may impact on tourism in the long-term. However, the BS4 mine site is not overlooked by or adjacent to populated or sensitive areas such as scenic outlooks, settlements or National Parks, and access to the area is limited. Unlikely to be any significant impacts to landscape or geoheritage as there are no areas of significance in the Project area.	Minimise any adverse impacts to visual amenity through relocation of facilities where practicable, minimising vegetation clearing and conducting progressive rehabilitation. Rehabilitated structures will be stable, re-contoured to blend with surrounding topography and sympathetic to surrounding landforms.	No significant impact on visual amenity, landscape or geoheritage as a result of the BS4 Project.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Rehabilitation and Decommissioning	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.	BS4 Project area generally undisturbed except for areas affected by grazing, weed invasion, large fires and exploration activity.	Poor rehabilitation and decommissioning may result in long-term adverse impacts on flora, fauna, soil and water quality, visual amenity and economic and social impacts. Poor closure planning may result in insufficient allocation of funds/resources for closure, particularly in the event of unforeseen closure.	Review and update the Closure and Rehabilitation Plan on a regular basis. Accounting methods to be used for managing financial closure provisions. Carry out progressive rehabilitation where possible. Conduct research and develop rehabilitation techniques to improve the quality of rehabilitation. Rehabilitation to achieve a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.	Sound rehabilitation and decommissioning will minimise the impact of the BS4 Project, and result in safe, stable and functioning landforms consistent with the surrounding landscape.

1. Introduction

1.1 Background

Global steel production is undergoing a significant expansion that has resulted in iron ore demand exceeding supply. This has predominantly been a result of recent production growth in China. Australian iron ore operations, particularly in the Pilbara region of Western Australia, are well positioned to supply significant quantities of the global iron ore required.

During 2004, Hamersley Iron Pty Limited (Hamersley Iron) conducted a review of available iron ore deposits, and identified the Brockman Syncline 4 (BS4) deposit has having the best potential to be developed to meet this increase in iron ore demand. Based on exploration drilling completed to date, the BS4 deposit has a reserve of approximately 600 Mt of high-grade iron ore.

1.2 Location

The BS4 Project is located approximately 25 km south-west of the existing Brockman 2 mine, and approximately 60 km west-north-west of Tom Price in the Pilbara region of Western Australia (**Figure 1**).

1.3 The Proposal

Hamersley Iron is proposing to develop the BS4 Project. The Project would involve conventional open pit mining of iron ore, dry processing and transfer of the ore by rail to the coast for loading onto ships.

The major components of the BS4 Project are:

- Three new mine pits, referred to as the Western, Central and Eastern Lenses (**Figures 2** and **3b**);
- A dry processing plant[1] with a nominal capacity of 20 Mtpa;
- Associated mine infrastructure (e.g. waste dumps, topsoil and low-grade stockpiles haul roads);
- An extension of the existing Brockman 2 rail spur to BS4 (approximately 35 km in length); and,
- Associated infrastructure, including village (operations), contractor's camp (construction), mine access roads, mine offices, airstrip, mine and camp bore fields, power transmission line, warehouse, bulk fuel storage, various workshops and wastewater treatment plant.

[1] Construction of a wet processing plant and residue storage facility may occur some time after Project start-up, but this is outside the scope of this current proposal.

The land proposed for mining is held under the Iron Ore (Hamersley Range) State Agreement Act 1963 area AML 70/4 Sections 123, 124 and 125 (granted 1965), in addition to various mining tenements under application. Part of the proposed rail spur route, the camp location, the airstrip, and the water supply bore locations are to be covered by Miscellaneous Licences and General Purpose Lease applications (refer to **Section 1.7** for more details).

1.4 Purpose of this Document

An Environmental Referral for the BS4 Project was submitted to the Environmental Protection Authority (EPA) on 22 October 2004. On 8 November 2004 the EPA advertised the level of assessment for the Project as a Public Environmental Review (PER) with a four-week public review period. The EPA subsequently approved an Environmental Scoping Document (see **Appendix A**) outlining the proposed scope of works for the environmental impact assessment studies on 9 March 2005[2].

This PER document has been prepared in accordance with Part IV Division 1 of the WA Environmental Protection Act 1986 (EP Act) for proposals of "local or regional significance that raise a number of significant environmental factors, some of which are considered complex and require detailed assessment". The EPA considers that such proposals should be subject to a formal public review period and the setting of environmental conditions under Part IV of the EP Act to ensure they are implemented and managed in an environmentally acceptable manner.

The purpose of this PER document is to:

- Place the proposal in the context of the local and regional environment;
- Adequately describe all components of the proposal to allow the Minister for the Environment to review and consider a well-defined project;
- Provide the basis of the proponent's environmental management program, outlining how environmental impacts of the proposal are minimised and acceptably managed;
- Communicate clearly with stakeholders so that the EPA can obtain informed comment to assist in providing advice to government; and,
- Outline the reasons why the proposal should be judged by the Minister and the EPA to be environmentally acceptable (EPA, 2004a).

This document is structured as follows:

Section 1 Introduction.

Section 2 Project Justification and Alternatives.

Section 3 The Project.

Section 4 Existing Environment.

[2] Note: Some aspects of the Project have since changed from that described in the Scoping Document, namely, three mine pits are now proposed as opposed to four, approximately 20 % of the orebody is below the water table as opposed to 10 % and no wet plant or residual storage dam is currently proposed.

Section 5 Stakeholder Consultation.

Section 6 Environmental Principles, Sustainability and Management.

Section 7 Potential Impacts and Management.

Section 8 Environmental Management Commitments.

1.5 The Proponent

The Proponent and owner of the proposed BS4 Project is Hamersley Iron Pty Limited, a wholly owned subsidiary of Rio Tinto Limited. The Proponent contact details are as follows:

Mr Peter Royce

Senior Advisor - Environmental Approvals

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The BS4 Project will be wholly owned by Hamersley Iron (no joint venture partners exist). All tenements held or applied for over the land that is the subject of the Project are in the name of Hamersley Iron. Hamersley Iron will be responsible for the Project development (including financing) and day-to-day management of the operation.

The Project will be managed by Pilbara Iron (a member of the Rio Tinto Group) on behalf of Hamersley Iron. Pilbara Iron, which was established in 2004, operates and maintains mining, rail and export facilities on behalf of asset owners, including Hamersley Iron and Robe River Iron Associates. This arrangement facilitates closer cooperation between Hamersley Iron and Robe, whilst ensuring they remain independent, with each Company separately marketing its products and retaining accountability for strategic development of its mineral resources.

1.6 Environmental Approvals Process

1.6.1 Relevant Legislation

State

The EP Act is the primary legislation on environmental impact assessment and protection in Western Australia. The EP Act makes provision for the establishment of the EPA for the prevention, control and abatement of pollution and for the conservation, preservation, protection, enhancement and management of the environment.

Other State government legislation relevant to the BS4 Project include the following:

- Aboriginal Heritage Act 1972;
- Agriculture and Related Resources Protection Act 1976;
- Building Regulations 1989;
- Bush Fires Act 1954;
- Conservation and Land Management Act 1984;
- Contaminated Sites Act 2003;
- Electricity Act 1945;
- Environmental Protection Regulations 1987;
- Environmental Protection (Noise) Regulations 1997;
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004;
- Explosives and Dangerous Goods Act 1961;
- Dangerous Goods (Transport) Act 1998;
- Dangerous Goods Regulations 1992;
- Dangerous Goods Safety Act 2002;
- Health Act and Regulations 1911;
- Iron Ore (Hamersley Range) Agreement Act 1963;
- Land Administration Act 1997;
- Local Government Act 1995;
- Mining Act 1978;
- Mine Safety and Inspection Act 1995;
- Occupational Safety and Health Act 1984;
- Private Railways (Level Crossings) Act 1966;
- Rail Safety Act 1998;
- Rail Freight System Act 2000;
- Rights in Water and Irrigation Act 1914;
- Waterways Conservation Act 1976;
- Water Supply Sewage and Drainage Act 1912; and,
- Wildlife Conservation Act 1950.

Commonwealth

The primary Commonwealth environmental legislation is the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Under the EPBC Act, an action requires approval from the Federal Environment Minister if the action has, will have, or is likely to have, a significant impact on one or more of the following 'matters of national environmental significance':

- World Heritage properties;
- National Heritage places;

- Ramsar wetlands of international significance;
- Nationally listed threatened species and ecological communities;
- Listed migratory species;
- Commonwealth marine areas; and,
- Nuclear actions (including uranium mining).

Hamersley Iron considers that the BS4 Project will not have a significant impact on any of these matters of national environmental significance.

Hamersley Iron has, and will continue to, adopt and comply with the above listed legislation as required during the design, construction and operation of the BS4 Project.

1.6.2 Decision-Making Authorities

The two main Decision-Making Authorities (DMAs) involved in the environmental assessment of the BS4 Project are the EPA and the Department of Environment (DoE).

Other DMAs relevant to the BS4 Project approvals include:

- Department of Land Information;
- Department for Planning and Infrastructure;
- Department of Conservation and Land Management (CALM); and
- Department of Indigenous Affairs (DIA).

The BS4 Project is located within the geographical jurisdiction of the Shire of Ashburton.

1.6.3 Approvals Process

As stated in **Section 1.4**, the EPA set a PER level of assessment for the BS4 Project in November 2004. Once the level of assessment has been set, the process for preparation, submission and assessment of a PER is outlined below (also refer to **Figure 4**).

1) The Proponent prepares an Environmental Scoping Document outlining the scope of works for the PER assessment.
2) The EPA agrees to the Environmental Scoping Document as the basis for the PER.
3) The Proponent prepares the PER.
4) The PER is submitted as a draft to the EPA for review and authorisation to release as a public document.
5) The PER is finalised based on the EPA's comments and then released for public review for the period determined by the EPA when setting the level of assessment.
6) The EPA receive and collate all submissions made on the PER during the review period and provide the Proponent a copy of the submissions or a summary of the issues raised.
7) The Proponent responds to any submissions made on the BS4 Project.

8) The EPA undertakes an assessment of the PER, the submissions received and the Proponent's response to issues raised in submissions and makes recommendations on the Project to the Minister for the Environment.
9) The Minister publishes the EPA's Report and Recommendations for a two-week period during which appeals can be lodged.
10) The Minister determines any appeals, and consults with relevant DMAs to seek agreement on whether or not, and in what manner, the proposal may be implemented.
11) The Minister issues a Statement on the Project.

This PER gives the public and regulators an opportunity to review the potential environmental impacts of the BS4 Project. It also provides opportunity to examine the proposed management measures that will be put in place by Hamersley Iron. Information on making a submission is provided at the front of this document.

Should approval for the BS4 Project be obtained from the Minister for the Environment under Part IV of the EP Act, licensing of construction and operations is required under Part V of the EP Act. This requires applications for a 'Works Approval' and 'Licence to Operate' to be submitted to the DoE.

The DoIR administers the Mining Act 1978. Under the Mining Act 1978, 'No developmental or productive mining or construction activity may be commenced until the tenement holder has submitted a plan of the proposed operations and measures to safeguard the environment to the State Mining Engineer for assessment and until his written approval has been obtained'. The 'plan' of the proposed operations and measures to safeguard the environment' is referred to as a Notice of Intent (NOI). This PER document will serve as the NOI document required by the DoIR for approval.

1.7 Land Tenure

1.7.1 State Agreement

Mining Leases covered under the State Agreement (Iron Ore (Hamersley Range) Agreement Act 1963) and other mining tenements occur within the BS4 Project area (see **Figure 2**). Approximately 80 % of the BS4 Project mining area is held under the Iron Ore (Hamersley Range) Agreement Act 1963 area AML 70/4 Sections 123, 124 and 125. Exploration Licences E47/53 and 48 cover the remainder of the deposit. Hamersley Iron is currently proceeding with the conversion of parts of these EL's to new AML 70/4 sections.

State Agreements are contracts between the State and major project developers that establish a framework of rights and obligations to facilitate the development of resources and/or downstream processing projects in Western Australia.

Exploration and mining titles are approved in accordance with the Mining Act 1978. The Mining Act makes provision for a number of different tenements, including prospecting and special gold

prospecting licences, exploration, retention and miscellaneous licences, and mining and general purpose leases.

1.7.2 Native Title

The BS4 Project area lies within two native title claims (**Figure 2**).

The native title claim over the western area was lodged in 2001 by the Puutu Kunti Kurrama and Pinikura (PKKP) people and is not yet the subject of any agreements with Hamersley Iron. Currently all tenure within the PKKP native title claim area has been objected to pursuant to the provisions of the Mining Act 1978. A native title agreement with the PKKP would need to be reached and objections withdrawn, or the tenure secured via a procedural rights process, prior to the BS4 Project commencing.

The Eastern Guruma group lodged a native title claim over the eastern part of the BS4 Project area in 1997. This part of the Project area is subject to an Indigenous Land Use Agreement between the Eastern Guruma group and Hamersley Iron that was executed in 2001.

1.7.3 Pastoral Leases

The majority of the BS4 Project is situated on Rocklea Station (owned by Hamersley Iron), which borders Hamersley Station (also owned by Hamersley Iron). Rocklea Station is 390,079 ha in area. A small portion of the western BS4 mining area also occurs within the boundary of Wyloo Station land (refer **Figure 2**).

All pastoral leases in Western Australia issued under the now repealed Land Act 1933 expire on 30 June 2015. CALM has nominated portions of numerous pastoral leases in the Pilbara to be released to the conservation estate, or to be set aside for conservation management within the pastoral leases under conservation agreements, when the pastoral leases are renewed. At the time this PER document was prepared, CALM had not identified any significant areas around the BS4 Project area for possible exclusion for conservation purposes from the land covered by the three pastoral leases.

1.8 Community Consultation

Hamersley Iron conducted a consultation programme during the planning/design phase of the BS4 Project and during the preparation of this PER. The programme aimed both to inform the key stakeholders of the proposal, and to identify those environmental issues that the stakeholders considered most significant. A summary of this consultation programme and its outcomes is given in **Section 5**.

Hamersley Iron will continue to meet with stakeholders as required to keep them informed of current developments, and to seek information on potential concerns they may have as the Project progresses.

1.9 Timing and Staging of Project

Subject to gaining all necessary approvals, Hamersley Iron will develop the BS4 Project as soon as feasibly practicable.

The BS4 Project will continue for approximately 30 years, though this is dependent on future demand requirements and any possible future increase in production capacity.

2. Project Justification and Alternatives

2.1 Justification

Hamersley Iron is currently experiencing an unprecedented growth in the demand for iron ore due principally to high rates of growth in Asia, especially China. In order for Hamersley Iron to continue to maintain its market share within Asia and China, further mine developments are required within the next 2-4 years.

Recent growth in world sea-borne trade in iron ore has been driven by China, whose imports have risen from 70 million tonnes in 2000 to 208 million tonnes in 2004. This rapid growth in Chinese iron ore imports has been driven by the compound effect of an acceleration in finished steel consumption - which grew at an average rate of 20 % Year-on-Year between 2000-2003. Domestic steel production has moved in step with this growth in demand. As domestic ore production is constrained by resource and cost issues, and scrap availability is low, most of the consequential increase in demand for iron units was realised by imports of iron ore. Rio Tinto has recently updated its outlook for future Chinese steel demand and considers that continued additional demand for iron ore will continue.

An important aspect is that several mines that have been in operation for the past 10-30 yrs are approaching the end of their mining life within the next 5-10 yrs. As these high-grade sources of iron ore are depleted, there is a requirement to bring on large long life mines to secure future supplies. After detailed internal review of available options, the BS4 deposit was selected to meet this requirement. Factors that have influenced this decision include:

- Proximity to existing operations (to minimise distances for connecting infrastructure);
- Large size (to enable a long term operation);
- Suitable grade (>60 % Fe) and ore type; and,
- The potential for further future developments.

The design work that is currently being carried out for the BS4 Project takes into consideration the potential for further expansions in capacity, the possible addition of a low-grade processing plant and the introduction of pisolite material from the adjacent Beasley River Pisolite deposits to the south that may be mined sometime in the next 10-15 yrs as Robe River replacement ore. These possible future options are outside the current scope of the BS4 Project or this PER.

2.2 Project Benefits

The BS4 Project will result in a number of State and National Benefits. These include:

- Employment opportunities that will arise as a result of the construction and operation of the Project. Approximately 300 new positions will be created for the general operation of the Project. During periodic maintenance shutdown periods, this will increase by a further 40 positions. During construction, the workforce will peak at 700;

- A number of indirect employment opportunities will also arise through the use of local businesses and services, mostly located in the nearby towns of Tom Price and Paraburdoo;
- The Project will require capital expenditure in the order of $1,000 million, which represents a significant contribution to the regional, Western Australian and Australian economy;
- Increased opportunities for local indigenous communities, including employment and vocational training opportunities as part of existing Hamersley Iron programmes;
- An increased contribution towards the Nation's annual income through export sale of iron ore; and,
- Increased revenue to the State and Federal Government from taxes, levies and royalties from the production of iron ore and taxation income.

2.3 Project Alternatives Considered

2.3.1 Project

The BS4 Project mining area was chosen because mineralisation in this area has been identified as being suitable for the development of an economically viable and environmentally sound mining and primary processing operation. The location of the orebody and therefore pit development cannot be varied, but other options have been considered for the Project infrastructure, and are described below.

2.3.2 Rail Spur

The BS4 mine will be serviced by a 35 km rail spur that will link BS4 to the existing Brockman 2 mine (**Figure 1**). Several options for the rail spur alignment and rail loop location were investigated. The western end through to the eastern end of the deposit was examined to determine the most suitable location for the rail loop.

The location of the rail loop at the western end of the deposit would require a large amount of earthworks and consequential environmental impact in order to achieve manageable gradients for the rail route, or would require the use of banker locomotives in order to move ore from the plant. Hence, the two options considered for the rail loop location were the loop centrally located to the mining area and the loop located at the eastern end of the mining area. Due to the steep gradient of the central location, it was decided the eastern location was the most suitable.

2.3.3 Plant

The preferred processing option was assessed using the Pilbara Iron Sustainability Development Decision Making Methodology (Ernst and Young, 2004a). The assessment considered:

- The preferred processing option; and,
- The preferred plant layout with respect to the orebody and required infrastructure.

In carrying out the assessment, key stakeholders and key economic, environmental and social factors were identified. Each option was scored for economic, environmental and social factors linked to the sustainability principles adopted by Hamersley Iron.

The process allowed the Project team to identify a preferred option and put in place actions and mitigations throughout the Project development process to ensure the Project maintained its performance against the selected factors and their limits. The dry processing option was selected.

Haulage and crushing studies were also carried out comparing trucking and conveying options in order to determine the most suitable location for the plant. Two variants on plant location were considered, i.e. one centralised plant with all ore being hauled into this location, or a main plant and a satellite crushing facility feeding into the main plant via an overland conveyor. The latter option was selected.

The choice of site for the processing plant considered the potential environmental impacts on the area chosen, minimising cut and fill on the site, maximising the use of natural contours and the protection of natural drainage features wherever possible.

The application of the sustainability development methodology for selected aspects of the Project will be ongoing as the Project progresses.

2.3.4 Workforce Access to Site

The sustainability development methodology, as described above, was applied to the preferred workforce delivery option (Ernst and Young, 2004b). Three options were considered for the BS4 workforce, namely:

- Live in the Pilbara and drive-in drive-out;
- Fly-in fly-out from Perth and reside at the mine site; and,
- A portion of the workforce fly-in fly-out to the mine site with the remainder drive-in drive-out from Tom Price.

Each option was scored for economic, environmental and social factors linked to the sustainability principles adopted by Hamersley Iron and the preferred option selected was fly-in fly-out (refer to **Section 7.15**).

2.3.5 No Development

If Hamersley Iron is unable to maintain and expand the capacity of its mining operations, a significant opportunity to increase its export earnings will be lost. Potentially, the increased market demand would be met by increased production elsewhere in Australia or overseas. If the shortfall in production was taken up by overseas operations, the economic benefits would be lost to the local area, Western Australia and Australia.

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3. The Project

3.1 Overview

Hamersley Iron proposes to develop the BS4 Project. The mine plan has identified approximately 600 Mt of high-grade ore reserves (>60 % Fe) providing a Life of Mine of approximately 30 years for a 20 Mtpa dry high-grade plant. Mining will be by open pit operation using conventional equipment. The introduction of ore from the BS4 deposit will result in a change in the material type and grade of the traditional bedded Brockman Iron deposits from high-grade moderate phosphorous ore to high-grade higher phosphorous bedded material.

This section of the document provides a description of facilities, which comprises the following elements:

- The BS4 mine, which will include:
  - Pits;
  - Waste dumps, low-grade stockpiles, product stockpiles and topsoil stockpiles; and,
  - Haul roads.
- The plant, being the main and satellite plants (including overland conveyor) located at BS4.
- The rail spur between the existing Brockman 2 mine and BS4.
- Infrastructure associated with the BS4 Project, including:
  - Roads (including main access roads and maintenance tracks for rail);
  - Power transmission line (including substations and transformers);
  - Water supply (including remote borefields, pumps and piping);
  - Village (including landfill, wastewater treatment plant, emergency power generation and all services);
  - Airstrip for fly in fly out operation; and,
  - Buildings and facilities associated with the Mine and Plant, such as workshops, warehouse, bulk fuel facility and offices.

A summary of the key project characteristics of the BS4 Project is given in **Table 3-1**.

Table 3-1 Key Project Characteristics

Component	Project Characteristic	Detail
General	Project life	Estimated 30 years
	Potential ore reserves	600 Mt high-grade (>60% Fe) 290 Mt low-grade (>50% Fe)
	Mining rate	Minimum 20 Mtpa
	Waste rock	415 Mt (approx 150 Mt of which will be used to backfill pits)
Mine and mining	Pits and ore type	Three pits with high phosphorus Brockman ore
	Ore below water table	Approximately 20 % of total ore (variable between each pit)
	Stripping ratio	Ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average 1.2:1)
	Waste rock disposal	Surface dumps until mined out pit void become available, then backfill to above pre-mine water table level
	Pit voids	Three pits proposed, none to remain with the water table exposed upon closure, as backfilling of mine voids will occur to a height above the pre-mine water table level.
Dewatering	General	Dewatering only required to access ore from below the water table toward latter phases of mining - there will be no surface discharge as water will be used for mining, processing and dust suppression. Water to be sourced from lower reaches of orebody.
Water supply for mine	Combined rates	6,200 Kl/d
Power supply	Project life	13.5 MW supplied from the Dampier – Tom Price 220 kV transmission system via a 66 kV sub-transmission system.
Processing	Plant design	A dry plant with a crushing and screening circuit for 20 Mtpa
	Product transport	By rail via a 35 km long rail spur from BS4 to Brockman 2 mine then along the existing spur line and main line to port.
	Airstrip	New airstrip to be constructed.
Workforce	Construction Operation	Peak of 700 300 (plus approximately 40 during periodic shutdown maintenance periods).
	Accommodation	A new permanent village and contractor's camp will be constructed plus minor rail spur camps.

3.2 BS4 relationship to Other Projects

The nearest mining operations to the BS4 Project are the Brockman 2 operation, located 25 km to the north-east and Mt Tom Price located approximately 60 km to the east south-east. Both Brockman 2 and Mt Tom Price are iron ore mines owned by Hamersley Iron. The BS4 Project will be primarily independent of these operations. However, synergies exist, such as utilisation of the existing rail line from Brockman 2 to the port and the 66 kV sub-transmission line located north-east of Brockman 2.

The BS4 Project forms an integral part of Pilbara Iron's overall expansion programme. Other projects that have some potential to interact with, or be influenced by, the BS4 Project include:

- Increasing throughput at Dampier (proposal subject to separate environmental approval);
- Developing the Yandicoogina Junction South East deposit (proposal subject to separate environmental approval);
- Constructing and commissioning the Nammuldi Above Water Table Project (under construction);
- Operations at the Brockman 2 mine (operational mine);
- Construction of the railway duplication (under construction); and,
- Increasing the throughput from Hamersley Iron's Tom Price and Marandoo mines.

3.3 Disturbance Area

The estimated disturbance footprint of the BS4 Project is 2,470 ha (**Table 3-2**). Disturbance will be minimised to that required for safe and efficient operations (refer to **Appendix B** for a breakdown of disturbance by tenement).

- **Table 3-2 Approximate ground disturbance for the BS4 Project**

Project Component	Estimated area of disturbance (ha)
Access roads	54
Airstrip	40
Borefields	6
Conveyor	24
Haul roads	32
High-grade stockpiles	20
Low-grade stockpiles	244
Mine offices	20
Mine pits	949
Powerline	40
Process plant	27
Product stockpiles	44
Rail spur (inc. embankment, roads and borrow pits)	300
Run of Mine (ROM) Pad	5
Topsoil stockpiles	12
Village & camp	82
Waste stockpiles	529
Water pipelines	34
Water storage tanks and RO plants	4
Water testing drill lines	4
Total	**2,470**

3.4 Schedule

The pit development sequence will be:

- Central Pit – east and central region;
- East Pit – east region; and,
- West Pit and then remainder of East Pit.

Subject to gaining all necessary approvals, Hamersley Iron will develop the BS4 Project as soon as feasibly practicable.

Main works, including power supply, bulk earthworks, the airstrip and mining pre-strip are expected to commence initially followed by construction in all other areas, including the rail spur and processing plant, which will commence approximately five months after the main works.

3.5 Mining Operations

3.5.1 Mining

Mine planning work, which applies economic constraints around the resource, has produced an initial total mining reserve of around 600 Mt. The average strip ratio of waste rock to ore is expected to be 1.2:1. As such, an additional 700 Mt of waste material will have to be moved over the life of the deposit. However, almost 40 % of this waste material is actually low-grade ore (50-60 % Fe) and may be processed some time in the future to produce saleable ore.

Mining will be by open pit operation using conventional equipment (e.g. likely to be 350 t shovels, 240 t class trucks, dozers, graders etc). Mining will involve drill, blast, load and haul (refer to **Figure 5**). For ore blending purposes, several mine faces within the same pit will be worked simultaneously, and more than one pit will be mined at any given time.

The BS4 Project will gradually ramp up to the production rate of 20 Mtpa. There is future potential to increase to 30 Mtpa with either further dry crush or screening processing or wet beneficiation of low-grade material. Any such change in processing would be the subject of a separate environmental approval process. Low-grade ore will be stockpiled separately for possible future treatment.

Haul roads external to the pit area will be constructed using selected waste fill material sourced during initial pre-strip operations.

Site Preparation

Bulldozers will undertake the clearing and grubbing of mining areas by pushing the vegetation into piles. The vegetation piles will be track-rolled in order to break down the vegetation. The vegetative material cleared from areas such as the pits, external waste dumps, low-grade stockpiles, ROM pads and associated infrastructure will then be transported to designated stockpile areas by truck, or later as areas become available, spread directly onto areas being rehabilitated.

Topsoil from the pits, external waste rock dumps, ROM pads and associated infrastructure areas will be removed to a depth of approximately 300 mm (dependent on the depth of the topsoil, in some areas the ore is exposed at the surface) and then subsoil removal (500 – 800 mm) where practicable. The topsoil and subsoil will be pushed up into piles and then transported by haul truck to designated stockpile areas. These stockpiles will be no more than 2 m high and up to 50 m wide and will be protected from erosion by abutting them against the vegetation stockpiles where practicable to do so. Direct return of topsoil will be incorporated at a later date to areas being rehabilitated to minimise the potential for topsoil quality to degrade.

Drilling and Blasting

Drilling and blasting will be required in all pits to remove the hard-cap layer immediately above the ore body. Overburden material from the mine pits will be used as fill during construction of the rail spur, haul roads, ramps and levees or stored in waste dumps until it is required for fill or backfill.

3.5.2 Mine Pits

The BS4 deposit extends for approximately 14 km (almost east-west) and is 1 km wide and averages 150 m in depth (deepest parts are around 250 m). The total indicated high-grade (>60 % Fe) geological resource is 720 Mt, which is contained in three main pods labelled East (150 Mt), Central (330 Mt) and West (240 Mt). Current pit designs yield in the order of 600 Mt high-grade ore (>60 % Fe), and 290 Mt low-grade ore (>50% Fe). For ore blending purposes, several pits will be mined at any given time.

Pit design parameters have been determined following geotechnical modelling (Pells Sullivan Meynink Pty Ltd, 2005). The predominant stratigraphic units at BS4 are Joffre, Whaleback Shale and Mt McRae Shale and are similar in character to that at Hamersley Iron's mines at Mt Tom Price and Paraburdoo. Current design parameters are summarised in **Table 3-3**, however, further detailed geotechnical investigations will be undertaken during the feasibility design.

- **Table 3-3 Pit Design Parameters (combined pits)**

Component	Parameter
Pit depth	Up to 250 mbgl
Haul Roads	30 m width
Gradient	1:10
Benches	5-20 m
Berms	10 m
Bench Slope Angles	55^{o} - 70^{o}

mbgl = metres below ground level

Dewatering and Discharge

Approximately 20 % of BS4's high-grade reserves lie below the regional water table and dewatering will be required as a component of the mining operation to ensure dry mining conditions and pit wall stability towards the latter stages of mining. Dewatering requirements vary

greatly across the BS4 orebody; the western deposit extends up to 150 m below the water table whereas the central and eastern deposits extend 60 m below the water table (**Table 3-4**). Mining below the water table is not scheduled to commence until about year 6 (i.e. 2013), however water will be sourced for dust control purposes from within the mine pits from Project start-up.

Table 3-4 High-grade ore reserves below the water table

Deposit	Reserve (Mt)	Reserve (wet) (Mt)	% (wet)
East	120	26.4	22
Central	280	25.2	9
West	210	71.4	34
Total/Average	610	123.0	21.7

Dewatering will be achieved by pumping from a combination of in-pit bores and sumps. Where practicable, it is proposed to integrate mine dewatering, mine water supply requirements and pumping from the orebody from the outset of the BS4 Project. This will be an important component of the mine water supply. Using this approach, it is anticipated that groundwater can be abstracted from the orebody progressively without the need for large pumping campaigns to achieve rapid dewatering and without associated excess-water disposal.

The dewatering quantities are given in **Figure 8**. In addition, a breakdown of the dewatering quantities for each bore is given in Table 5.2 of the BS4 Project hydrogeological report (see **Appendix C**).

Average pumping rates from individual orebody bores will vary between 400 kL/d and 1,200 kL/d and the combined abstraction from the orebody will peak at approximately 6,200 kL/d. All of this water will be used for mine water supply and no excess-groundwater discharge is anticipated. Further information is provided in **Section 3.8.3**.

Drainage Control Structures

Surface water runoff will be managed to prevent drainage of surface water to open pits and to prevent erosion or contamination of ground and surface water.

Floodways will be used to manage runoff where existing terrain, road standards and peak flow allow. Culverts and a combination of culverts and floodways will be used where this is not possible. The peak flow estimated for the runoff towards the mine pits is 180 m^3/s based on a 1 in 20 year Annual Recurrence Interval (ARI). Runoff towards the mine pits will be controlled by earth channels and bund walls to divert the water around mining areas and back into natural drainage lines. Waste rock and overburden from mine pre-strip and mining operations will be extensively used to re-contour the area adjacent to the pits.

3.5.3 Waste Rock and Overburden Handling

Approximately 415 Mt of waste material (overburden plus waste rock) will be generated. The predicted stripping ratio for all pits ranges from 0.5:1 to 1.5:1 waste to ore depending on processing and stockpile strategies (average is approximately 1:1.2).

Sequential mining and backfilling of the pits will occur during the mining operation. However, during the initial mining period, it will be necessary to place the overburden not used for construction purposes in a permanent storage area situated outside the mine pit area. Waste rock material generated post-start up mining will also need to be stored until a portion of it can be placed back into the mine voids. This waste rock material will initially be placed in surface waste dumps and then a portion used to backfill the mine pits to above pre-mine water table levels as they become wholly or partly available for backfilling.

Approximately 265 Mt of waste material (out of a total movement of 415 Mt of waste) will need to be placed in waste dumps external to the pit. The design of waste dumps is yet to be finalised, but it is proposed to locate the majority of the waste dumps along the northern side of the orebody. Waste will also be stored on the southern side of the ore body, between the central and eastern lenses. The proposed waste dump locations are shown in **Figure 3b**. The extent and location of these dumps is subject to further detailed mine planning and feasibility studies that will aim to consolidate the mine footprint.

Geochemical test work indicates that there will be negligible black shale material (i.e. potentially acid forming) encountered during mining. However, in the event that potentially acid-forming black shale is encountered, this material will be encapsulated in designated and appropriately designed waste dumps to minimise the potential for acid rock drainage (see **Section 7.11**).

Design and construction of waste dumps will incorporate features to control surface runoff, facilitate progressive rehabilitation and reduce visual impacts after mine closure. Dumps will be constructed outside the zone of instability of the pits (as described by the DoIR) and initially at angle of repose in 10 m lifts to their maximum height of 40 m, with 25 m berms. Upon completion, the embankments will be battered down and batter slopes reduced to a maximum slope angle of 20 degrees and berm widths of 10 m. The potential impacts and management of waste rock is discussed in **Section 7.11**.

3.5.4 Low-Grade Stockpiles

Approximately 290 Mt of low-grade (50 – 60 % Fe content) ore material will be generated and stockpiled. This material will be stockpiled in a similar fashion as described for the waste rock dumps (**Figure 3b**). Low-grade ore stockpiles will be considered for possible future processing or sale. In the event that this material is not processed at some future time, the low-grade stockpiles will be rehabilitated.

3.5.5 Borrow Pits

Borrow material will be required to supply suitable construction material to raise and develop the foundation of haul roads and stock yards, ore crushing, screening and handling facilities, administration buildings and product conveyor etc. The majority of the construction material required will be sourced from pre-strip overburden taken from the pit footprints, with the remainder sourced from local borrow pits (e.g. for rail, roads).

In addition, initial pit development and ore extraction will commence to develop the ROM and ore stockpiles ready for plant commissioning and the first shipment of ore.

3.5.6 Mining Area Construction

On-site construction will consist of setting up water supply pipelines and outlets, construction of surface water drains and all buildings, including the accommodation camp and service facilities/areas. The majority of the buildings will be pre-fabricated and will be transported to the BS4 Project area for assembly on-site.

Site preparation for all mining areas will involve vegetation and topsoil removal, overburden and waste rock removal, blasting, waste dump construction, development of access roads and tracks and installation of appropriate drainage control structures.

3.6 Ore Processing

Hamersley Iron will operate the mine with a production output rate of 20 Mtpa minimum. Depending on market demand, there is future potential to increase production capacity to 30 Mtpa, and to possibly incorporate a low-grade wet beneficiation plant.

The BS4 Project will produce two products:

- Lump (-31.5 to +6.3 mm); and,
- Fines (-6.3 mm).

The process design proposed for the BS4 Project is for a crushing and screening plant capable of producing 20 Mtpa of products containing up to 55 % lumps product and 80 % fines product.

The materials handling system will consist of a primary crushing station and secondary crushing and screening station located in close proximity to the active mining area and a tertiary crushing and product screening building, stockyard, and a train load out system located at the eastern end of the ore body (refer to **Figures 3b** and **6**).

3.6.1 Primary Crushing

The primary crushing station(s) will be located in the vicinity of the active mining area, towards the centre of the orebody (refer to **Figure 3b**).

Large ore haul trucks (Komatsu 730E or equivalent) will deliver ore to the receival system. To minimise the need for double handling of ore on the ROM pad and to improve plant utilisation, a

large ROM bin has been selected with a live capacity of 600 t. Inevitably some trucks will be unable to tip into the ROM bin (e.g. during periods of crusher maintenance) and a ROM pad area has been allowed for ore storage. The ROM pad area will be adjacent to the ROM bin to minimise front-end loader travelling time. The ROM pad includes a certain amount of infrastructure to support mining operations. A large fuel storage tank will serve as a 'day tank' to refuel haul trucks, and suitable bunding and fire protection will be provided for this tank.

The ROM bin will be fitted with a 1,100 mm aperture fixed grizzly at the opening. Ore will be withdrawn from the bin by an apron feeder and then passed to a vibrating grizzly.

A hydraulic rock-breaker will be positioned above the ROM hopper, adjacent to the crusher control cabin, to break oversized material delivered from the mine. Water-misting sprays will be used for dust suppression in the ROM bin and crusher.

Oversize material from the vibrating grizzly will pass to a single toggle jaw crusher. Crusher discharge and grizzly undersize will drop onto a conveyor fitted with a magnet, metal-detector and weightometer and be fed to the secondary screen building.

The primary crushing station will be fitted with a dry baghouse type dust collection system, as this system reduces water use compared to alternatives.

Dust will be collected in the baghouse and returned to the flow.

3.6.2 Secondary Crushing and Screening

Primary crushed ore will be transported via a conveyor to the secondary screen building. The ore will pass to a 450 t capacity bin and then fed by a diverging vibratory feeder to a screen for removal of - 80 mm ore. Screen oversize will pass to a secondary crusher. Screen undersize and crusher discharge will be collected on a conveyor fitted with a magnet and metal detector.

The secondary crushing station will be fitted with a dry baghouse type dust collection system. Dust from the bins and screenhouse will be collected in a baghouse and returned to the flow.

3.6.3 Overland Conveyor

Secondary crushed product will be transported via an overland conveyor where it will be conveyed to a transfer station at the processing plant approximately 2.4 km to the east. A 500 t capacity surge bin at the discharge of the overland conveyor will allow the conveyor to be emptied should there be downstream equipment stoppages.

The conveyor can be accessed for inspection and maintenance from ground level for the majority of the conveyor route. A track will be provided on both sides of the belt, with one side being accessible along its length from the access road between the main processing plant and the remote tip and crushing plant. Only minor earthworks (cut and fill) and drainage are required along the conveyor.

The conveyor design incorporates conventional idlers and belting with support modules similar to that established for the Channar mine overland conveyor.

To prevent possible resonance effects experienced on similar installations, idler spacing will be varied along the length of the conveyor. To reduce pickup of wind born dust from ore being carried on the belt, wind guards will be installed along its length.

The route of the overland conveyor is indicated on **Figure 3b**.

3.6.4 Product Screening / Tertiary Crushing

Product Screening

Ore will be withdrawn from the overland conveyor surge bin by belt feeder and passed via a conveyor to the product screen feed bins. A tripper at the head of the conveyor will feed five 300 t nominal capacity bins. Ore will be withdrawn from each bin by a diverging vibrating feeder and subsequently screened. The undersize will be collected on a conveyor and delivered to the fines stockpiles. Oversize from the bottom decks will be collected on a conveyor and conveyed to the lump stockpiles.

Tertiary Crushing

Product oversize will pass to two 400 t nominal capacity crusher surge bins by chutes and conveyor fitted with weightometer, magnet and metal detector. Two tertiary crushers will be fed from the crusher feed surge bin by belt feeders. Crushed ore will be recycled to the product screens together with the secondary crushed ore in closed circuit.

Dust will be collected from the bins and conveyor feed points in the screen house and the crusher feed and discharge points by a system of ducts feeding a fabric baghouse dust collection system. Dust that is collected in this system will be returned to the conveyor belts. Each screen will be fitted with a dust sealing system comprising a frame and rubber hood and sealing system.

3.6.5 Product Stockpiles

The stockyards are to be laid out to enable the establishment of at least three piles in each yard for lump and fines respectively. Each pile will be 200,000 t. The nominal live volume for each stockpile will be 100,000 m^3.

The overall length of each stockpile will be 180 m plus a nominal 5 m between the toes of the successive stockpiles. When full, the stockyards will supply approximately three weeks of production.

The stockyard location has been selected to minimise cut and fill with a fall of 1:100 incorporated for drainage purposes. Surface water runoff from the stockyard area will drain into a suitable sized sedimentation pond or silt trap. The stockyards will have road access beside each stacker (offside) and road access up to the reclaimer from each end.

3.7 Ore Transport

3.7.1 Stacking and Train Load-out

Train load-out (TLO) facilities will be located adjacent to the stockyard at the eastern end of the mining area.

The TLO system will consist of a reclaimer, a reclaim yard conveyor, a separate load out bin conveyor, a TLO bin, a TLO gate, a belt weigher system and a local control room. This is to be similar to systems already operating extensively throughout the Pilbara.

The system is designed to be able to load three trains per day. Based on 232 car trains, with each car loaded to 107 t, the approximate load per train will be 25,000 t.

3.7.2 Drainage Control Structures

The implications of regional flooding were investigated using an assessment of the catchment hydrology and testing of the hydrology through a hydraulic model. The investigation focused on 1 in 20 year and 1 in 50 year ARI flood events.

The regional flood modelling found that the 1 in 20 and 1 in 50 year ARI flood events would cause extensive short term flooding north of the mine. A review of the existing flooding situation suggests that it should not cause problems provided that appropriate designs are implemented (e.g. earth channels and bund walls).

3.8 Infrastructure

3.8.1 Access Roads

Access to BS4 is currently via Brockman 2, which is accessed by an existing unsealed spur road from Hamersley Iron's Tom Price to Dampier Rail Access Road (**Figure 2**). Road access between Brockman 2 and BS4 will be via a track that will need to be constructed adjacent to the rail spur (see **Figure 3**).

The BS4 Project area can also be accessed from Tom Price along the White Quartz Road, which approaches the BS4 area from the south-east (**Figure 9**). The White Quartz Road will be upgraded to a 'graded track' level similar to other Hamersley Iron access roads. During the construction period, the White Quartz Road will be used for access to the mining/processing area and the Brockman 2 road will be used for the construction of the rail/power line. Both access routes require upgrading. After construction, the White Quartz Road will become the main access route to the site.

A number of roads need to be built to service internal movement around the site. These include:

- Internal plant roads;
- An access road adjacent to the overland conveyor between the satellite plant and the main plant;
- Level crossings and one road over the rail line;

- Access road from the village to the new airstrip; and,
- A spur road from the village to the main Brockman 2 to BS4 road.

All roads will be designed and constructed in compliance with relevant standards and will avoid east-west orientation wherever possible to avoid sun glare.

3.8.2 Airstrip

The existing Boolgeeda airstrip lies in a generally east-west direction within a horseshoe shaped valley area surrounded by high terrain on the northern and southern sides approximately 4 km from the centre of the valley. This airstrip has been used for several years to support light aircraft and helicopters.

A new airstrip will be required because the rail spur alignment currently crosses the existing airstrip. This new airstrip will be constructed approximately 3 km west of the existing airstrip (see **Figure 3**) and has been provisionally sited with respect to topography and preliminary floodway investigations. The final location will be confirmed during the feasibility stage of the BS4 Project, and will take into consideration detailed wind direction investigations, geotechnical analysis, detailed floodway studies and lease ownership.

The new airstrip has been planned to conform to Civil Aviation Safety Authority requirements, and has been located in a position that will allow for possible upgrades/expansions in the future. It would include an airstrip with associated taxiways, as apron for single power in/ power out aircraft, a terminal building and defined visual aids (including aerodrome lighting for emergency Royal Flying Doctor Service operation). Refuelling facilities will be required for smaller aircraft that do not have the range for a return flight to Perth.

The proposed airstrip borders on the shallower reaches at the extent of the 1 in 50 year regional flood. These regional flooding impacts have been considered, and appropriate flooding protection will be provided.

3.8.3 Water Supply

Total mine and plant (dry processing only) water demand will be approximately 6,200 kL/d. The accommodation village will require an additional 360 kL/d. Water will be used for dust suppression and potable purposes. Water supplies will be required during Project construction and operation for the following:

- Construction – construction of infrastructure, roads and rail spur (demands will vary seasonally and will range between 2,000-4,000 kL/d).
- Mine Operations – dust suppression on haul roads, product stockpiles, in the process plant and general use in workshop and office areas (average demand will be 6,200 kL/d and may peak seasonally at 8,000 kL/d).

- Camp – potable and domestic usage both during the construction phase until the accommodation village is built and during subsequent operations (average demand will be 300 kL/d).

Two main aquifers have been identified in the BS4 Project area; the orebody aquifer and the Wittenoom Dolomite in the valley immediately to the south of the orebody. Both aquifers offer water supply potential. Additionally, groundwater abstraction from the orebody aquifer will be necessary for mine dewatering to access the mineralised ore body below the water table.

It would also be necessary to develop the Boolgeeda dolomite borefield in approximately year 5-6 to achieve required rates for the 20 Mtpa dry crush and screen plant, as the mine dewatering source will not be capable of supplying the required volumes at a sustainable rate.

In the event that the Boolgeeda borefield option proves to be unsustainable, a fall back option is to source water from the Silvergrass Valley, which is located 35 km from the BS4 Project area. The water resources in this area are extensive, which is supported by test production bores that have been installed. A preliminary evaluation of other water supply options over a wider area has also been undertaken to provide some targets for future work should additional water be required (Aquaterra, 2005; see also **Appendix C**). The proposed water supply sources are illustrated on **Figure 2** and schematic of the water balance is provided in **Figure 8**.

Process Water Supply

The main process water supply will be obtained from bores constructed in the orebody and in the valley immediately to the south of the orebody (targeting a dolomite aquifer).

The hydraulic characteristics of the orebody were investigated during a field programme in 2004. The orebody and valley borefield will comprise up to sixteen bores (six in the dolomite and ten on the orebody). The bores will be up to 200 m in depth, and long-term average pumping rates from individual bores will vary between 200 kL/d and 1,200 kL/d.

Numerical modelling of abstraction from the orebody and dolomite aquifers showed the following (Aquaterra, 2005):

- Average annual abstraction of 6,200 kL/d can be sustained for around 5 years;
- Thereafter, abstraction falls to a long-term rate of around 3,000 kL/d – 4,000 kL/d; and,
- In general, abstraction from the orebody effectively achieves mine dewatering over a period of years leading to mining ore from below the water table around year six.

The Boolgeeda borefield (located adjacent to the rail spur – see **Figure 2**) will be developed as an additional back-up water source. This borefield targets the Wittenoom Formation in the strike valley on the northern side of the Brockman Syncline. Mineral exploration has confirmed the presence of Wittenoom Formation at a depth of around 40 m below ground level with Tertiary detritals overlying in the proposed development area, and the water table varies between 10 and 20 m below ground level.

It is estimated that sustainable groundwater resources in the area are between 4,000 kL/d and 8,000 kL/d (based on likely volumes in storage and throughflow in the system). The proposed Boolgeeda borefield will comprise up to eight production bores and two backup bores.

The Boolgeeda borefield will provide make-up water when abstraction from the BS4 mine borefield starts to decrease. In addition, it will act as a backup water source should any of the BS4 bores have to be shut down for operational purposes.

Village Water Supply

It is proposed to obtain water for the village and contractor's camp from low-capacity bores installed into alluvium overlying fractured basement aquifers in the vicinity of the village. Two production bores and one backup bore will be required which will extract from a combination of local fractured aquifers and overlying alluvium close to creek channels. The location of bores close to creek channels will enhance the prospects of groundwater recharge. The village borefield remains to be field-tested but is considered likely to be of sufficient capacity to meet the daily village demand. It is proposed that the water infrastructure servicing the village be wholly independent of the water infrastructure for the mine and plant.

Construction Water Supply

The main water supply borefield (orebody and valley to the south of the mine) will be partially developed during on-going feasibility studies throughout 2005. Any remaining bores would be drilled and constructed early in the development phase of the Project. The main borefield will be the prime water supply during construction of the mine, processing plant and associated infrastructure.

Water Reticulation

The borefields will supply various storage or transfer tanks that will feed the mine, plant or the village. Pipes will be of iplex polyethylene material, installed above ground and positioned on a suitable access track to minimise disturbance. Four storage tanks are required:

- Village Storage Tank – 800 kL capacity.
- Plant / Administration / Workshop Storage Tank – 5,000 kL capacity.
- Northern Borefield transfer tank – 3,000 kL capacity.
- Dewatering Bores transfer tank – 3,000 kL capacity.

It is anticipated that the Dewatering Bores transfer tank will be used for mine dust suppression. Two standpipes will feed off this tank for this purpose.

Water Treatment

Reverse osmosis treatment plants will be incorporated at the village, contractor's camp and administration areas to treat water drawn from the aquifers.

Recycling Opportunities

Two key opportunities will be utilised as part of the BS4 Project to recycle water:

- Water drawn from the pit dewatering bores to supply part of the mine and plant's supply requirements will be recycled; and,
- Wastewater from both the mine and village will be treated and then re-used for non-potable purposes.

3.8.4 Power Supply

The BS4 Project will require a continuous source of electric power to supply the process plant, buildings, workshops, village and mine facilities. The BS4 Project's estimated power demand is 13.5 MW.

A new zone substation is proposed to provide power to BS4, and will be established on the Hamersley Iron 220 kV transmission system, which supplies power to inland mine sites at Mt Tom Price, Paraburdoo, West Angelas and Yandicoogina.

A new 66 kV sub-transmission network will be built to supply power to BS4 from the new substation. The zone substation and 66 kV network will be integrated into the existing SCADA system and controlled from Dampier. Voltage will be transformed down to 66 kV (High Voltage), and subsequently to 33 kV for delivery of Medium Voltage to the BS4 plant.

The transmission line has been routed within existing leases and the tenure is under application. The new line's route approximately follows the proposed rail spur between Brockman 2 and BS4 (refer **Figure 3**).

Two standby generators rated at 1 MW each will provide backup power; one at the process plant to provide lighting and small power requirements, and the other at the village for emergency purposes.

3.8.5 Wastewater Treatment

A wastewater treatment plant will be established adjacent to the village and contractor's camp to treat sewage and grey water. The wastewater treatment plant will be located at least 250 m from the village towards the north-west. Wastewater from the village and camp will gravitate to a pump station where it will be transferred to a wastewater treatment plant. The treated effluent will be chlorinated, filtered and pumped to a 'sprinkler farm' spray irrigation disposal system. Other smaller-sized wastewater treatment facilities may be located around the plant and offices; these will be either septic tanks or leach drains. Options for the re-use of a portion of the treated grey water from the village and office for watering lawns and landscaped gardens will be considered during further detailed feasibility studies.

3.8.6 Dangerous Goods

Diesel fuel will be delivered to the BS4 Project area by road. Four 110 kL storage tanks will be located in a specially constructed facility situated at the infrastructure building complex.

Additional storage tanks will be provided at the ROM pad(s) for daily filling of mine vehicles. An on-site fuel truck will refill these tanks. Double-skinned storage tanks, which do not require bunding, may be used instead of standard storage tanks and bunded slabs.

Bulk quantities of oil and lubricants will be stored in storage tanks at the mine workshops. The lubricant storage area has been designed to provide separation between storage vessels and the edge of the bunded slab so that leaks can be contained, and also to allow forklift access within the bunded area for delivery of cube storage vessels.

Two relocatable explosives magazines, purchased as pre-fabricated buildings, will be provided for storage of explosives and detonators. These magazines will be fenced, set back from any other buildings and will conform to DoIR guidelines.

A separate facility will be constructed near the mining area to receive and store ammonium nitrate required for blasting. This facility will be an open ended shed with a concrete floor. The facility will allow for delivery from a high level roadway into the hopper of a screw conveyor that distributes to the relevant stockpiles. A skid steer will then be used to load the ammonium nitrate into a hopper that will transfer it into the explosives truck.

3.8.7 Waste Management

All hazardous waste, including unwanted or contaminated hydrocarbons and chemicals, will be removed from site and disposed of by a contractor to a licensed facility off-site.

Non-reusable or recyclable waste will be disposed of in an on-site landfill in accordance with relevant legislation and standards.

Any recyclable materials will be collected separately from general industrial and domestic waste and transported off-site for recycling.

3.8.8 Administration Buildings, Workshops, Laboratory and Service Areas

Mine infrastructure will be located south of the overland conveyor and west of the rail loop. This location allows separation between the heavy vehicle and light vehicle movements to increase safety for personnel that require access to the infrastructure buildings without requiring access to the plant and mine operations.

The following facilities will be constructed:

- Administration building - including offices / workstations, a kitchen/crib area, toilet facilities, a first aid room, and parking for the ambulance and emergency service vehicles;
- Heavy vehicle workshop;
- Warehouse and external laydown area;
- Fabrication / Electrical workshop;
- Light vehicle workshop;

- Tyre workshop;
- Fuel storage;
- Lubricant storage;
- Explosives storage; and,
- Ammonium Nitrate storage.

3.8.9 Vehicle Washdown

The heavy vehicle and light vehicle washdown areas will utilise common components. The facility will be designed to operate using recycled water to reduce the water demand of the facility. The washdown facility will incorporate a sediment trap and oily water treatment plant.

3.8.10 Accommodation and Workforce

Once the Project is operational, BS4 personnel, visitors, temporary staff and contractors will be accommodated at either a permanent village or contractor's camp. These camps will be located approximately 10 km north east of the plant (refer to **Figure 2**).

The permanent village will be built around central facilities incorporating:

- Dry mess and kitchen building;
- Wet mess;
- Common use and administration facilities such as office/retail, store, first aid room, ablution facilities, laundries, gatehouse, maintenance block;
- Sport and recreation centre; and,
- Car/coach parking areas, loading/unloading zones.

The accommodation section will cater for 360 permanent staff. The design and location will allow for future expansion of the village to house up to 500 people, if needed.

Separate messing and recreational facilities will be established for the contractor's camp. The contractor's camp will provide for a peak of 700 rooms.

Utility services include:

- Power / gen-set facility, fuel storage, maintenance shed, water tanks and electrical substation (located away from the building areas).
- Sewer pumping station, located at the lowest end of the site and able to pick up gravity feed sewer lines.
- Wastewater from the village will gravitate to a pump station where it is transferred to a water treatment plant. The treated effluent will be chlorinated, filtered and pumped to a 'sprinkler farm' spray irrigation disposal system. The wastewater treatment plant will be located at least 250 m from the village towards the north-west.
- Telecommunications.

Landscaping will include a mix of native vegetation and other shrubs with lawns between all permanent accommodation and at the mess facilities. All landscaping will be irrigated from grey water sources, subject to further detailed feasibility studies.

3.9 Mine Access - White Quartz Road

The main access to the BS4 Project area will be via the existing White Quartz Road (refer to **Figure 9**). The White Quartz Road is approximately 60 km long and starts in Tom Price and heads north-west crossing the Nannutarra Wittenoom Road approximately 20 km outside of Tom Price. The road continues in a north westerly to westerly direction towards the Beasley River and the south side of the BS4 mining leases. Much of this road is reasonably flat and of a reasonable condition. The road provides the safest and shortest journey time to the minesite.

This proposal covers the 41 km length from the junction of the White Quartz Road and the Nanutarra Wittenoon Road to the BS4 minesite. This segment of the road will need to be upgraded (widened) to a 'graded track' level similar to other Hamersley Iron access roads. Cattle grids will be provided where pastoral fences cross the access road. In pastoral areas, fences along the roads will be relocated or built as required. Clearing will be minimised, and the road will be 10 m wide (currently the road is up to 6 m wide in places). Culverts will be used if considered appropriate, with road drainage designed for a 1:20 year flood event.

Flora and heritage surveys have been completed along the road. Priority flora exists along a section of the road (refer to **Section 4.8.6**) and two Aboriginal heritage sites have been identified. The upgrading of the road will take into consideration these areas to ensure they are not impacted.

3.10 Powerline Corridor

A 66 kV sub-transmission network will be installed to supply power to the BS4 mine site from a new substation to be located approximately 12 km north-east of the Brockman 2 mine, between transmission towers 249-2 and 249-3. The transmission line from the substation and Brockman 2 was covered as part of the Nammuldi Mine approval (Ministerial Statement 558). The proposed transmission line has been routed within existing leases and the tenure is under application. The line's route into BS4 approximately follows the proposed rail spur between Brockman 2 and BS4.

The transmission line corridor will consist of a track for construction and ongoing maintenance, a 66 kV line constructed on steel or concrete poles, or narrow based steel towers with a delta configuration, and an overhead earth wire for lightning protection. The track will allow surface water to flow over, and it will therefore not interfere with surface water drainage.

3.11 Rail Spur

3.11.1 Overview

A new rail spur will be constructed to transport ore past Brockman 2 to the Rosella Siding, then along the main line through to the port facilities at either Dampier or Cape Lambert. This will be achieved by extending the existing railhead at Brockman 2 south-west along the north-west perimeter of the Brockman Syncline, then cross over the ranges and continue in a south easterly

direction towards the BS4 mine site, culminating in a load-out loop (a distance of 35 km including the load-out loop).

The load-out will allow for parking of rail cars and for maintenance to be carried out. The rail loop and TLO facility will be located at the eastern end of the BS4 orebody. The location of the final rail loop effectively fixes the position of the plant stockyards, which are located as close to the TLO as possible in order to reduce the length of the high-speed load-out conveyor from the stockpile reclaimer.

Construction will consist mainly of new embankment formations and mainline standard track work, and will require construction roads, borrow pits, water supplies, accommodation, offices and other facilities. The rail spur will be designed and constructed to incorporate earthwork standards, construction methods and rock protection works that were applied to the construction of recent Rio Tinto railway projects in the Pilbara region.

A fibre optic cable will run adjacent to the rail spur to provide data and voice communications to both the proposed and existing mines as well as a communications backbone for both voice radio and the signalling system. Solar power will be used for signal locations. The cable will be buried below natural ground level.

All turnouts outside the yard areas will be motorised and controlled from 7 Mile Central Train Control in Dampier.

A summary of the key characteristics of the BS4 rail spur is given in **Table 3-5**.

Table 3-5 Key characteristics of proposed rail spur

Component	Description
Length	35 km
Disturbance Area	75 m wide corridor (approximately) 300 ha (including embankment, roads and borrow pits)
Sidings	No sidings required
Ruling Gradient	Against empty 1.5 % Against loaded 0.275 %
Flood Interval	1:20 year
Track	Standard gauge (1,435 mm)
Trains	Two locomotives x 232 ore cars

3.11.2 Route

The proposed rail spur alignment between Brockman 2 and BS4 is largely dictated by ruling grade (0.275 %) and drainage requirements. The chosen grade (0.275 %) minimises the required earthworks and avoids the need for banker locomotives. On leaving the Brockman 2 loop, the alignment heads south-west following the run of the valley. The terrain becomes increasing undulating as the alignment heads past Mt Brockman, approaching the Boolgeeda Creek valley. Through this section the alignment holds close to the base of the hills to avoid lower valley

drainage and to minimise earthworks. The drainage through this area is well defined and crosses the alignment from left to right. The alignment then approaches BS4, on the north side of the ore body (refer to **Figure 9**).

3.11.3 Drainage

Drainage works for the new rail spur will comprise culverts, off formation drainage works, rock protection and other erosion protection works to reduce the potential impacts of disturbance and alteration to surface drainage.

The proposed rail spur alignment is located in close proximity to a number of ephemeral drainage lines and seasonal pools. There is no requirement for bridges, and surface water crossings can be accommodated entirely by culverted crossings. Culverts will be constructed where practicable to ensure that down-stream vegetation is not affected by watercourse diversion or obstruction (i.e. 'water shadow'). There will be areas where drainage lines intercept the rail alignment in cuttings. In these instances natural flows will be interrupted.

The design and location of drainage control structures will be confirmed during detailed engineering design and it is anticipated that corrugated steel pipes (wrapped in an impermeable geomembrane to prevent corrosion where the pipes are buried) and concrete box culverts will be used where cover is limited. The location and positioning of these structures will be determined by embankment heights and predicted flood flows at each drainage line crossing. Erosion protection will be in accordance to the Austroads Waterway Design Guide.

One major waterway crossing will be at Boolgeeda Creek. The Boolgeeda Creek is the most significant drainage feature in the area and has a catchment area of approximately 150 km^2. A design recurrence interval of 1:20 years has been used for the crossing, which equates to a peak of 360 m^3/s. At this crossing, the access road and rail spur will share a common formation and have 10 x 3,600 mm corrugated steel pipes in place.

3.11.4 Borrow Pits

Borrow material will be required at various locations along the rail spur. The 'cut-to-fill' method i.e. material from cuts used in areas requiring fill, will be applied to minimise demand for borrow material. Any shortfall of fill material will be sourced from borrow pits. The amount of borrow material required is estimated to be 400,000 m^3.

Borrow pits will be spaced out along the length of the rail corridor to minimise haulage distance and concentrated disturbance. Borrow pits will be selected based on the characteristics of the fill required and the need to minimise disturbance to vegetation, drainage patterns and other significant features. Once an area has been selected, topsoil will be stripped and stockpiled for later use in rehabilitation. The borrow pits will be designed to encourage natural drainage and prevent the establishment of ponded water where practicable.

3.11.5 Water Supply

The water demands for the rail spur construction are estimated to be around 1,200 kL/day.

Five water supply bores will be installed along the rail/road corridor between BS4 and the existing Brockman 2 mine at spacings between 5 km and 8 km. These bores will be for short-term use during construction activities, with some of these water sources being maintained for minor, periodic abstraction related to ongoing maintenance works.

3.11.6 Rail Spur Access Road

The rail spur access road will be constructed in accordance to Main Roads WA Pilbara Region standards for gravel roads. The road will be constructed as close as practical to the rail spur alignment. Stock grids will be provided where fences are crossed. The road will for allow construction of the rail spur and will be later used to access the line for maintenance work.

The road will share the same embankment as the rail spur for the crossing of Boolgeeda Creek.

The road will likely be down-gradient of the rail spur, and will allow water to overtop. It will not interfere with the drainage of any water passing through culverts in the rail embankment.

3.11.7 Accommodation

The crew working on the rail spur extension will be housed in the new BS4 camp. Some personnel may also be accommodated in a separate camp near Brockman 2 mine.

3.11.8 Rail Spur Construction

Topsoil and vegetation will be removed ahead of construction of the proposed BS4 rail spur and stored separately for use during rehabilitation.

Earthmoving equipment such as graders, bulldozers, scrapers, dump trucks, water carts, rollers and loaders will be utilised in the construction of the rail embankment and formation. In areas that have large amounts of rock, blasting will be undertaken. Excavation and placement of suitable material will be undertaken in a manner to ensure the integrity of the rail formation is maintained, and be able to withstand the weight of the loaded rolling stock and weathering by the natural elements.

Once the rail formation has sufficiently progressed, sleeper and track-laying will commence. Sleepers will be delivered by road and distributed at a set spacing using a purpose built trailer and distribution mechanism. A train will be used to transport 400 m lengths of pre-welded rail to site, and a crane used to pull the rail on the sleepers. The train will then roll forward over the newly laid track and another length of track will be taken off and put in place. Ballast will be delivered by rail and surfacing carried out from bottom dumping rail wagons.

Construction will be monitored and controlled to ensure compliance with specifications, drawings, performance, safety and environmental standards.

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4. Existing Environment

4.1 Climate

The climate of the Pilbara region is described as arid tropical with two distinct seasons, summer and winter (Gentilli, 1972). The summer months extend from November to April when temperatures can reach 47°C (mean daily maxima of 39°C in January), while winter temperatures are cool (mean daily maxima of 24°C in July). Bureau of Meteorology data for Tom Price, which is the closest weather station to the BS4 Project area, shows a mean daily maximum of 37.1°C in Summer and 24.0°C in Winter (**Table 4-1**). The local climate is influenced to some degree by the topography, and the climatic conditions experienced at the BS4 Project area may vary slightly from those experienced at Tom Price.

Peak rainfall occurs during the summer months, with smaller peaks occurring during May and June. Annual rainfall is highly variable from year to year and ranges from 180 mm to over 400 mm, but is mostly between 300 mm and 400 mm, with an annual average of 398 mm at Tom Price. This variability is a consequence of periodic summer cyclones that pass along the Pilbara coast, and which occasionally extend inland, becoming rain-bearing depressions causing widespread and intensive rainfall. Rainfall during May and June is generally a result of cold fronts moving across the south of the State and which occasionally extend into the Pilbara (Bureau of Meteorology; *www.bom.gov.au*).

Table 4-1 Temperature and rainfall data for Tom Price (1972 – 2004)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann*
Mean Daily Max. Temp (°C)	38.4	35.3	33.5	31.8	27.5	23.7	22.9	25.4	28.7	33.3	35.6	37.7	35.6
Mean Daily Min. Temp (°C)	23.3	22.4	20.3	17.0	13.3	8.4	7.4	8.6	11.4	15.8	18.9	22.1	15.7
Mean monthly rainfall (mm)	81.2	93.2	61.2	30.3	23.6	28.8	15.6	12.0	2.4	3.1	8.0	38.8	398.2
Highest monthly rainfall (mm)	231.5	335.9	201.1	135.8	90.0	128.6	70.9	98.2	31.6	33.2	45.7	152.0	-
Highest daily rainfall (mm)	113.5	90.0	142.4	67.0	63.6	56.4	43	29.5	8.6	33	26.2	102	142.4
Mean no. rain days	7.9	8.6	6.8	4.0	3.3	3.8	2.9	1.4	0.9	0.9	2.3	5.3	48.1

*Annual average or total

Annual evaporation rates in the Pilbara are high, with the highest rates recorded during the summer months. Pan evaporation is 3,600 mm (PPK Environment & Infrastructure, 1999) that greatly exceeds the mean annual rainfall.

Winds are predominantly east-south-easterly between May and August with stronger west-north-westerly winds between September and March.

4.2 Major Physiographic Units

The BS4 Project area lies within the Hamersley Plateau physiographic unit, as described by Beard (1975). The Hamersley Plateau is characterised by rounded hills and ranges, mainly of Banded Iron Formation (BIF) and dolomite with some siltstone, shale and volcanic rocks (see **Figures 10, 11** and **12**).

The BS4 Project area is located within the Pilbara bioregion as described in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995; Environment Australia, 2000). The IBRA bioregions are used as a framework for conservation planning and sustainable resource management in a bioregional context.

Within the Pilbara bioregion, the BS4 Project is located within the Hamersley Range subregion (based on the physiographic work of Beard, 1975). This subregion is described as 'a mountainous area of Proterozoic sedimentary ranges and plateau with Mulga low woodland over bunch grasses on fine textured soils and Snappy Gum over *Triodia brizoides* on skeletal sandy soils of the ranges' (Beard, 1975).

4.3 Land Systems

Land System (Rangelands) mapping covering the BS4 Project area has been prepared by the WA Department of Agriculture (Payne *et al*., 1988; Department of Agriculture, 2002). These are broad units that each consist of a series of 'land units' that occur on characteristic physiographic types within the Land System.

One hundred and seven (107) Land Systems occur in the Pilbara bioregion. The BS4 Project area includes seven of the Land System units listed in **Table 4-2**.

Most of the Land Systems occurring in the BS4 Project area are widespread through at least the Hamersley subregion, whilst the River, Newman and Rocklea Land Systems are widespread through the entire Pilbara bioregion (see **Table 4-2**). The Table Land System has scattered occurrences within the Pilbara bioregion, but is relatively widespread in the northern Gascoyne region (to the limit of the Ashburton Land System mapping). All of the Land Systems occurring within the BS4 Project area are also represented within the Karijini National Park.

4.4 Conservation Estate

The BS4 Project area is located approximately 90 km from the nearest boundary of the Karijini National Park and 100 km from the nearest boundary of the Millstream-Chichester National Park (**Figure 10**). Both these National Parks are managed by CALM.

Table 4-2 Distribution of Land Systems within the BS4 Project area and wider Pilbara region

Land System	Total Area in the Pilbara Bioregion (ha) (Rank†)	General Distribution through the Pilbara Bioregion	Area within BS4 Project Area	
			Hectares	% of total in Pilbara bioregion
Boolgeeda	961,634 (103rd)	Widespread with a large number of occurrences, particularly through the Hamersley Range subregion.	5,409	0.6 %
Newman	1,993,741 (106th)	Relatively widespread through the Hamersley Range, also occurring as a band along the Chichester Range to the north of the Fortescue Marsh; numerous occurrences.	4,622	0.2 %
Platform	236,335 (92nd)	Occurs predominantly in the Hamersley Range with small occurrences also in the Chichester Range.	757	0.3 %
River	482,175 (101st)	Widespread in major river systems.	698	0.1 %
Robe	128,859 (76th)	Occurs within the central and western region of the Hamersley subregion, with a few occurrences in the Chichester subregion.	351	0.3 %
Rocklea	2,881,199 (107th)	Widespread through both the Hamersley and Chichester Ranges.	1,950	0.1 %
Table*	20,645 (31st)	Scattered occurrences in the south of the Pilbara bioregion and also within the Gascoyne bioregion.	311	1.5 %

† Ranking of Land System in terms of area out of the 107 Land Systems in the Pilbara bioregion; ranked from least abundant in terms of area (1) to most abundant (107).

* Based on Biota ground-truthing of the BS4 Project area, two areas ascribed to the Robe Land System by Payne *et al*. (1988) actually represent the Table Land System, as characterised by the presence of calcrete outcroppings. Both of these polygons are in the north-western portion of the Project area.

Ref: Biota (2005b) - data from Payne *et al*., 1988 and Department of Agriculture, 2002.

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The Pilbara bioregion is listed as a high priority for funding for land purchase under the National Reserves System Co-operative Program due to the limited representation of the area in conservation reserves. For example, a 'Mulgalands Conservation Park', east of Karijini National Park, has been proposed to provide for reservation of species and floristic communities that are not present or are inadequately represented within the Karijini National Park. Similarly, portions of numerous pastoral leases in the Pilbara have been nominated to be released to the conservation estate in 2015 or to be set aside for conservation management within the pastoral leases under conservation agreements. The BS4 Project area does not impinge on any areas proposed for conservation.

4.5 Geology and Soils

4.5.1 Geology

Regional Geology

The Brockman Syncline[3] lies within the Hamersley Province of the Pilbara Craton in the north-west of WA. It contains Archaean to Lower Proterozoic Fortescue and Hamersley Group rocks comprising the Jeerinah Formation, the Marra Mamba Iron Formation, the Wittenoom and the Mt. Sylvia Formations, Mt. McRae Shale, the Brockman Iron Formation, the Weeli Wolli Iron Formation, the Woongarra Volcanics and the Boolgeeda Iron Formation. The more resistant iron formations form prominent ridges outlining the syncline. The area consists of a large regional syncline trending almost east-west to north-east/south-west on the eastern portion approaching the nose of the syncline. On the local scale it contains many areas of superposed structural complexities with west to north-west trending tight synclines, anticlines and normal faults.

Small outcrops of Turee Creek Group sediments occur towards the centre of the syncline. Tertiary to Recent sediments comprising canga (hematite conglomerate) and scree deposits flank the main iron formation outcrops. Extensive areas within the syncline are covered by colluvium.

BS4 Project Geology

BS4 is a typical high phosphorus Brockman martite-goethite type deposit (refer to **Figures 11** and **12**). Mineralisation occurs in both Dales Gorge and Joffre Members of the Brockman Iron Formation over a strike length of approximately 14 km, with mineralised thicknesses over 100 m encountered during drilling. Minor mineralisation also occurs in the Whaleback Shale Member.

In addition to the bedded mineralisation, small deposits of secondary surficial ironstone have accumulated as cover over the bedded Brockman mineralisation and along the valley between the Marra Mamba and Brockman Iron Formations. These include canga, limonite or unbedded goethite, pisolite and detrital material types. In the small valleys separating the western, central and eastern zones this material can be up to 40 m thick and may overlie a hydrated zone between

[3] Geological term for a fold in the rocks of the Earth's crust in which the layers or beds dip inwards, thus forming a trough-like structure with a sag in the middle.

10-30 m thick. The detrital material is too low-grade to constitute part of the BS4 resource, although it comprises more than 55 % Fe in places.

The mine area contains bedded hematite/goethite ore hosted by the Dales Gorge and Joffre Members of the Brockman Iron Formation. The maximum depth of the orebody is approximately 150-200 m, with the deepest point located in the Western lens.

Ore and Waste Characterisation

The physical and chemical properties of some ore and waste rocks often have the potential to cause environmental contamination and to adversely affect rehabilitation. To determine the chemical and physical attributes of the various materials which comprise the ore and wastes, the results of analysis on ore samples undertaken for a range of geochemical parameters was evaluated. The results of chemical analysis are summarised in **Table 4-3**.

Table 4-3 Chemical composition of ore samples

Element	Min (%)	Max(%)	Mean (%)	Std Dev (%)
As	0.001	0.001	**0.001**	0.000
Co	0.001	0.025	**0.001**	0.000
Cu	0.001	0.015	**0.001**	0.001
Pb	0.002	0.026	**0.002**	0.001
Ni	0.001	0.443	**0.003**	0.012
Zn	0.001	0.017	**0.001**	0.001
Ba	0.005	0.005	**0.005**	0.000
Cr	0.001	0.182	**0.003**	0.005
Sn	0.003	0.015	**0.004**	0.002
V	0.002	0.040	**0.002**	0.001

The average concentrations of heavy metals (e.g. arsenic, cobalt, copper, nickel and zinc) in the waste material surrounding the ore are expected to be similar to that in the ore, and are at levels that are very unlikely to be harmful to the environment[4].

Whilst the BS4 ore is referred to as having a high phosphorus content (approximately 0.12 %, whereas iron ore preferred for processing has a phosphorus content of approximately 0.08 %), there are no environmental implications for mining, crushing, screening, railing or shipping.

[4] Refer to EPA (2003a).

With regard to the potential for acid rock drainage, the orebody contains a section of materials that contains pyritic black shale on the southern boundary. This material extends the length of the proposed pits, and is approximately 14 m thick (refer to **Figure 12**). Pyritic black shale contains sulfide minerals (e.g. pyrite) that can react with air and water to produce acidic drainage water. However, this material will not be mined or exposed during the mining operation as it is not target ore. Should pyritic black shale be encountered, Hamersley Iron will employ appropriate management strategies, as are currently applied at its Tom Price and Paraburdoo mines, to ensure this material is encapsulated in waste dumps and therefore has no impact on the environment.

Whilst amphibole minerals may be encountered in the Banded Iron Formations of the Hamersley Group rocks, no asbestos minerals have been detected in the drilling of the BS4 Project.

Dispersive clays can also be an issue in rehabilitation. Whilst clays (kaolinite) occur irregularly within the BS4 orebody as isolated pods, clay will only make up a very small component of the total waste.

Hamersley Iron will continue to address the occurrence of any potentially acid forming waste rock through exploration activity and waste characterisation studies as the Project progresses.

4.5.2 Soils

The soils of the BS4 Project area have been classified according to Northcote (1979), and are dominated by:

- Soil type Um5.51, which is a shallow coherent and porous loamy soil occurring on hills; the A-horizon is very shallow (<30 cm), with dark red to red sandy clay loam and a stony, hard-setting surface and a low to high coarse fraction. It has low salinity, a slightly acid pH and low nutrient levels.
- Soil type Um5.52, which is similar to Um5.51, but occurs on lower slopes of hills and on stony undulating plains and has a deeper A-horizon (75-100 cm). It also has low salinity, is slightly acidic and has low nutrient levels (Halpern Glick Maunsell, 1999a).

4.6 Topography and Surface Drainage

4.6.1 Local Area

The Brockman Syncline lies within the Hamersley Province of the Pilbara Craton. The syncline encloses the rail loop and the mining area, which are located on a large floodplain area. The Brockman Iron Formation rises over 150 m above the adjacent valley floors.

4.6.2 Mine

The topography consists of moderate to steep slopes bordering the mine pits on the north side, and mild to moderate slopes within the BS4 Project area.

There are no major river systems or permanent water bodies passing through the BS4 mining area. The mining area is located in the Boolgeeda Catchment, which covers an area of approximately 400 km^2. Surface drainage from the mining area is to the west-south-west and is dominated by a number of small ephemeral drainage lines that flow only for a short period during rainfall events. These drainage lines are minor tributaries of the Boolgeeda Creek (see **Figure 7**). During the wet season, the ephemeral drainage lines lead to the headwaters of the Boolgeeda Creek, which joins Duck Creek 30 km west of the BS4 Project area.

Hamersley's Central Pilbara Wetlands Study mapping shows no wetlands within a 10 km radius of BS4 Project. The closest water holes are located approximately 20 km south-east of the Project area.

Hydraulic modelling was used to assess the surface hydrology of the BS4 Project area. The peak flow estimated for the runoff towards the mine pits is 180 m^3/s, based on a 1 in 20 year ARI. Flood modelling showed that a 1 in 20 and 1 in 50 year ARI would cause extensive short-term flooding north of the mine. These impacts have been considered during the design of the rail spur and infrastructure in this area.

4.6.3 Rail Spur

The rail spur will cross ephemeral drainage lines ranging from event-drainage a few metres wide to larger seasonal drainages, some of which may hold water in ephemeral pools for a few days to weeks. The one major waterway crossing will be at Boolgeeda Creek.

4.6.4 White Quartz Road

Most of the White Quart Road is reasonably flat and crosses ephemeral drainage lines ranging from event-drainage a few metres wide to larger seasonal drainages. The topography becomes mild to moderate as the road approaches the mining area.

4.7 Hydrogeology

4.7.1 Investigations Undertaken

Groundwater conditions in the BS4 Project area were extensively investigated by Aquaterra through 2003-2005 (Aquaterra, 2005). Investigations involved geological studies, drilling, aquifer testing and the development of a numerical (computer) model of the groundwater system. Thirty-two bores were drilled and constructed in 2004, with hydraulic testing having been completed on the majority of these. In addition, water level information has historically been collected from over 100 mineral exploration bores in the general area. The studies focused on:

- Developing an understanding of the regional groundwater system;
- Assessing the sustainability and associated impacts of groundwater abstraction to meet Project water demands; and,
- Assessing the requirements for mine dewatering to allow full development of the mineral reserves and assessing the associated impacts on the regional groundwater system.

The results of these studies are summarised in the following sections. A copy of the BS4 Project's hydrogeological report is given in **Appendix C**.

4.7.2 Aquifer Hydraulics

In the BS4 Project area, aquifers are associated with basement rocks and estimates of hydraulic conductivity are low (ranging between 0.001 m/d and 1 m/d). Aquifers are generally confined, with water levels in bores rising significantly above the depth at which water was intersected during drilling. The exceptions to the generally low permeability are: i) the dolomite of the Wittenoom Formation, which strikes in parallel with the regional geological structural trend south of the orebody, and which exhibits high permeability (around 5 m/d); and, ii) the orebody aquifer that is a high permeability unconfined aquifer (around 6 m/d). Only the orebody and dolomite aquifers offer any significant groundwater development potential within the immediate vicinity of BS4.

4.7.3 Groundwater Levels and Flow

Outside the mine area, groundwater flow in the BS4 Project area occurs from the upper reaches of the Brockman Syncline in a broadly south-west direction along the Boolgeeda Creek valley. The depth to water across the Project area varies between 7 mbgl and over 100 mbgl. Groundwater levels range from between 491.25 mAHD and 527.80 mAHD in the east and north to 488.74 mAHD and 503.93 mAHD in the west and south.

Groundwater gradients along the Boolgeeda Valley are around 0.003 with a broad south-westerly orientation. Flow converges on the BS4 ridge between the Western and Central deposits and then occurs to the south along the regional fault zone and into the Beasley River catchment. Groundwater gradients through this fault zone are much lower, suggesting an increase in permeability along the structure. Flow in the valley south of the orebody similarly converges on the fault zone between the western and central deposits (see **Figure 13**).

A key feature of the groundwater flow system is that flow does not follow the current course of Boolgeeda Creek, flowing instead through a gap in the BS4 ridge to the south, into the Beasley River system. It is believed that during the early to middle Tertiary, the ancestral Beasley River drained the upper catchment of the Boolgeeda Valley. Outcrops of pisolite mesa crossing the floor of the Boolgeeda valley mark the ancestral river course. Based on the trend of these pisolite mesas, the paleo-flow direction was to the south through the gap in the BS4 ridge, aligned with the regional fault between the Central and Western deposits where there is now a saddle in the ridge. The remnant pisolite in the Boolgeeda Valley may have been contiguous with the Beasley River Limonite further south (an extensive pisolite mesa).

4.7.4 Groundwater Quality

The quality of groundwater in the BS4 area ranges from fresh to slightly brackish. The salinity of the groundwater increases in a downstream direction along the flow direction, associated with mineral dissolution during increasing aquifer residence times. In the Boolgeeda Valley groundwater system, salinity ranges between 180 mg/L upstream and 1,400 mg/L downstream. In

the orebody and dolomite aquifers, salinity ranges between 500 mg/L upstream and 700 mg/L downstream.

Groundwater levels show that water from the Boolgeeda Valley and the valley to the south of the orebody flow to the south through the main fault zone running between the Western and Central deposits. Where water from the two flow systems mixes, a 'shandy' is produced comprising higher salinity groundwater from the Boolgeeda Valley (up to 1,400 mg/L) and fresher groundwater from the orebody/south valley (700 mg/L). The salinity of this shandy, as measured in a bore at the outflow from the BS4 area into the Beasley River catchment, is 980 mg/L.

In general, groundwater in the BS4 area is of an intermediate chemical type with no dominant cations or anions. The results for major ion analysis for water samples collected from bores is provided in **Table 4-4**.

Table 4-4 Groundwater Quality Analysis

Bore	Cations					Anions				WQ Data		
	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	Fe mg/L	CO_3 mg/L	HCO_3 mg/L	SO_4 mg/L	Cl mg/L	PH mg/L	EC mg/L	TDS mg/L
PZ02	94.0	7.7	29.0	27.0	0.1	5.0	200.0	45.0	110.0	8.5	800.0	520.0
PZ03	80.0	9.6	32.0	30.0	0.4	0.0	200.0	58.0	96.0	8.2	720.0	400.0
PZ04	18.0	5.6	10.0	7.9	0.1	0.0	95.0	5.0	13.0	8.0	200.0	180.0
PZ05	150.0	9.7	120.0	120.0	0.1	5.0	310.0	480.0	230.0	8.4	1900.0	1400.0
PZ06	150.0	17.0	74.0	81.0	0.1	1.0	330.0	140.0	280.0	8.3	1600.0	980.0
PZ07	79.0	130	60.0	39.0	0.0	3.0	210.0	58.0	160.0	8.3	980.0	540.0
PZ09	140.0	11.0	41.0	61.0	0.2	6.0	320.0	74.0	220.0	8.5	1300.0	710.0
PZ10	220.0	17.0	39.0	57.0	0.5	7.0	350.0	100.0	280.0	8.5	1700.0	930.0
PZ12	370.0	19.0	47.0	74.0	0.1	10.0	430.0	160.0	450.0	8.6	2400.0	1400.0
PZ18d	140.0	13.0	52.0	72.0	0.0	7.0	310.0	120.0	260.0	8.5	1600.0	830.0
PZ18s	140.0	13.0	48.0	72.0	0.1	3.0	310.0	110.0	250.0	8.4	1500.0	820.0
PZ19	130.0	14.0	52.0	67.0	0.0	5.0	290.0	100.0	250.0	8.4	1500.0	840.0
PZ20	140.0	16.0	54.0	77.0	0.1	5.0	320.0	120.0	260.0	8.4	1600.0	840.0
PZ24	140.0	13.0	65.0	56.0	0.0	0.0	320.0	160.0	180.0	7.6	1400.0	780.0
PZ25	100.0	3.2	100.0	73.0	0.1	5.0	340.0	190.0	180.0	8.4	1500.0	950.0
PZ26	180.0	16.0	46.0	74.0	0.1	5.0	270.0	200.0	220.0	8.4	1500.0	900.0
PZ29	110.0	15.0	52.0	48.0	0.0	5.0	200.0	73.0	240.0	8.4	1300.0	670.0
PZ30	80.0	13.0	57.0	47.0	0.0	7.0	210.0	59.0	170.0	8.6	1000.0	610.0
PZ31	83.0	12.0	46.0	44.0	0.0	5.0	210.0	59.0	180.0	8.4	1100.0	620.0
PZ32	150.0	14.0	45.0	64.0	0.0	5.0	280.0	200.0	210.0	8.4	1500.0	920.0
PZ34	110.0	12.0	58.0	57.0	0.0	5.0	220.0	76.0	250.0	8.5	1300.0	780.0
WB14	85.0	7.2	43.0	47.0	0.0	0.0	260.0	77.0	140.0	8.0	1000.0	660.0
WB17	75.0	9.8	33.0	40.0	0.0	0.0	130.0	55.0	160.0	7.7	890.0	500.0
WB18	140.0	19.0	55.0	75.0	0.0	0.0	340.0	110.0	260.0	7.9	1600.0	920.0

4.7.5 Groundwater Recharge and Discharge

Groundwater recharge rates are considered to be relatively low, and active recharge is principally limited to the main creek channels and the orebody itself. Based on the observed groundwater levels and water chemistry in the area, average annual recharge is estimated to be less than 1 % of the rainfall volume falling over the catchment.

There is no indication of shallow water table aquifers within the BS4 Project area. Consistent with this, zones of phreatophytic vegetation and evapotranspiration from groundwater-dependent vegetation are likely to be negligible. All groundwater discharge occurs as subsurface outflow, predominantly to the south into the Beasley River catchment, although there may also be a component of flow that continues west along the Boolgeeda Valley.

4.7.6 Orebody Hydrogeology

Water table elevations range between 517 mAHD and 501 mAHD in the Eastern Deposit and between 495 mAHD and 490 mAHD in the Central and Western Deposits; the associated depth to water varies with topographic elevation, ranging between 30 and 100 m below ground level.

Water table gradients are generally flat through the orebody (0.001 or less); however, some abrupt changes in elevation occur either side of structural features, such as dolerites and faults (e.g. in the Eastern Deposit, water levels drop by almost 20 m across the dolerite sill that dissects the northern half of this deposit). These abrupt changes in water table elevation indicate that some degree of hydraulic compartmentalisation occurs within the orebody aquifer. During pumping tests on orebody-bores, the influence of low permeability boundaries to the orebody was noted in the hydraulic response, suggesting the orebody has poor hydraulic connection with the surrounding regional system, being isolated by low permeability un-mineralised BIF, shale and dolerite.

4.8 Vegetation and Flora

Biota Environmental Sciences conducted extensive flora and vegetation surveys of the BS4 Project area, with the most recent survey being conducted in October 2004 (Biota, 2005a). A copy of Biota's report from this survey is provided in **Appendix D**, and the key findings are summarised below.

At the time the original flora surveys were undertaken, the preferred route for the rail spur and road access had not been finalised. As a result, detailed searches for Declared Rare Flora (DRF) and Priority species in these areas were not conducted. These routes have now been determined, with Biota now undertaking DRF and Priority flora survey work. It is anticipated that the additional surveys will be completed in October/November 2005. Once this work is finalised, Hamersley Iron will forward the resultant reports to the EPA and CALM, and any other interested stakeholders upon request.

Given the current known distribution of threatened flora in the BS4 Project area, and the likelihood of being able to re-route rail spur and other linear infrastructure within their respective corridors if necessary, the risk of a DRF species being found by the additional flora surveys, and this species being impacted, is considered very low.

4.8.1 Regional Vegetation

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The BS4 Project lies within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by Spinifex (*Triodia* spp), wattles (*Acacia* spp) and occasional eucalypts. According to Beard's mapping, there are predominantly two main vegetation associations in the BS4 Project area:

- Snappy Gum *Eucalyptus leucophloia* scattered trees over *Triodia wiseana* hummock grassland on the hills of the BS4 range and the stony undulating plains of the transport corridor; and,
- An area of Mulga *Acacia aneura* continuous low woodland in the broad stony plain to the north of the BS4 range.

Given the coarse scale of Beard's mapping, these mapping units show only a broad correspondence with the vegetation types identified by the current botanical study of the BS4 Project area (Biota, 2005a).

A number of broad-scale botanical surveys have been conducted in the vicinity of the BS4 Project area due to Hamersley Iron's mining and exploration activities, in particular the Brockman 2, Nammuldi, Silvergrass and Mt Tom Price operations and development areas over the last 18 years. Surveys to date have found the main vegetation types within the BS4 Project area are widespread, with the exception of the vegetation in the valley south of the main ridge, associated with Priority 1 flora (Biota, 2005a).

4.8.2 Vegetation Condition

The BS4 Project area has been extensively grazed for over 100 years, by sheep and more recently by cattle. Grazing as well as periodic wild fires (from lightning strikes) and historic exploration activities in the area have adversely impacted on flora and vegetation health over time in some areas. The extent of managed grazing and mustering of cattle in the immediate BS4 Project area is now limited.

The vegetation types of the low stony hills habitats are generally in very good to excellent condition. Several creeklines in the western section of the main BS4 Project area are substantially degraded by invasion from Buffel Grass, and are also subject to some grazing and trampling by cattle.

4.8.3 Vegetation Communities

Fifty-three (53) broad vegetation types were identified in the BS4 Project area (refer to **Figures 14a** and **14b**). These vegetation types were located within the following three main habitat types:

- Vegetation of stony hills;
- Vegetation of plains; and
- Drainage vegetation.

4.8.4 Vegetation of Conservation Significance

Of the 53 vegetation types identified in the BS4 Project area, none are listed as Threatened Ecological Communities by CALM. However, a number of vegetation types are considered to be ecosystems at risk, principally from grazing and trampling by stock, weed invasion and large fires (Kendrick, 2001).

PATN analysis (i.e. clustering analysis) was used in the identification of potentially restricted vegetation types in the BS4 Project area. The analysis identified one vegetation type to be of 'high' conservation significance, and a further 18 vegetation types to be of 'moderate' conservation significance (**Table 4-5**). The remainder of the vegetation types identified are considered to be of 'low' conservation significance, representing units that are likely to be widely distributed and relatively well represented in the Hamersley Range subregion.

It is unlikely that all of these vegetation types are genuinely restricted in the Pilbara region. The current analysis was limited by a lack of additional sites in comparable habitats in the Brockman – Tom Price locality outside of the immediate BS4 area. It is anticipated that a second PATN analysis, planned for October/November 2005, will further clarify the floristic groups identified by the current study (Biota, 2005a). The potential impacts on these vegetation types are considered in **Section 7.2**.

- **Table 4-5 Vegetation types of High and Moderate conservation significance in the BS4 Project area**

Vegetation Type	Level of Conservation Significance	Area (ha) within BS4 Project (% of vegetation type to be impacted by the Project)	Description
P11	High	80.1 (0.0)	Does not belong to a restricted floristic group, but is the main associated vegetation type for the Priority 1 flora *Ptilotus* sp Brockman.
H10 H11 H12 H13 H16	Moderate	138.2 (17.5) 4.8 (23.3) 14.3 (62.1) 0.6 (25.2) 6.9 (30.6)	Floristic group apparently restricted in the region, and gorge habitat (while not uncommon) has a limited area of extent in the Brockman locality.
P1	Moderate	46.4 (1.8)	Does not belong to a restricted floristic group, however floristically similar Mulga woodlands in drainage habitats appear to be uncommon in the region.
P2 P3 P8 P9 P10	Moderate	15.8 (62.1) 449.3 (9.2) 16.6 (0.0) 73.4 (4.6) 292.1 (12.0)	Belong to floristic groups that are apparently not widespread in the region, and habitats are likely to have a relatively limited distribution in the Brockman area.
C1 C2 C3 C18	Moderate	184.8 (0.7) 562.0 (0.6) 16.9 (2.3) 42.9 (0.0)	Vegetation of major creeklines in the BS4 area; C2 and C3 occur within a floristic group that does not appear to be widespread in the region.
C6	Moderate	1.3 (0.6)	Vegetation with unusual floristic composition that is likely to have a restricted distribution in the region.
C17 C20	Moderate	18.9 (0.3) 13.3 (18.5)	No sites were assessed in these vegetation types, however these Mulga shrublands are unlikely to be widespread in the region.

Ref: Biota (2005a)

4.8.5 Terrestrial Flora

A total of 367 taxa of native vascular flora from 149 genera belonging to 52 families were recorded from the BS4 Project area. In addition, six species of introduced flora were recorded. These native vascular flora and introduced flora species are listed in **Appendix D**.

The families with the greatest number of native flora taxa within the BS4 Project area were those also found in the dominant vegetation types of the Pilbara region generally. The families best represented were Poaceae (grasses; 46 taxa), Malvaceae (hibiscus; 37 taxa), Mimosaceae (wattles; 31 taxa), Amaranthaceae, Caesalpiniaceae, Asteraceae, Papilionaceae, Chenopodiaceae, Goodeniaceae, Myrtaceae and Euphorbiaceae. The best represented genera were *Acacia*, *Cassia*, *Ptilotus*, *Sida*, *Hibiscus*, *Goodenia*, *Abutilon* and *Eremophila*.

4.8.6 Flora of Conservation Significance

While all native flora are protected under the Wildlife Conservation Act 1950, some species are assigned an additional level of conservation significance based on the number of known populations and the perceived threats to these populations (**Table 4-6)**. Species of the highest conservation significance are designated DRF. Species that appear to be rare or threatened, but for which there is insufficient data to properly evaluate their conservation significance, are assigned to one of four Priority flora categories by CALM.

- **Table 4-6 WA categories of conservation significance for flora species**

Category	Description
DRF - Extant Taxa	Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction or otherwise in need of special protection.
DRF - Presumed Extinct	Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
Priority 1	Taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under threat.
Priority 3	Taxa which are known from several populations, at least some of which are not believed to be under threat.
Priority 4	Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Ref: Atkins, 2005

A search of CALM's Threatened (DRF) and Priority flora database and the WA Herbarium Specimen database was carried out for an area that incorporated the BS4 Project. This search yielded 88 records of 37 Priority species; however, only seven records (comprising four species) occurred within 10 km of the BS4 Project area, and only one record within the BS4 Project area. This latter record was a location for the Priority 1 *Ptilotus* sp Brockman (E Thoma & A Joder ET & AJ 145), which was submitted by Hamersley Iron after the discovery of this species in the valley south of the BS4 mine area during standard DRF surveys in advance of evaluation drilling (see **Plate 4-1**).

Records of specimens from the other three Priority flora occurring within 10 km of the BS4 Project area are:

- *Tephrosia* sp Cathedral Gorge (F.H.Mollemans 2420) (Priority 3) – two records from ~9 km east-north-east and ~10.5 km north-north-west of the northern end of the rail corridor;
- *Triumfetta leptacantha* (Priority 3) – two records from ~1.5 km north and ~6 km east of the northern end of the rail corridor; and,
- *Goodenia stellata* (Priority 4) – two records from ~7 km east-north-east and ~8.5 km north of the northern end of the rail corridor.

Six Priority flora were recorded during surveys in 2003 (Thoma and Joder, 2003) and 2004 (Biota, 2005a) of localities within and around the BS4 Project area (**Table 4-7**). These flora species are discussed below.

- **Table 4-7 Priority flora identified within and just outside the BS4 Project area**

Species	Number of Records within BS4 Project Area (Number in Vicinity)
Priority 1	
Ptilotus sp Brockman (E Thoma & A Joder ET & AJ 145)	31 (13)
Priority 3	
Abutilon trudgenii ms	8 (9)
Phyllanthus aridus	1 (0)
Sida sp Wittenoom (WR Barker 1962)	8 (12)
Priority 4	
Eremophila magnifica subsp *magnifica*	25 (0)
Goodenia stellata	0 (1)

(a)

(b)

- **Plate 4-1 *Ptilotus* sp Brockman – (a) habit (shown to right of a spinifex hummock for scale); and (b) flowering branchlets. (Source Biota, 2005a)**

Ptilotus sp Brockman (E Thoma & A. Joder ET & AJ 145) (Priority 1)

This species was first collected during a flora study of the BS4 Project area conducted in 2003 by Hamersley Iron. The WA Herbarium is currently conducting a formal description of this species.

Ptilotus sp Brockman is distinctive in both habit and floral characters. This species has a particular floral character (an elongated staminal cup) that is shared by only one other species in this genus, although it is common within the closely related genus *Gomphrena*.

Within the BS4 Project area, a large population of *Ptilotus* sp Brockman occurs within the depositional valley between the BS4 mine area and the range of hills along the southern edge of the Project area (see **Figure 15**). Thirty-one separate records of this species were made in this area, however the population is essentially continuous. This population is located along the southern

edge of the Central Lens, however this is outside the active mining area and there is not expected to be any disturbance of this population as a result of mining activities. .

Ptilotus sp Brockman has also been located outside the BS4 Project area, and recent recordings made by Hamersley Iron personnel include:

- Three records from the calcareous stony plain immediately west of the BS4 Project area;
- Two records immediately south of the BS4 Project area, in the area referred to by Hamersley Iron as the 'Beasley River area'; and,
- Eight records to the east of the BS4 Project area along the White Quartz Road (the access road between Tom Price and BS4), extending over some 19 km.

The populations along the White Quartz Road in particular are very large, estimated at 2,000 – 3,000 individuals (Emil Thoma, Hamersley Iron, pers comm). It is not yet known whether the three areas from which this species has been recorded support genetically distinct populations.

The distribution of this species could not be correlated with any particular Land System as it was recorded from the Robe, Newman and Rocklea Land Systems. However, it appears to be associated with fine silt/clay substrate with *Triodia angusta* and/or *Triodia longiceps* hummock grasslands.

Abutilon trudgenii ms (Priority 3)

This low shrub species has a relatively straggly habit and tends to occur in recently burnt areas. Both factors are likely to account for it being poorly collected in the past, however it is now recorded routinely on surveys in the Hamersley Range.

Abutilon trudgenii is widespread through the Hamersley and Chichester subregions of the Pilbara bioregion. Specimens are lodged at the WA Herbarium from Cane River, Hillside Station, Goldsworthy and Tom Price. According to the Priority flora species list, this species is also known from other locations including Warralong, Woodstock, Point Sampson, Karratha and Pannawonica (Atkins, 2005).

It has also been recorded from Yanrey Station on the eastern side of the Exmouth Gulf (M Maier, pers obs), west of Dampier (Halpern Glick Maunsell 2000), south-southeast of Port Hedland (Trudgen *et al*., 2002), 23 times by Trudgen and Casson (1998) during the West Angelas surveys, seven times during the initial survey of the Hope Downs rail corridor (Biota and Trudgen, 2002), once during the survey for the Hope Downs rail corridor Hamersley Range Extension (Biota, 2004a), three times during the survey of the FMG Stage A rail corridor between Port Hedland and Mindy Mindy (Biota, 2004b) and four times from the FMG Stage B rail corridor and mine areas (Biota, 2004c). This species is considered to warrant removal from the Priority flora listing.

There were several records of *A. trudgenii* from the BS4 Project area, mainly from the broad clayey plains on the northern side of the BS4 mine area (**Figure 15**), and a similar number of records were also made outside the Project area.

Phyllanthus aridus (Priority 3)

This annual herb is infrequently recorded in the Pilbara, typically from creek lines but also occasionally from rocky outcrops. It is likely to be poorly collected due to its inconspicuous habit.

Three individuals of *P. aridus* were recorded from the broad gravelly bed of Boolgeeda Creek. This species may well occur more widely in this habitat.

Sida sp Wittenoom (WR Barker 1962) (Priority 3)

This low to moderate-height shrub species is similar in appearance to a more common species, *Sida echinocarpa* and also to *A. trudgenii*. It is believed that *Sida* sp Wittenoom has been poorly collected in the past but is now recorded frequently during surveys in the Hamersley Range. This species is widespread throughout the Pilbara bioregion, occurring in both the Hamersley and Chichester subregions.

This species was recorded eight times from the BS4 Project area and twelve times in the vicinity, and tended to occur as scattered individuals, often together with *A. trudgenii*, and was most frequently recorded on the clayey plains north of the BS4 range.

Eremophila magnifica subsp *magnifica* (Priority 4)

This moderate-height shrub was recorded 25 times from the BS4 Project area. All records were from the stony hillslopes associated with Mt West, which is typical habitat for this species. The population located within the footprint of the West Pit and adjacent waste dump will be impacted. *Eremophila magnifica* subsp *magnifica* is distributed through the central-eastern Hamersley Ranges.

Goodenia stellata (Priority 4)

This small perennial herb is known from numerous populations in the Hamersley Range subregion, where it typically occurs within relatively dense hummock and tussock grasslands on clayey substrates in drainage areas.

G. stellata was recorded from a single creek line west of the BS4 Project area, where it was associated with *Acacia citrinoviridis*, *Chrysopogon fallax* and *Corymbia hamersleyana*. It is possible that it may occur within the *Acacia citrinoviridis* creeklines in the western section of the Project area, but targeted searches have not recorded it to date.

Two species of special interest were also collected from the BS4 Project area:

- *Indigofera monophylla* (BRO46-12) - a tall shrub (to 1.5 m in height) that was associated with creek lines. This taxon was recorded from five locations associated with Boolgeeda Creek, and one location in the moderate-sized creek at the western end of the BS4 Project area.
- Malvaceae family - The Malvaceae family in the Pilbara contains numerous undescribed taxa, many of which are poorly collected. The taxon *Sida* sp, which was recorded from a single gully (vegetation type H11) in the southern half of the transport corridor, appears to be a new entity that has not been previously collected.

4.8.7 Introduced Flora Species

Six species of introduced flora were recorded from the BS4 Project area. None of these are listed as Declared Plants for the Pilbara under the Agriculture and Related Resources Protection Act 1976, and are largely common and widespread species of the Pilbara region. The species are:

- Buffel Grass *Cenchrus cilliaris*;
- Birdwood Grass *Cenchrus setigerus;*
- Whorled Pigeon Grass *Setaria verticillata*;
- Spiked Malvastrum *Malvastrum americanum*;
- Beggars Ticks *Bidens bipinnata*; and,
- Ruby Dock *Acetosa vesicaria*.

The majority of these species were found in low-lying areas and ephemeral creek lines, which are habitats particularly susceptible to weed invasion.

4.9 Fauna

Comprehensive fauna surveys of the Project area were conducted by Biota Environmental Sciences in October 2004 and April 2005 (Biota, 2005b). The results are summarised below, with a copy of the full report given in **Appendix E**. Comprehensive annotated lists of all species recorded during the survey, including details of voucher specimens lodged with the WA Museum, are included in the report. **Figures 14a** and **14b** show the location of the fauna trapping sites (e.g. 'BRO10', 'BROMD').

4.9.1 Fauna Habitats

Fauna habitat classification was developed on the basis of the dominant landform and vegetation type. Five primary habitats were identified within the BS4 Project area, with these being largely based on vegetation structure and landforms as follows:

- Creeklines – comprising minor drainage lines to wide flood channels with *Acacia* shrubland over *Triodia epactia* (Sites BRO10, BRO25, BRO32, BRO46A, BROF, BROSB).
- Mulga – Dense *Acacia aneura* over *Triodia epactia* and *T. wiseana* on drainage within plain (Sites BROMD, BRO04).
- *Acacia* over *Triodia* – situated on stony soils (Sites BRO30, BRO36, BRO37), situated on soft soil in a wide valley (Site BRO13A).
- Gorge – gorges associated with the ore body (Sites BRO13E, BRO25E).
- *Triodia* hilltop – site towards the top of the hills on the ore body (Site BROHT).

Key habitats in the BS4 Project area comprised those habitats that supported taxa with potentially narrow distributions e.g. mulga woodland (vegetation type P1) in the vicinity of Site BROMD and habitats of the Table Land System comprising calcareous outcrops and soils. Calcrete outcroppings have been identified as being of conservation importance for stygal, troglobitic and land snail communities.

Indicative areas of the fauna habitats within the BS4 Project area are given in **Table 4-8**.

Table 4-8 Area of fauna habitat types that would be impacted by the BS4 Project

Fauna habitat (Associated Vegetation Codes)	Total area mapped within Project area (ha)	Indicative area to be impacted (ha)	% of total area to be impacted
Creeklines (all C-prefixed vegetation types)	1301	53	4
Mulga shrublands (vegetation types P1 to P5)	715	107	15
Acacia over Triodia on plains (all vegetation types P6 to P16)	5523	818	15
Mulga shrublands/Acacia over Triodia on plains (mosaic mapping unit of vegetation types P3/P6)	798	146	18
Gorges (vegetation types H10 to H13 and H16)	169	37	22
Triodia hilltops (vegetation types H1 to H9, H14 and H15)	3262	965	30
Triodia hilltops/Gorges (mosaic mapping unit of vegetation types H2 and H16)	43	32	75

Ref: Biota (2005b)

4.9.2 Vertebrate Fauna

Herpetofauna

Fifty-six species of herpetofauna (two frogs and 54 reptiles) were recorded from the BS4 Project area during the fauna surveys.

The reptiles comprised five species of Agamidae (Dragon Lizards), 11 species of Gekkonidae (geckos), five species of Pygopodidae (Legless Lizards), 18 species of Scincidae (skinks), seven species of Varanidae (Goannas), two species of Typhlopidae (blind snakes) and six species of Elapidae (front-fanged snakes). The most abundant group encountered was the geckos with 368 records, comprising 48 % of all the herpetofauna records for the survey. The most common reptile species was the gecko, *Diplodactylus stenodactylus*, with 140 occurrences comprising some 40 % of all gecko records.

The frog species recorded were Main's Frog, *Cyclorana maini* and the Desert Tree Frog *Litoria rubella*.

Ground Mammals

A total of eight native and five introduced ground dwelling mammals were recorded in the BS4 Project area. These comprised two carnivorous marsupials, two kangaroos, five rodents, and one each of a dingo/dog, feral cat, donkey and horse.

The Muridae (rodent) and the Dasyuridae (carnivorous marsupial) families were the most well represented of the mammal species, with a total of 20 and 30 records for each family respectively. The ground mammal assemblage was considered poor, likely due to hot conditions during both surveys, and it is expected that additional species occur in the BS4 Project area.

Bats

Seven species of bats from three families were identified from 130 bat call sequences recorded in the BS4 Project area.

The taxa identified were *Taphozous georgianus* (Common Sheathtail-bat), *Chalinolobus gouldii* (Gould's Wattled Bat), possibly *Nyctophilus arnhemensis* (Arnhem Land Long-eared Bat), *Scotorepens greyii* (Little Broad-nosed Bat), *Vespadelus finlaysoni* (Finlayson's Cave Bat), *Tadarida australis* (White-striped Freetail-bat) and *Mormopterus loriae* (Little Northern Freetail-Bat). These species represent the three families; Emballonuridae, Vespertilionidae and Mollosidae.

Avifauna

A total of 83 bird species representing 25 families were recorded in the BS4 Project area. The most abundant and widespread species was the Zebra Finch (*Taeniopygia guttata castanotis*), (Passeridae Family), with a total of 2,051 records representing 37 % of all records for the survey. The next two most commonly noted species were recorded with similar abundances, the Weebill (*Smicrornis brevirostris*) (Acanthizidae Family) (431 records) and Budgerigar (*Melopsittacus undulates*) (Psittacidae Family) (304 records), representing 8 % and 5 % of all records respectively. The most abundant group of birds recorded were the honeyeaters (Meliphagidae Family) with nine species present representing 12 % of all records for the survey.

Breeding records were noted for three species; Zebra Finch (*Taeniopygia guttata castanotis*), the Ground Cuckoo-shrike (*Coracina maxima*) and the Cockatiel (*Nymphicus hollandicus*).

4.9.3 Invertebrate Fauna

Over 100 invertebrate taxa were recorded during the fauna surveys. Many of these were not identified beyond family level and are not discussed in Biota (2005b). Only those taxa belonging to groups known to include short-range endemics (e.g. Mygalomorph spiders, millipedes, land snails (see Harvey 2002)), that were otherwise of conservation significance (e.g. Buprestidae Jewel Beetles) or for which expertise was readily available at the WA Museum (e.g. pseudoscorpions, wolf spiders and other spider groups) were identified to genus or species level.

Short Range Endemics

The EPA's Guidance Statement on Terrestrial Fauna Surveys (EPA, 2004b) requires that potential impacts on the conservation of short range endemic fauna be considered. Short range endemics are more common among invertebrates than vertebrates. Invertebrate groups of interest were targeted for survey in the BS4 Project area. The invertebrate groups selected for survey were identified by the WA Museum as potentially supporting narrow range taxa.

Three key groups of invertebrates potentially supporting narrow range taxa were identified:

- Diplopoda (millipedes) – three taxa;
- Pulmonata (land snails) – four taxa; and,
- Mygalomorphae (trapdoor spiders) – two taxa.

Millipedes

In general, this group is poorly studied taxonomically (Harvey, 2002) and poorly collected (Harvey, 2002; Hoffman, 2003). With the exception of the pin-cushion millipedes that have been collected from a number of localities including Barrow Island, near Fortescue Marshes, West Angelas and Yandicoogina, millipedes of other types are rarely collected in the Pilbara.

A juvenile Polydesmida sp was collected from the BS4 Project area (Site BRO936) during the October 2004 survey phase, however it could not be identified beyond family level.

Two additional millipede taxa were recorded from along the White Quartz Road during the April 2005 survey phase. Both taxa have been lodged with the WA Museum and are awaiting identification. Given the narrow, linear nature of the proposed upgrade to the White Quartz Road, it is unlikely that the proposed development would alter the conservation status of the millipede taxa recorded, as it would probably intersect and partially affect any existing populations (rather than completely removing them).

Terrestrial Molluscs (Land Snails)

In Western Australia there are 230 described terrestrial mollusc taxa with 201 of these restricted to this State (Ponder, 1997). Within the Pilbara bioregion, the most conspicuous elements of this fauna are the *Rhagada* and *Quistrachia* spp (Camaenidae), though several *Bothriembryon* spp (Bulimulidae) are known.

Four species of land snail were recorded during the BS4 fauna surveys: *Rhagada* sp "Mt Brockman"; *Quistrachia* sp?; a subulinid, possibly of the genus *Eremopeas*; and, a pupilid land snail. All of these have been lodged with the WA Museum. **Figures 14a** and **14b** show where land snails were identified within the BS4 mine and rail spur corridor areas; Figures 5.1 and 5.2 in **Appendix E** show where land snails were recorded outside these areas.

During the April 2005 survey phase, *Rhagada* sp. "Mt Brockman" was searched for within and outside of the BS4 Project area.

Rhagada sp "Mt Brockman"

Currently no mainland *Rhagada* species are known to have overlapping distributions. On the basis of distribution, the specimens collected from the BS4 Project area would be expected to be *R. radley*i. However, the specimens collected in the BS4 Project area differ from the description of *R. radleyi* on at least two key external features, size and umbilicus opening. Given this, the *Rhagada* sp collected during the BS4 fauna surveys may represent an undescribed or new taxon (currently termed '*Rhagada* sp "Mt Brockman"').

Rhagada sp "Mt Brockman" was collected at five fauna sampling sites in the BS4 Project area within the mine and rail spur corridor areas, and from five sites along the White Quartz Road. Although all the collection sites were either outside of, or immediately adjacent to, proposed impact areas, it is likely that *Rhagada* sp "Mt Brockman" would also occur inside the area to be impacted.

Live *Rhagada* sp "Mt Brockman" were excavated from the top five cm of soil at the confluence of the stems of large *Triodia* bushes across two vegetation types:

- *Acacia aff. aneura, A. ayersiana, Acacia tetragonophylla* tall shrubland over *Eremophila forrestii, Acacia bivenosa* shrubland over *Triodia epactia* mid-dense hummock grassland.
- *Eucalyptus leucophloia* scattered low trees over *Acacia aneura* (various forms), *A. ayersiana* tall open shrubland over *Triodia epactia, T. wiseana* mid-dense hummock grassland.

There is an outcropping of calcrete in the north western edge of the BS4 Project area coinciding with the Table Land System that may be an important habitat to this and other land snail taxa.

Additional fauna surveys around Pannawonica, located approximately 140 km north-west of the BS4 Project area, recorded 180 live land snail (from 19 sites) that resemble *Rhagada* sp "Mt Brockman" on the basis of shell morphology. Resolution of this apparent similarity is awaiting completion of molecular studies (for more details see **Appendix E**).

Quistrachia sp?

The single *Quistrachia* shell collected was too damaged to identify beyond genus. The single specimen was collected from the BROF fauna sampling site (see **Figure 14a**) in a broad valley intersected by the proposed transport corridor. As with *Rhagada* sp, none of the described *Quistrachia* have overlapping distributions, however, they are not as well collected as *Rhagada* (Solem, 1997). According to Solem (1997), no *Quistrachia* has been collected from the vicinity of the BS4 Project area, although an as yet undescribed taxon was collected from Marandoo in 1976 (Solem, 1997).

Subulinidae

The one land snail recorded the fauna surveys from the family Subulinidae has been tentatively identified by the WA Museum as a subulinid, probably belonging to the genus *Eremopeas*, and to the species *E. interioris*. However, the final identification of this specimen can not be resolved until the relocation of the WA Museum is completed.

Pupoides

One species of land snail of the family Pupillidae was collected from the BS4 Project area during the fauna surveys. Preliminary identification suggests that the specimens belong to the taxon *Pupoides* aff *beltaianus* (Solem, 1986). The taxonomic status of this taxon remains unresolved. If it is conspecific with *Pupoides beltaianus* from central Australia then it has a very broad

distribution. If it is not conspecific, then the distribution extends from the northern Pilbara through to Shark Bay (Solem, 1986).

Mygalomorph Spiders

A single mygalomorph spider was collected from site BRO32 during the first survey phase (October 2004). This specimen was unable to be identified as it represented a dispersing juvenile female.

During the April 2005 survey, a further four male mygals from the genus Aname (family Nemesiidae) were collected. Based on an examination of key features, these all appear to represent the same taxon. In addition, a single male from the genus Synothele (family Barychelidae) was recorded.

Other Invertebrates

Spiders

The fauna surveys recorded 15 families of Araneomorph spiders. These specimens have been identified to morpho-types, and are awaiting confirmation by the WA Museum.

Scorpionida

Three taxa of scorpions were collected from the BS4 Project area during the fauna surveys, all from the family Buthidae. According to Dr Harvey from the WA Museum they comprise possibly two species from the genus *Isometroides* and one species from the genus *Archisometrus*.

Pseudoscorpionida

Pseudoscorpion taxonomy is currently being investigated by Dr Harvey of the WA Museum. Two species of pseudoscorpions from two families were collected during the current survey. Individuals of the Olpiidae family were collected from beneath rocks at BRO13E and BROF and possibly belong to the genus *Xenolpium*. One species of *Garypidae pseudoscorpion* belonging to the genus *Synsphyronus* and of the *paradoxus* species group was collected from beneath bark of *Corymbia hamersleyana* at BRO936. It represents an undescribed *Synsphyronus* that may have been collected previously from the Mt Brockman area.

4.9.4 Stygofauna

Stygofauna is a general term used to describe the obligate subterranean fauna occurring in groundwater (Humphreys, 2000). These animals tend to be highly specialised inhabitants of subterranean groundwater and may be restricted spatially in distribution (Watts and Humphreys, 1999). The occurrence of stygofauna in the Pilbara region appears to be related to certain geology types and hydrological regimes (HDMS, 2002). Stygofauna are known to be present in a variety of rock types, primarily karst (limestones, calcretes) and other porous stratigraphies (e.g. alluvium and gravels) (Marmonier *et al*., 1993) but have also been recorded in non-calcrete aquifers in the East Pilbara. Recently stygofauna have also been found inhabiting aquifers associated with Marra Mamba, karstic dolomite and shear zones in Jeerinah dolerite.

Two field surveys were conducted to sample for stygofauna in the BS4 Project area. Boreholes were sampled in February 2005, and again in April 2005 (along with three new bores drilled in

February 2005). Stygofauna sampling was consistent with that outlined in EPA Guidance Statement Number 54 (EPA, 2003b). In February 2005 twenty-seven boreholes were sampled, five in "control" sites outside the proposed area of impact, and 22 within the proposed area of impact. Only one bore contained stygofauna and this was located approximately 2 km south of the proposed airstrip (see **Figure 2**). The single specimen from the control site was identified as a Bathynellid, in the Super-order Syncarida. The second phase of sampling (completed in April 2005) did not record any stygofauna from the BS4 Project area.`

The BS4 Project stygofauna sampling report is provided in **Appendix F**.

4.9.5 Threatened Fauna

Native fauna species that are rare, threatened with extinction or have high conservation value are protected by law under the Wildlife Conservation Act 1950. **Table 4-9** lists the classifications of rare and endangered fauna under the Wildlife Conservation (Specially Protected Fauna) Notice 2005 and Priority fauna categories recognised by CALM. In addition, the EPBC Act classifies threatened fauna species according to the categories 'Critically Endangered', 'Endangered', 'Vulnerable' or 'Conservation Dependent'.

Table 4-9 WA categories of conservation significance for fauna species

Category	Description
Schedule 1	Taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection.
Schedule 2	Taxa are fauna which are presumed to be extinct.
Schedule 3	Taxa are birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction which are declared to be fauna in need of special protection.
Schedule 4	Taxa are fauna that are in need of special protection, otherwise than for the reasons mentioned above.
Priority 1	Taxa with few, poorly known populations on threatened lands. Known from few specimens or sight records from one or a few localities on lands not managed for conservation.
Priority 2	Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands. Known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation.
Priority 3	Taxa with several, poorly known populations, some on conservation lands. Known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	Taxa in need of monitoring, and considered to have been adequately surveyed, or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5	Taxa in need of monitoring; are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Four Priority fauna species were recorded from the BS4 Project area. In addition, three Scheduled and four Priority species have either been historically recorded from, or are likely to occur in the BS4 Project area; two of these species are also listed fauna at the Federal level. One fauna species, the Northern Quoll, while not listed at the State level, is listed as 'Endangered' at the Federal level (see **Table 4-10**).

- **Table 4-10 Species of State and Federal level conservation significance recorded from, or likely to occur, within the BS4 Project area**

Species	Conservation Status	
	State Level	Federal Level
Northern Quoll *Dasyurus hallucatus*	-	Endangered
Night Parrot *Pezoporus occidentalis*	Schedule 1	Endangered
Pilbara Olive Python *Liasis olivaceus barroni*	Schedule 1	Vulnerable
Peregrine Falcon *Falco peregrinus*	Schedule 4	-
Spectacled Hare-wallaby *Lagorchestes conspicillatus leichardti*	Priority 3	-
Long-tailed Dunnart *Sminthopsis longicaudata*	Priority 4	-
Ghost Bat *Macroderma gigas*	Priority 4	-
Lakeland Downs Mouse *Leggadina lakedownensis*	Priority 4	-
Western Pebble-mound Mouse *Pseudomys chapmani**	Priority 4	-
Australian Bustard *Ardeotis australis**	Priority 4	-
Bush Stonecurlew *Burhinus grallarius**	Priority 4	
Notoscincus butleri *Notoscincus butleri**	Priority 4	-

* Denotes fauna species recorded during the BS4 Project fauna surveys. Ref Biota (2005b).

Northern Quoll *Dasyurus hallucatus* (Endangered)

The distribution of the northern Quoll is restricted to: the Hamersley Ranges and Kimberley in WA; the north and western top end of the Northern Territory; north of Cape York; Atherton-Cairns area; and, the Carnarvon Range-Bowen area of Queensland (Menkhorst, 2001). This species was not recorded during the BS4 Project area surveys, but was recorded by fauna surveys of the Nammuldi / Silvergrass areas, and is considered likely to occur in the BS4 Project area. The BS4 Project would not be expected to alter the conservation significance of this species in the Pilbara bioregion.

Night Parrot *Pezoporus occidentalis* (Schedule 1, Endangered)

The Night Parrot has been recorded from every state in inland Australia. This species was not recorded during the BS4 Project area surveys, and only a single record of this species from 1967 is recorded by CALM in the area. It is considered unlikely that this species occurs in the BS4 Project area, and is therefore unlikely to be impacted by the BS4 Project.

Pilbara Olive Python *Liasis olivaceus baroni* (Schedule 1, Vulnerable)

This subspecies has a known distribution that coincides roughly with the Pilbara bioregion (Environment Australia, 2000). This species was not recorded in the BS4 Project area, though suitable habitat for this species occurs within the area. There is some potential for habitat loss, and

possible direct mortality associated with construction of the rail spur; however, it is considered unlikely that the BS4 Project will affect the conservation status of this species.

Peregrine Falcon *Falco peregrinus* (Schedule 4)

This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country of the Pilbara. The availability of prey is apparently more important than habitat in determining its distribution. It was not recorded during the BS4 survey, but it is possible that this species could reside in the BS4 Project area, given that suitable prey species, such as parrots are common. This species has been recorded near Tom Price as well as within the Nammuldi-Silvergrass Project area 40 km to the north of the BS4 Project area (Biota, pers comm). Whilst its status is difficult to determine in the Pilbara, it is certainly relatively common. The conservation status of this species is not likely to be affected by the BS4 Project.

Spectacled Hare-wallaby *Lagorchestes conspicillatus leichardti* (Priority 3)

There are scattered records of this species from the Kimberley and Pilbara regions of Western Australia. It prefers large spinifex (*Triodia*) clumps in which to shelter during the day. It was not recorded during the BS4 Project survey, nor is there any recent records of this taxa from the area. The most recent Pilbara records are from adjacent to the BHPBilliton rail alignment in the vicinity of Chinnamon Creek in the eastern Pilbara (Dr Peter Kendrick, CALM Karratha, pers comm).

Long-tailed Dunnart *Sminthopsis longicaudata* (Priority 4)

This species inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region in the west to central Northern Territory and South Australia. It was not recorded during the BS4 Project survey, though two individuals have been trapped in the Silvergrass area 40 km to the north in 1999. The distribution and conservation status of this species is not likely to be affected by the BS4 Project.

Ghost Bat *Macroderma gigas* (Priority 4)

The distribution of Ghost Bats is fragmented, with each population showing some genetic differentiation (Dr Kyle Armstrong, Biota, pers comm). Whilst not detected during the surveys, it is possible that this species forages in the BS4 Project area and may use some of the larger caves in the area for roosts.

Lakeland Downs Mouse *Leggadina lakedownensis* (Priority 4)

This species is found in the Pilbara and Kimberley regions. It has been recorded on "cracking clay" communities from Cape Preston in the west to the northern flanks of the Fortescue Marshes in the east. This species was not recorded during the current survey and its core habitat (cracking clay communities) is absent from the BS4 Project area. Occasional individuals may utilise the BS4 Project area given its proximity to known populations. The BS4 Project is not expected to affect the distribution or the conservation status of this species.

Western Pebble-mound Mouse *Pseudomys chapmani* (Priority 4)

This species is common to very common in suitable habitat within the Hamersley and Chichester sub-bioregions. Although no active mounds were recorded, a single individual was captured in a pitfall trap in the Triodia hilltop habitat during the April 2005 survey phase. The conservation status of this species will not be impacted by the BS4 Project either at the bioregion or sub-bioregion level.

Australian Bustard *Ardeotis australis* (Priority 4)

This species occurs over much of WA, with the exception of the more heavily wooded southern portions of the state (Johnstone and Storr, 1998). Its wider distribution includes eastern Australia and New Guinea. Five birds were sighted during the October 2004 fauna survey flying through creekline habitat at BRO10, BRO25 and BROF, and one bird was recorded from amongst native grasses at BRO32. There were 11 records from the second survey phase at several locations along the White Quartz Road. The conservation status of this species will not be impacted by the BS4 Project either at the bioregion or sub-bioregion level.

Bush Stonecurlew *Burhinus grallarius* (Priority 4)

This species is widespread in Australia and southern New Guinea. It remains common in tropical Australia but has declined alarmingly in temperate Australia, and has disappeared from many regions (Marchant and Higgins, 1993). However, populations of this species are considered secure in the Pilbara (Mr Ron Johnstone, WA Museum, pers. comm. 2003). One record of this species was made in the BS4 Project area at BRO04. The conservation status of this species will not be impacted by the BS4 Project either at the bioregion or sub-bioregion level.

***Notoscincus butleri* (Priority 4)**

Endemic to WA and restricted to the arid north-west (Storr *et al*., 1999) of the Pilbara bioregion. This species was recorded in the BS4 survey in creek line habitat (BRO46A: R110727) associated with the Boolgeeda Creek. Another individual was recorded from the Nammuldi Silvergrass area in the Brockman valley (Biota, pers comm). The conservation status of this species is unlikely to be impacted by the BS4 Project at either at the bioregion or sub-bioregion level.

4.9.6 Other Vertebrate Species of Interest

The BS4 fauna survey recorded specimens from eight complexes of species where the taxonomy is poorly known and thus may contain significant species, but this will not be ascertained for some years. These species are detailed in **Table 4-11**.

Table 4-11 Other vertebrate fauna of interest in BS4 Project area

Species	Comments
Diplodactylus stenodactylus	Complex is currently under review, with possibly six new species occurring in the Pilbara Bioregion (Laurie Smith WAM pers comm., 2004). The conservation status of those specimens recorded during the BS4 survey is unclear.
*Diplodactylus savage*i	Has recently been recognised as a potential species complex or at least comprised of two distinct forms. The form recorded at BS4 has distinct golden bands across the dorsal surface as opposed to a transverse series of discontinuous yellow spots seen elsewhere.
Menetia greyii	Known to be a species complex. The taxonomic status of the specimens recorded at BS4, or the conservation significance of the taxa, is unclear.
Ctenotus affin. *helenae*	Is well known and has been collected from a wide area of the Pilbara over the past few decades. It is unclear whether it represents a hybrid between *C. saxatilis* and *C. helenae* or a discreet morphotype.
Lerista muelleri complex	Has been subject to revision by Laurie Smith (WAM); the individual collected from the rail corridor appears to be a form of this species complex that has previously been recognized.
Cryptoblepharus plagiocephalus	A species complex that is currently being reviewed by the Northern Territory Museum. The taxonomic status, distribution and conservation status of those collected at BS4 is unclear.
Cryptoblepharus carnabyi	A species complex that is currently being reviewed by Paul Horner of the Northern Territory Museum. The taxonomic status, distribution and conservation status of those collected at BS4 is unclear.
Ctenotus schomburgkii	The taxonomic status, distribution and conservation status of those collected at BS4 is unclear.

Ref. Biota (2005b)

4.10 Regional Social Setting

The BS4 Project is located in the Shire of Ashburton. The nearest towns are Tom Price and Paraburdoo, located approximately 60 and 80 km from the Project area, respectively (refer to **Figure 1**). Tom Price was established in 1966 by Hamersley Iron to support mining at Mt Tom Price and has a population of approximately 3,600. Paraburdoo was established in 1971 to support mining at Paraburdoo (and later Channar and the Eastern Range Project) and has a population of approximately 1,700. Most of the town residents work directly or indirectly for Hamersley Iron.

The town of Tom Price provides services for Hamersley Iron's mining operations at Brockman 2, Nammuldi, Marandoo, Mt Tom Price and Greater Paraburdoo. The majority of the workforce for Brockman 2 and Nammuldi commute on a fly-in fly-out roster, but some employees commute by road from Tom Price. Employees at Marandoo and Mt Tom Price drive in/drive out of Tom Price. Employees of the Greater Paraburdoo Operation (i.e. Paraburdoo, Channar and the Eastern Ranges Project) commute to work from Paraburdoo by vehicle.

In the late 1980s, the Government requested that a town 'normalisation' process commence for the towns of Paraburdoo and Tom Price. Under this arrangement, state and local government authorities are gradually assuming the role of providing services and utilities, with Hamersley Iron continuing to contribute funds.

4.11 Land Use

4.11.1 Pastoral Activities

Pastoralism has been active in the area for over 100 years, with grazing by sheep until about 1970, and by cattle thereafter. Hamersley Iron owns four stations in the Pilbara region; Karratha, Hamersley, Rocklea and Juna Downs.

The BS4 Project is mostly located within Rocklea Station, which borders Hamersley Station. The Hamersley Station homestead is the closest residential premise (other than the Brockman 2 camp) and is located approximately 55 km from the Project area. Wyloo Station extends over a portion of the BS4 Project area. The Wyloo Station homestead is located approximately 110 km south-east from the BS4 Project area.

4.11.2 Mining

The Brockman 2 mine, which commenced in 1990, is located approximately 25 km north east of the BS4 Project area. Construction at Nammuldi (north-east of Brockman 2) commenced in 2005 and will be operational in Q1 2006. The Brockman 2 and Nammuldi construction workforce will be based in the Nammuldi camp, located to the east of the Brockman 2 mine.

4.11.3 Tourism

Although the mineral and petroleum sectors continue to make the most significant contribution to the Pilbara economy, the region is continuing to diversify and the local the economy is expanding through further development of the tourism industry. Tourism is considered a valuable contributor to the Pilbara regional economy.

National Parks are the major tourism focus in the central Pilbara region. The BS4 Project area is located approximately 90 km from the Karijini National Park and 100 km from the Millstream-Chichester National Park.

The BS4 Project area contains no significant features in its own right that warrant attention from the tourism sector. There are few public roads in the vicinity to facilitate access for tourists, therefore tourism is very limited in the BS4 Project area.

4.11.4 Aboriginal Communities

The Puutu Kunti Kurrama and Pinikura (PKKP) and the Eastern Guruma native title claimant groups have interests in the BS4 Project area. The Pilbara Native Title Service is the representative body for the PKKP, while Eastern Guruma is represented by the Guruma Maliwartu Aboriginal Corporation.

An agreement is currently under negotiation between Hamersley Iron and the PKKP people over the entire area of their native title claim, including a large proportion of the BS4 Project area. This agreement will address, among other things, the particular mining benefits from the BS4 Project that may be delivered to claimants during the course of the mine-life. In addition, the parties are

also discussing the proposed registration of an Alternate Procedure Indigenous Land Use Agreement relative to the PKKP native title claim area.

Hamersley Iron/Rio Tinto already has an Indigenous Land Use Agreement in place with the Eastern Guruma people.

The main Aboriginal communities are located at:

- Karratha - Aboriginal population of about 300 people of mixed language groups;
- Roebourne - about 900 Aboriginal people of mixed language groups;
- Wakathuni (20 km south of Tom Price) - 100 Aboriginal people of mixed language groups;
- Bellary (between Tom Price and Paraburdoo); and
- Onslow.

In addition, there is a camp located along the White Quartz Road, which is used intermittently by the Eastern Guruma people during law times and for educational activities.

Hamersley Iron operates over the traditional lands of ten Aboriginal language groups and believes these people, as stakeholders in its business, should have opportunities to participate in the local economy that mining generates. The Aboriginal Training and Liaison Group (ATAL) was established by Hamersley Iron in 1992. Hamersley Iron is strongly committed to preserving and protecting the traditional culture and heritage of Aboriginal people in the Pilbara and, through ATAL, works closely with Aboriginal organisations, communities and their Elders to maintain this commitment.

Hamersley Iron actively supports local Aboriginal people in the maintenance of their culture through providing assistance with maintenance of lore grounds and burial sites, transport for elders to conduct traditional activities, and recording and mapping of traditional stories and the management of heritage sites. ATAL has implemented a number of programs to increase Aboriginal participation within the mining industry. These programs range from education and scholarships, skills and personal development, clerical and trade apprenticeships, to business development and alliances.

Hamersley Iron’s operator skills development program provides on the job training and skills enhancement over an 18-month period allowing graduates to compete for jobs at mine sites. Over 95 % of Aboriginal people completing the program have gained full time employment with Hamersley Iron.

4.12 Aboriginal and European Heritage

4.12.1 Aboriginal Heritage

Rio Tinto has adopted national heritage guidelines to regulate the manner in which all business units within the group manage cultural heritage issues. All business units within the group are required to comply with internal heritage policies, as well as comply with both State and Federal legislation.

The current survey work at BS4 is divided into two separate sections reflecting existing Native Title boundaries. The survey area is divided between the Eastern Guruma people and the PKKP people.

Approximately 16.2 km^2 of the total area to be surveyed lies within the PKKP Native Title boundary. The PKKP are involved with ongoing commercial negotiations with Rio Tinto, and a working group meeting is planned to resolve any heritage related issues and allow heritage surveys to progress. It is anticipated that survey work will commence in July 2005.

The remainder of the survey area falls with the Eastern Guruma Native Title boundary. Previous heritage surveys have been conducted covering some 25 km^2 of the BS4 Project area and a total of 27 archaeological sites have been located. As shown in **Table 4-12**, the majority of these sites are rock shelters but also include artefact scatters, water sources and scarred trees. The BS4 Project's potential impact on these sites is discussed in **Section 7.14.2**. Remaining areas are currently being surveyed, including the White Quartz Road corridor. To date, two sites of significance have been identified along the road, namely a White Quartz block and a camp site above a rock hole.

A 300 m wide corridor along the proposed rail spur has also been surveyed, with no areas of Aboriginal heritage significance being identified.

4.12.2 European Heritage

No place or object within the BS4 Project area is included on the Register or the Interim List of the Register of the National Estate. There are no known sites or items of non-Aboriginal heritage significance in the BS4 Project area.

Table 4-12 Archaeological Sites Located Within the BS4 Project area

Site Type	Site Size	Site Number
Scarred Tree	5 m x 5 m	BROCK-01
Rock Shelter	16 m x 3 m	BROCK-02
Rock Shelter	9 m x 6 m	BROCK-03
Rock Shelter	7 m x 7 m	BROCK-04
Artefact Scatter & Water Source	160 m (north-south) x 160 m (east-west)	BROCK-05*
Rock Shelter	3 m x 10 m	BROCK-06
Scarred Tree	5 m x 5 m	BROCK-07
Rock Shelter	10 m x 10 m	BROCK-08
Rock Shelter	6 m x 4 m	BROCK-09
Scarred Tree & Water Source	10 m x 10 m	BROCK-10
Rock Shelter	10 m x 17 m	BROCK-11
Walled Rock Shelter	12 m x 2 m	BROCK-12
Rock Shelter	5 m x 4 m	BROCK-13
Rock Shelter	5 m x 3 m	BROCK-14
Artefact Scatter & Water Source	70 m x 70 m	BROCK-15*
Rock Shelter	6 m x 7 m	BROCK-16
Rock Shelter	7 m x 12 m	BROCK-17
Rock Shelter	9 m x 8 m	BROCK-18
Artefact Scatter	30 m (north-south) x 60 m (east-west)	BROCK-19
Rock Shelter	25 m x 3 m	BROCK-20
Rock Shelter	23 m x 9 m	BROCK-21
Rock Shelter	8 m x 2 m	BROCK-22
Rock Shelter	6 m x 2 m	BROCK-23
Rock Shelter	6 m x 2 m	BROCK-24
Artefact Scatter	300 m (north-south) x 100 m (east-west)	BROCK-25

* Sites marked with an asterix are counted as two separate sites.

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5. Stakeholder Consultation

5.1 Overview

Hamersley Iron initiated a Stakeholder Consultation Programme for the BS4 Project mid 2004. The timing of this programme enabled the issues raised to be taken into account in the design of the BS4 Project and preparation of the PER. Wherever possible, face-to-face meetings were conducted with the people consulted. Key agencies have been actively consulted during the preparation of the PER, including:

- EPA Services Unit;
- DoE – Karratha regional office and water specialists based in Perth; and,
- CALM – Karratha regional office.

Non-government organisations (NGOs) considered key stakeholders and consulted during the preparation of the PER, were:

- Conservation Council of Western Australia;
- Wildflower Society; and,
- Guruma Aboriginal group.

A briefing to the PKKP was scheduled in May 2005, but was postponed to a later date.

Discussions were also held with representatives of pastoral stations who operate in the proposed area of the BS4 Project area, namely Rocklea and Hamersley Stations. Letters were issued to Wyloo Station providing broad details of the Project and providing an opportunity to discuss the BS4 Project.

The main issues raised by stakeholders related to water and closure management, vegetation disturbance (particularly Priority flora) and disturbance of Aboriginal heritage values. The issues raised by stakeholders have been addressed in this PER document and **Table 5-1** summarises the organisations consulted by Hamersley Iron to date and the issues raised.

5.2 Peer Review

The BS4 Project vegetation/flora and fauna reports were submitted for review to CALM Perth, CALM Karratha, DoE Karratha and the EPA Service Unit. In addition, a copy of these two reports was sent to the Wildflower Society of WA and the Conservation Council of WA following separate meetings with representatives of these two groups.

Biota's Stygofauna report was submitted to Dr Stuart Halse at CALM Woodvale and a meeting held on 27 May 2005. Dr Halse, a Principal Research Scientist in CALM's Bioconservation Group, is CALM's advisor on stygofauna issues.

The BS4 Project hydrogeological report (see **Appendix C**) was submitted to Mr Gary Humphreys (Senior Hydrogelogist, DoE Perth) for review. A copy of this report was also provided to DoE office in Karratha.

Table 5-1 Stakeholder consultation carried out for the BS4 Project

Who	Consultation Type	Date	Comments/Issues Raised	Hamersley Iron Response	Relevant Section in PER
WA Government Organisations					
Pilbara Iron Ore Environment Committee	Meeting/ briefing as part of broad development programme	1 Oct 04	Short range endemics should be considered as part of fauna surveys.	Fauna surveys have included identification of short range endemics.	4.9.3
			Project specifications e.g. % below water table, access, tenure, wet/dry processing to be included in EIA document.	Key characteristics table and Figures contain Project specifications.	3.0
EPA Chairman Director Evaluation Manager Resources Branch	Meeting	14 Oct 04	The PER should include a preliminary rehabilitation and closure plan.	Hamersley Iron has prepared a preliminary rehabilitation and closure plan for the BS4 Project.	Appendix G
DoIR (Perth) ▪ A Conn (Environment Division) ▪ A Hopkins & B Preston (Investment Facilitation Division); and ▪ C Kneen (Project Approvals Coordination Unit)	Meeting, phone call	22 Dec 04, 27 Apr 05	Watersheds, erosion, water shadows and any land-bridges to be addressed in engineering design.	Detailed engineering of the Project infrastructure will address erosion and drainage issues. No land bridges are proposed.	3.10.3 7.2.2 7.5
			Options for workforce transport to site needs to be addressed.	Hamersley Iron sustainability methodology was applied to the preferred workforce delivery option.	2.3.4 7.15.2
			PER should address mining, processing and safety aspects.	This has been addressed as part of the Engineering Design. Safety aspects are not included in this document, but will be reported to the DoIR separately as required.	3.0
			How would drawdown impact on any Mulga communities in the Project area?	Some areas of vegetation containing Mulga (*Acacia "aneura"*) are present towards the southern end of the transport corridor.	7.2.2 7.5
			What are the synergies of BS4 and other Hamersley Iron mines and deposits in the vicinity?	Rail line linking BS2 and the Dampier Port and 220 kV power line between Dampier and Tom Price.	
			Provide disturbance figures by tenement.	Undertaken.	Appendix B
			Show area/location of waste dumps and how these will be formed, both during construction and upon rehabilitation.	Undertaken.	3.5.3
			Show location of topsoil stockpiles and evidence they will not be impacted by mining, waste dumps or other infrastructure.	To be completed during detailed engineering design.	

Who	Consultation Type	Date	Comments/Issues Raised	Hamersley Iron Response	Relevant Section in PER
			Topsoil should be pushed back from under waste dumps and stockpiled until able to be pushed back up re-shaped waste dump slope.	This will be undertaken.	3.5.1
			Include plant layout.	Tertiary crushing and product screening building, stockyard, and a train load out system located at the eastern end of the ore body.	Figure 3 Figure 6
			Give general approach to waste dump rehabilitation. Take into account waste characterisation in rehabilitation and slope.	10 m lifts, 10 m wide berms, 20^{o} slopes. Some work has been undertaken, and additional work will be done during the operation.	3.5.3 4.5.1 7.11
CALM (Perth) ▪ N Caporn and D Coffey	Meeting	22 Dec 04	CALM Karratha should be consulted on the Project.	CALM Karratha consulted.	
			Are the vegetation communities over the orebody distinct or unique?	Primary habitat "Triodia hilltop habitat" that is widespread in the area.	4.8.4
			PER should address Mulga communities in relation to overland water flow.	Some areas of vegetation containing Mulga (*Acacia aneura*) are present towards the southern end of the transport corridor.	7.2.2 7.5
			Was overland sheet-flow considered for the rail spur alignment?	This has been considered, and will be included in the detailed engineering design.	3.10.3 7.2
			Are the *Ptilotus* populations genetically distinct, and what is the pollination vector? If not wind, will the Project prevent vector movement?	Pollination vector has not been determined. However, the majority of *Ptilotus* species produce nectar and are largely insect pollinated, although this has not been recorded in the literature to date (Rob Davis, WA Herbarium, pers comm, 2005). Rob Davis considers that the presence of the elongated staminal cup suggests that this species may have a specific pollinator.	4.8.6 Appendix D
			Stuart Halse at CALM should review the stygofauna work.	Carried out.	4.9.4
			Flora and fauna reports should be submitted to CALM for review.	Reports submitted to CALM 31 Mar 05.	Appendix D Appendix E Appendix F

Who	Consultation Type	Date	Comments/Issues Raised	Hamersley Iron Response	Relevant Section in PER
EPA Service Unit ▪ G Whisson, M Bundrett (Ecological Systems Division) ▪ S Perry (EIA Division)	Meeting	13 Jan 05	Scoping document is very comprehensive.	Noted.	See Appendix A
			Put the vegetation and flora in a regional context.	Done.	4.3 4.8
			The land snails were unlikely to be an issue considering the homogeneity of the Pilbara environment and the paucity of knowledge about the snails; the snails found were unlikely to be a restricted population.	Noted.	4.9.3
			Flora and fauna reports should be submitted to the EPA SU for review prior to inclusion in PER.	Reports submitted to 31 Mar 05.	Appendix D Appendix E
DoE (Perth) ▪ S Johnson	Meeting	1 Feb 05	Prepare a mine water balance for the Project, showing inputs, Project use and any discharges.	To be completed as part of detailed engineering design.	3.8.3 Figures 7 and 8
			Will there be any excess water and, if so, how will this be disposed of.	There will be no dewatering discharge. All groundwater removed from dewatering the pit areas will be used for processing and dust control.	3.5.2
			Need to demonstrate that the Project will have security of water supply.	Undertaken.	Appendix C
			Discuss potential for acid rock drainage (ARD) and management of this.	Some work has been undertaken, and additional work will be done during the operation. ARD material not expected to be encountered.	4.5.1 7.11
			Need to backfill to 2 m above the pre-mining water level.	Will be undertaken.	7.6.3
DoIR (Karratha) ▪ T Briggs	Phone call	3 Feb 05	No comments on proposal. DoIR Perth office will be responsible for assessing the Project.	Noted. Consultation carried out with DoIR Perth office, with further consultation planned.	
DoE (Karratha) ▪ S Worley, O Bennett and P Dunn	Meeting	8 Feb 05	Include closure objectives and principles in the PER e.g. progressive rehabilitation, backfilling of final mine pits to above the water table.	Closure and rehabilitation objectives stated.	7.13 Appendix G

Who	Consultation Type	Date	Comments/Issues Raised	Hamersley Iron Response	Relevant Section in PER
CALM (Karratha) ▪ S White and G Watson	Meeting	8 Feb 05	Requested a copy of the flora and fauna reports. No other comments on the Project.	A copy of the flora and fauna reports was sent to CALM on 31 Mar 05.	Appendix D Appendix E
Water Corp (Karratha) ▪ C Byers	Phone call, letter	14 Apr 05	No objections to the BS4 Project.	Noted.	
DoE (Perth) ▪ G Humphreys	Meeting	16 May 05	No issues raised on the hydrogeology overview provided. Requested copies of the hydrogeology report to be sent to the Perth and Karratha offices.	Noted. Reports issued 18 May and 19 May 2005.	Appendix C
CALM (Pilbara) ▪ I Walker	Correspondence	19 May 05	The Flora, Vegetation and Fauna reports reviewed. Overall satisfaction in regard to methodology, results and conclusions. The management recommendations made in reports supported.	Noted.	Appendix D Appendix E
CALM (Woodvale) ▪ S Halse	Meeting	27 May 05	Approach endorsed. Recommended overlaying regional geological mapping (1:250,000) to confirm adequate coverage of geological units. Also, add drawdown contours. Endorsed further sampling before dewatering commenced. Based on outcome of third sampling, determine whether BS4 Project needs to be incorporated into Hamersley Iron stygofauna sampling program.	Regional geological mapping and drawdown contours added to the BS4 Project stygofauna report. Third round of sampling to be undertaken prior to commencement of groundwater abstraction for mining purposes. If no stygofauna identified with conservation significance in the third round of sampling, the BS4 Project area will not be incorporated into Hamersley Iron's regional stygofauna sampling program.	Appendix F
Non-Government Organisations					
PKKP/ Pilbara Native Title Service	Meetings, correspondence, PowerPoint presentations	8 Jun 04, 13 & 14 Sept 04, 3 Nov 04 23 Nov 04 7 Dec 04 10, 11 & 13 Mar 05	Compensation package.	Negotiations ongoing.	1.7.2

Who	Consultation Type	Date	Comments/Issues Raised	Hamersley Iron Response	Relevant Section in PER
Eastern Guruma Community Group	Meeting, site visit	31 Mar 05, 14 Apr 05	Upgrade of White Quartz Road to avoid two areas. No other environmental issues raised to date	Heritage features identified along the White Quartz Road will be avoided.	4.12.1 7.14.3
Hamersley Station ▪ M Herbert (Manager)	Email of Project scope and Scoping document, and meeting.	30 Mar 05 6 April 05	No issues raised as cattle not grazed or mustered in BS4 Project area or around approach roads.	No response required.	
Rocklea Station ▪ R Morgan (Overseer)	Meeting	6 April 05	No issues– cattle not grazed or mustered in BS4 Project area or around approach roads.	No response required.	
Wyloo Station ▪ C/- Balmoral Hides Pty Ltd	Letter	1 May 05	No response received to date.	No response required.	
Wildflower Society of WA ▪ B Moyle	Meeting	14 Mar 05	Requested copy of flora and fauna reports.	Sent on 31 Mar 05.	Appendix D Appendix E
Conservation Council of WA ▪ C Tallentine	Meeting	21 Mar 05	Biodiversity needs to be maintained. Requested copy of flora and fauna reports.	Copy of flora and fauna reports sent on 31 Mar 05.	Appendix D Appendix E

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6. Environmental Principles, Sustainability and Management

6.1 Principles of Environmental Protection

General guidelines for environmental protection are set out in numerous guidance statements released by the EPA between 2000 and 2004. In 2003, the EP Act was amended to include a core set of Principles that are applied by the EPA in formal assessments.

In its assessment of the environmental impacts associated with the BS4 Project, Hamersley Iron has considered the principles of environmental protection contained in the EP Act (see **Table 6-1**). These principles address environmental, social and economic considerations, the Precautionary Principle, Intergenerational Equity, Conservation of Biological Diversity and Ecological Integrity (EPA, 2004d).

6.2 Sustainability

Australia has a National Strategy for Ecologically Sustainable Development (NSESD) that provides broad strategic directions and framework for governments to direct policy and decision-making. All levels of Australian government adopted the NSESD in 1992.

In 2003, the Western Australian Government released the State Sustainability Strategy 'Hope for the Future' (Government of Western Australia, 2003). The broad goals of the State Sustainability Strategy are:

- Ensure that the way we govern is driving the transition to a sustainable future;
- Play our part in solving the global challenges of sustainability;
- Value and protect our environment and ensure sustainable management;
- Plan and provide settlements that reduce the ecological footprint and enhance quality of life at the same time;
- Support communities to fully participate in achieving a sustainable future; and,
- Assist business to benefit from and contribute to sustainability.

With regards to mining and mineral processing in WA, the State Sustainability Strategy has a vision for a resources sector "that underpins a sustainable global economy by consistently enhancing its technological edge, and the development of the State through continuous improvement in safety, health and environmental management, superior product, excellence in risk management, transparent governance, and in-depth engagement of communities across Western Australia".

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Table 6-1 Principles of Environmental Protection

Principles of Environmental Protection				
Principle	**Relevant (Yes/No)**	**If yes, consideration given in Project**	**Addressed (Yes/No)**	**Section(s) in PER**
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	Careful evaluation of the BS4 Project has been undertaken to avoid, where practicable, serious or irreversible damage to the environment. Specialist studies (e.g. flora, fauna, heritage and groundwater) have been carried out in the Project area to assess the environment and potential impacts, and management plans will be put in place to protect the environment. Additional investigations are planned to provide sufficient information to address all potential environmental impacts. The management strategy of precluding development within the high conservation area containing the Priority 1 flora through fencing has been adopted.	Yes	4.0 7.2
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	Sustainable development is a cornerstone of Hamersley Iron's business and underpins many of the plans and targets set within the company. Hamersley Iron's definition of sustainable development is based on the widely accepted Brundtland definition - "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs", and Hamersley Iron recognises that sustainable development requires concerted collaborative effort from industry, governments, inter-governmental agencies and civil society. Detailed baseline environmental studies have been carried out in the BS4 Project area and ongoing studies will be undertaken. Information is provided on long-term emissions, and greenhouse gases emissions with respect to EPA Guidance Statement No. 12 (EPA, 2002a).	Yes	4.0 7.9
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	Conservation of biological diversity and ecological integrity is a fundamental consideration. Hamersley Iron's operations are required to address issues of biodiversity conservation. Baseline studies have been undertaken at the site to assess the environmental value of areas that could be impacted by operations and management plans will be implemented as required.	Yes	4.8 4.9

Principles of Environmental Protection				
Principle	**Relevant (Yes/No)**	**If yes, consideration given in Project**	**Addressed (Yes/No)**	**Section(s) in PER**
4. Principles relating to improved valuation, pricing and incentive mechanisms (a) Environmental factors should be included in the valuation of assets and services. (b) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. (c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. (d) 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 maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Yes	Environmental factors have played a major part in determining preferred operational options. Hamersley Iron recognises the polluter pays principle, and has designed the Project to ensure that pollution type impacts are minimised. Hamersley Iron endeavours to only purchase goods where the full life cycle costs have been considered. Environmental goals will be pursued in the most cost effective way. The full life-cycle cost of mining iron ore, including the use of natural resources and assets, the ultimate disposal of any wastes and decommissioning and closure of operations, is estimated. Costs are provided for over the life of each operation on a unit of production basis.	Yes	7.0
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Yes	All reasonable and practicable measures will be taken to minimise the generation of waste and its discharge into the environment. The preferred management options are to avoid, reduce, reuse, recycle and recover waste. Waste management will be addressed in the CEMP and OEMP.	Yes	7.10 7.11

In recognition of the above mentioned Principles, Hamersley Iron has developed a Sustainable Development (SD) decision-making methodology that is applied to major project decisions. Hamersley Iron has ensured that, as far as practicable, the BS4 Project meets, or is consistent with, the sustainability principles of the NSESD and WA State Sustainability Strategy.

The following SD principles are applied by Hamersley Iron during planning and decision-making:

- Reduce water use;
- Reduce net land disturbance and disruption of natural water bodies;
- Reduce net biodiversity loss;
- Reduce net emissions, particularly dust and greenhouse gas;
- Reduce injury and illness incidents;
- Improve equal employment opportunities;
- Improve contribution to community capacity building;
- Reduce impact on heritage; and,
- Optimise long-term economic value.

Hamersley Iron's SD decision-making methodology has been applied to aspects of the BS4 Project and will continue to be applied as appropriate. The methodology allows the Project team to assess the social, economic and environmental issues around a particular decision at the earliest possible stage of a Project's life (refer to **Plate 6-1**).

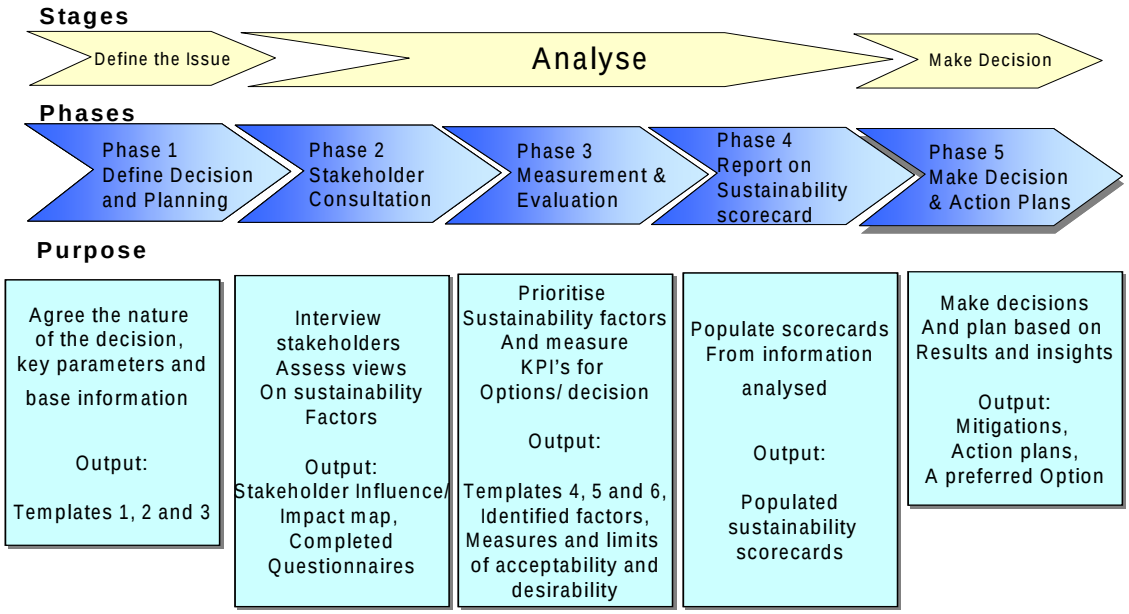


Plate 6-1 Hamersley Iron Sustainable Development decision making methodology

Subsequent to the release of the State Sustainability Strategy, the EPA published Preliminary Position Statement 6, Towards Sustainability (EPA, 2004e). The document contains a checklist that can be considered for new proposals with respect to sustainability. The questions listed in this checklist were considered in respect to the BS4 Project (see **Table 6-2**).

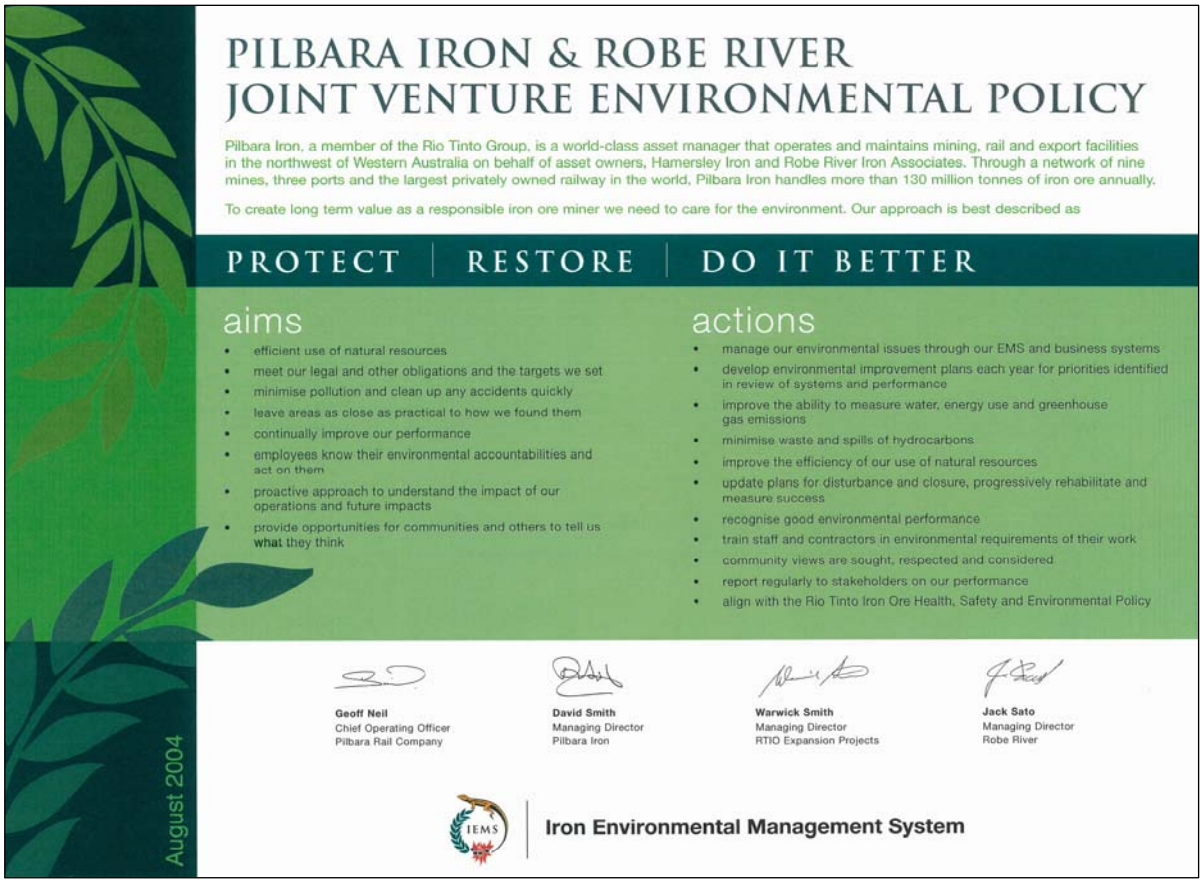
Table 6-2 Sustainability checklist for the BS4 Project (after EPA, 2004e)

Question	Response
Does the proposal deplete non-renewable resources significantly?	No - The Project mines 600 Mt of iron ore and relocates 290 Mt of low-grade ore. Relative to the volumes of other resources in the Pilbara and WA/Australia this is minor.
Does the proposal deplete assimilative capacity significantly?	No - Environmental discharges are minimised. No other similar operational discharges within approximately 30 km due to remoteness of the Project area.
Does the proposal use natural resources responsibly?	Yes - Water will not be discharged to the environment, dewatering water to be used to supplement alternative sources.
Does the proposal satisfactorily restore any disturbed land?	Yes - All areas to be rehabilitated upon closure. Progressive rehabilitation to be undertaken.
Does the proposal follow the waste hierarchy and manage satisfactorily any waste produced?	Yes - Waste will be reduced, reused, recycle where possible.
Does the proposal incorporate best practice in water and energy efficiency?	Yes - Hamersley Iron is continually improving energy and water use efficiency.
Does the proposal make good use of best practice to prevent pollution?	Yes - Prevention of pollution in accord with industry best practice.
Does the proposal increase use of non-renewable transport fuels?	Yes - Diesel will be used by the mining fleet and locomotives.
Does the proposal use energy efficient technologies?	Yes - The Project utilises technologies that are appropriate to its purpose and in line with industry standards. As an example, crushers use bearings and drive systems, and have crushing chambers that maximise energy transfer into material breakage.
Does the proposal result in net improvements in biodiversity?	No - No net change.
Does the proposal increase greenhouse gas emissions?	Yes - The mining fleet will use diesel, and vegetation will be cleared in the short term. Hauling of ore for shipping will also lead to greenhouse gas emissions.
Does the proposal involve acceptable levels of risk?	Yes - All aspects of the Project have been risk assessed, including financial, safety, environment and sustainability.
Does the proposal have a secure foundation of scientific understanding of its impacts?	Yes - Baseline studies carried out, including for stygofauna, flora, fauna, Aboriginal heritage and groundwater.
Does the proposal minimize the ecological footprint?	Yes - Engineering design has attempted limit the footprint wherever possible.
Does the proposal avoid or minimize adverse impacts and promote beneficial impacts on the surrounding community?	Yes - Economic and social benefits will be directly and indirectly attributable to the Project.
Does the proposal produce sustainable net economic benefits?	Yes - Positive contribution to SD.
Does the proposal produce sustainable net social benefits?	Limited – Fly-In Fly-Out Operation. No new town being developed that will require closure at end of mine. Nearest town 65 km away.
Does the proposal add to heritage protection and provide a sense of place?	Yes – Aboriginal heritage surveys conducted, giving expanded knowledge on local heritage.
Does the proposal produce net environmental benefits?	Limited - Disturbed areas will be rehabilitated with the aim of not impacting the surrounding environment; scientific knowledge base expanded e.g. for stygofauna, land snails, *Ptilotus* sp etc; and, protection of Priority 1 flora.
Does the proposal contribute to a more equitable and just society?	Yes - Economic and social benefits will be directly and indirectly attributable to the Project.
Does the proposal interact positively with other likely developments?	Yes - Existing infrastructure will be utilised (rail, power, road access) to reduce the need for the delivery of new infrastructure.
Does the proposal provide new opportunities (social, economic or environmental)?	Yes - New research, increase in scientific knowledge.

6.3 Environmental Management

6.3.1 Environmental Policy

The Pilbara Iron and Robe River Joint Venture Environmental Policy (see copy below) was signed in August 2004 by the Managing Directors of Pilbara Iron, Expansion Projects and Robe Joint Venture and the Chief Operating Officer of the Pilbara Rail Company. The Environmental Policy is the guiding document for driving environmental management and provides context and specific direction for continuous improvement. The signing of the new policy has renewed Hamersley Iron's commitment to care for the environment using the approach of 'Protect – Restore – Do it Better'.



PILBARA IRON & ROBE RIVER
JOINT VENTURE ENVIRONMENTAL POLICY

Pilbara Iron, a member of the Rio Tinto Group, is a world-class asset manager that operates and maintains mining, rail and export facilities in the northwest of Western Australia on behalf of asset owners, Hamersley Iron and Robe River Iron Associates. Through a network of nine mines, three ports and the largest privately owned railway in the world, Pilbara Iron handles more than 130 million tonnes of iron ore annually.

To create long term value as a responsible iron ore miner we need to care for the environment. Our approach is best described as

PROTECT | RESTORE | DO IT BETTER

aims

- efficient use of natural resources
- meet our legal and other obligations and the targets we set
- minimise pollution and clean up any accidents quickly
- leave areas as close as practical to how we found them
- continually improve our performance
- employees know their environmental accountabilities and act on them
- proactive approach to understand the impact of our operations and future impacts
- provide opportunities for communities and others to tell us what they think

actions

- manage our environmental issues through our EMS and business systems
- develop environmental improvement plans each year for priorities identified in review of systems and performance
- improve the ability to measure water, energy use and greenhouse gas emissions
- minimise waste and spills of hydrocarbons
- improve the efficiency of our use of natural resources
- update plans for disturbance and closure, progressively rehabilitate and measure success
- recognise good environmental performance
- train staff and contractors in environmental requirements of their work
- community views are sought, respected and considered
- report regularly to stakeholders on our performance
- align with the Rio Tinto Iron Ore Health, Safety and Environmental Policy

Geoff Neil
Chief Operating Officer
Pilbara Rail Company

David Smith
Managing Director
Pilbara Iron

Warwick Smith
Managing Director
RTIO Expansion Projects

Jack Sato
Managing Director
Robe River

August 2004

IEMS

Iron Environmental Management System

6.3.2 Environmental Management System

Hamersley Iron aims to conduct its business in an efficient and environmentally responsible manner that is compatible with the expectations of its shareholders, government and the community. Hamersley Iron also recognises that environmental responsibilities go beyond those required under statutory regulations, with these encompassing social obligations, leadership in sustainable development and minimising environmental impacts.

Hamersley Iron operates under an ISO14001 framework through the 'Iron Environmental Management System' (IEMS). ISO14001 is an internationally recognised continuous improvement model that has been implemented by organisations worldwide. Its basis lies in management commitment and the allocation of resources to establish systems based on reducing environmental risk. The key elements of ISO14001 include assessing environmental risk and legal requirements, developing objectives and

targets for improvement, training, operational control, communication, emergency response, corrective actions, audits and review. Rio Tinto has mandated that all its global operations be certified to this standard by July 2005. In 2003, Hamersley Iron sites gained certification to ISO14001 and successfully maintained their certification in 2004, following two external audits by NCS International Pty Ltd.

One of the key components of IEMS is ensuring that environmental planning processes are integrated fully with the overall business planning process. This ensures that objectives and targets are both realistic and resourced. Environmental Improvement Plans (EIP's) are established annually and document specific actions to be implemented during each year in order to demonstrate how environmental objectives and targets will be met. In 2004, Hamersley Iron formally tracked and signed off over 330 EIP's.

Each year, Hamersley Iron management reviews the IEMS to ensure its continuing suitability, adequacy and effectiveness.

The IEMS would be extended to incorporate the BS4 Project.

6.3.3 Environmental Management Plan

An Environmental Management Plan (EMP) will be developed and implemented for each of the construction and operation stages of the BS4 Project. The objective of these EMPs is to provide working manuals that will include specific management strategies and procedures addressing significant environmental issues. The Construction EMP will be developed during detailed Project design, in consultation with the specialist consultants and decision-making authorities. Following completion of the construction phase, the Construction EMP will be revised as necessary to form the Operational EMP. The EMPs will outline objectives, monitoring and reporting requirements.

While Hamersley Iron had initially planned to include a draft EMP in the PER document, given the current staging of the detailed Project design and the decision to develop both a construction and operations EMP, it is considered that the inclusion, at this stage, of a very preliminary draft EMP would not add significantly to the PER. Hamersley Iron has therefore focused on providing sufficient detail in the PER on each of the relevant issues that will be covered in the EMPs. Once prepared, the EMPs would be made available for targeted stakeholder review.

An employee awareness training programme will form part of the EMPs, and will capture the essence of Hamersley Iron's commitment to SD and industry best practice environmental management. The awareness training programme will also include an overview of expected environmental management responsibilities and minimum performance requirements from all staff, contractors and visitors.

The EMPs will incorporate commitments made in this PER, and subsequent conditions that may be imposed by the Minister for the Environment following assessment of the BS4 Project.

The EMPs will include management of the following issues:

- Flora (including Priority spp.);
- Fauna (including stygofauna);
- Weeds;
- Topsoil;
- Fire;
- Dust;
- Noise;
- Waste (non-mineral and mineralised waste);
- Hydrocarbons;
- Water (surface and groundwater);
- Acid rock drainage;
- Greenhouse gases;
- Rehabilitation;
- Aboriginal heritage; and,
- Reporting and auditing procedures.

6.3.4 Environmental Offsets

The EPA has provided guidance on environmental offsets in Preliminary Position Statement No. 9 (EPA, 2004f). In this Preliminary Position Statement, the EPA define environmental offsets as:

> "any environmentally beneficial activities undertaken to counterbalance an environmental impact or harm, with the aim of achieving a 'no net environmental loss' or 'net environmental benefit' outcome",

and state that,

> "environmental offsets should only be considered where on-site impact mitigation has been reasonably considered or demonstrated, and where residual adverse impacts are considered significant – but not significant enough to make the Project unacceptable."

Hamersley Iron will limit adverse impacts caused by the BS4 Project wherever possible, and has applied on-site impact mitigation with the aim (in order of preference) to avoid, minimise, rectify and reduce impacts. Potential environmental impacts have been addressed (see **Section 7**), and the predicted environmental outcomes are summarised below.

Biophysical

- The BS4 Project will not impact on high value assets such as conservation areas.
- No significant establishment of weeds as a consequence of the BS4 Project.
- The conservation status of Priority flora will not be adversely impacted upon by the BS4 Project.
- Native fauna will not be significantly impacted by the BS4 Project.
- The conservation status of threatened fauna will not be adversely impacted upon by the BS4 Project.
- The conservation status of stygofauna will not be adversely impacted by the BS4 Project.

- Groundwater reserves will not be significantly impacted upon by the BS4 Project other than in the immediate mine area.

Pollution Management

- No unacceptable impacts to the environment or human health as a result of dust generation during construction and operation.
- Minimised generation of greenhouse gas emissions where possible.
- The natural functions and environmental value of watercourses and sheet flow within the BS4 Project area and further downstream, will not be adversely affected by the Project.
- No unacceptable adverse impacts to surface water quality.
- No unacceptable adverse impacts to groundwater quality.
- No unacceptable impacts to the environment or human health as a result of noise generation during construction and operations.
- Appropriate management of waste with the potential for contamination of soil, surface water and groundwater minimised.
- No adverse impacts to soil, surface water or groundwater quality as a result of acid rock drainage.

Social Surrounds

- No net social and economic loss caused as a result of the BS4 Project.
- No significant impacts on visual amenity as a result of the BS4 Project.
- Potential for adverse impacts to landscape and geoheritage values avoided where practicable.

Based on the above predicted outcomes and consideration of the Principles of Environmental Protection (EPA, 2004c), Hamersley Iron considers that there is no need for environmental offsets to be applied to the BS4 Project. However, in applying on-site impact management, Hamersley Iron will indirectly deliver Primary and Secondary offsets according to the definition provided in EPA Preliminary Position Paper No. 9 (EPA, 2004f) (see **Table 6-3**).

Table 6-3 Examples of the mitigation of impacts for the BS4 Project

On-Site Impact Management (In Order of Priority)	Management Activity
Avoid	Priority 1 flora avoided and protected by strategic fencing.
Minimise	Disturbance footprint of the BS4 Project Waste Generation Greenhouse Gases
Rectify	Rehabilitation progressive and sustainable of disturbed areas.
Reduce	Risk to Priority 1 population.
Offset	**Primary Offsets** ■ The re-establishment of Priority species in rehabilitated areas. **Secondary Offsets** ■ Conduct research into the re-establishment of Priority species in rehabilitated areas. ■ Ongoing flora surveys to monitor significant flora and expand on knowledge of their distribution and to identify any additional species in the vicinity of the BS4 Project area. ■ A targeted survey for land snails was carried out, with collections being made well outside the BS4 Project area. The survey focused on locating further specimens of *Rhagada* sp “Mt Brockman”. ■ Hamersley Iron has initiated funding of a study to assist in resolving the taxonomic status and distribution of *Rhagad*a sp “Mt Brockman”. ■ A stygofauna research program was initiated by Hamersley Iron in 1998. This incorporates regular sampling for stygofauna at all Hamersley Iron sites, including Nammuldi, Silvergrass, Brockman 2 and Homestead operation areas. The BS4 Project will be incorporated into this research program. ■ The results of the BS4 stygofauna sampling program will be collated with other studies of the distribution and ecology of Pilbara stygofauna underway by BHP Billiton Iron Ore and the WA Museum, to determine the conservation status of any species found.

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7. Potential Impacts and Management

7.1 Environmental Factors

The significant environmental issues relating to the BS4 Project, and the environmental factors associated with these issues, were identified utilising EPA guidelines and preliminary stakeholder consultation (see also **Appendix A**).

A summary of the potential environmental issues and environmental factors are given below:

- Flora and Vegetation Communities;
- Flora – Significant Flora Species;
- Fauna;
- Fauna – Significant Fauna Species;
- Fauna – Stygofauna;
- Watercourses;
- Water Quality – Surface (including acid mine drainage);
- Water Quality – Groundwater;
- Groundwater;
- Air Quality – Dust;
- Greenhouse Gases;
- Noise and Vibration;
- Waste and Hazardous Substance Management;
- Acid Rock Drainage;
- Landscape and Geoheritage;
- Visual Amenity;
- Rehabilitation and Decommissioning/Closure;
- Aboriginal and European Heritage;
- Economic and Social Impacts; and,
- Principles of Environmental Protection (refer to **Section 6.1)**.

The following Sections (**7.2 – 7.15**) present a detailed discussion of the potential environmental impacts and management strategies for each environmental factor. The EPA has prepared a list of generic environmental factors and associated environmental objectives in the 'Guide to EIA Environmental Factors and Objectives' (EPA, 2002d). Where objectives and environmental factors have not been described by the EPA, Hamersley Iron has provided its own objective to ensure that the relevant environmental factor is managed appropriately.

A summary of the potential environmental impacts and management strategies is provided in **Table ES-10-1** and **7-3**.

7.2 Vegetation and Flora

7.2.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for management of terrestrial flora and vegetation communities is 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.

Applicable guidelines include:

- *EPA Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia (EPA, 2000a).*
- *EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002b).*
- *EPA Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004g).*
- *EPA Preliminary Position Statement No. 9: Environmental Offsets (EPA, 2004f).* .

7.2.2 Potential Impacts

Vegetation Clearing

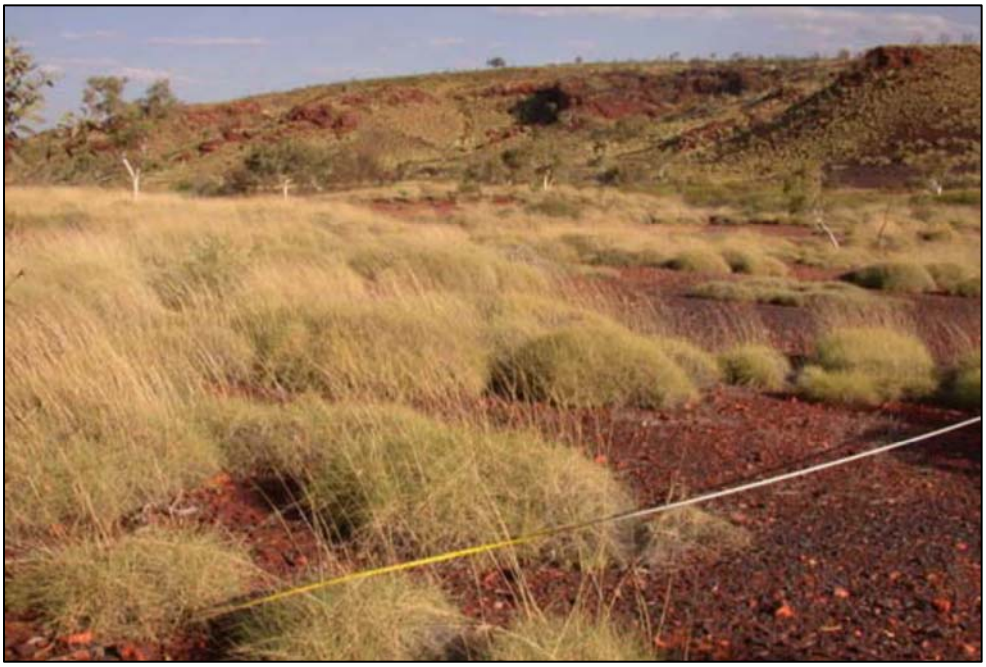
Approximately 2,470 ha of vegetation will be cleared or impacted by the BS4 Project (see **Table 3-2**). Clearing of vegetation will be required within the pit areas, processing locations, along the transport route, and for establishment of infrastructure such as borrow pits, lay-down areas, water bores and access tracks.

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

Priority Flora

The population of the Priority 1 *Ptilotus* sp Brockman, which occurs within the depositional valley between the BS4 mine area and the range of hills along the southern edge of the BS4 Project area (see **Figure 15**), will not be disturbed. The population is outside the active mining area. The location of this population also coincides with the vegetation type P11, which was the only vegetation type identified by Biota (2005a) as having a 'high' level of conservation significance (refer to **Plate 7-1** and **Figure 14b**). Access through this area has been limited to prevent erosion, and all staff and contractors involved in drilling programmes have been made aware of the significance of this area as part of the on-site induction programme. This induction programme will be extended to cover the construction and operations workforce.

A population of the Priority 4 flora, *Eremophila magnifica* subsp *magnifica* will need to be disturbed by the BS4 Project as it is located within the boundary of the West Pit (**Figure 15**). This species is distributed through the central-eastern Hamersley Ranges, and the removal of this population is not expected to have a significant impact on the distribution or conservation status of this species.



- **Plate 7-1 P11 Vegetation Type: recorded only from the very fine depositional substrates within the valley immediately south of the mining area (see also Figure 14b)**

Introduction and/or Spread of Weeds

Six introduced flora species were recorded from the BS4 Project area, and further weed species are likely to be present. Physical disturbance and additional movement of vehicles within the BS4 Project area may result in the introduction of additional weed species or the spread of the existing weed populations (particularly with respect to the Buffel grass infestations along creeks in the western section of the Project area).

Disruption to Surface Hydrology

The proposed transport route crosses a number of moderate-sized creek lines and the very broad drainage system of the Boolgeeda Creek. Disturbance to surface drainage flow has the potential to negatively impact downstream vegetation in such creek lines.

Some areas of vegetation containing Mulga (*Acacia aneura*) are present towards the southern end of the transport corridor. These are not of the grove/intergrove form that is typically associated with surface sheet flow across areas of very low topography. Construction of linear infrastructure through such areas of surface sheet flow can result in Mulga mortality through upstream ponding and downstream drainage shadow effects.

Groundwater Drawdown

Drawdown of water levels in underground aquifers may be caused by mine dewatering, where the ore body extends below the water table, or from extraction of process water from borefields. The drawdown of the water table reduces with distance from the main pit area. The predicted 10 m drawdown contour in piezometric levels extends northwards across the Boolgeeda valley, and 3 km

southwards from the mine area in the southern strike valley. Drawdown is elongated east-west along the southern strike valley owing to the permeable dolomite horizon. The predicted 10 m drawdown extends 4 km east of the eastern most pit and 5 km to the west of the western most pit (refer to **Section 7.6.2**).

Groundwater drawdown can potentially lower water levels beyond the reach of dependent plant species (termed phreatophytes). However, the majority of vegetation within the BS4 Project area is not phreatophytic. Vegetation types that could be impacted by groundwater drawdown comprise vegetation type C1 (Coolibah *Eucalyptus victrix* woodlands of creek lines; mainly along Boolgeeda Creek) and potentially vegetation type P1 (the Mulga woodlands in the broad drainage area within the valley south of the BS4 range).

Dust

Dust generated during the construction and operation of the BS4 Project has the potential to negatively affect surrounding vegetation, but this is considered likely to be a minor impact provided standard dust suppression measures are implemented.

Erosion

Clearing of vegetation has the potential to lead to increased rates of erosion and sediment runoff. The fine-texture soils of the valley containing the Priority 1 *Ptilotus* sp Brockman would be particularly susceptible to erosion.

Fire

Track grinding and rail maintenance activities have the potential to cause fire in adjacent areas. The presence of additional personnel and equipment in the area during construction of the rail and mine may also result in unplanned fires in the BS4 Project area.

Triodia hummock grassland habitats dominate much of the BS4 Project area and these are highly flammable. Mulga communities may be killed by repeated hot fires; the Mulga woodlands and tall shrublands within the BS4 Project area would be particularly susceptible to damage.

7.2.3 Management

Hamersley Iron will implement a number of management measures as part of the design, construction and operation of the BS4 Project to minimise the potential impact on vegetation communities and threatened flora species. The management measures to be implemented during the construction and operations stages are outlined below for each of the potential environmental impacts.

Vegetation Clearing

- Any new or varied transport routes will be searched for DRF prior to construction.
- The locations of other Priority flora have been considered as part of the mine planning process and will be avoided if possible.
- Vegetation clearing will be kept to the minimum necessary for safe construction and operation of the Project, particularly in areas adjacent to vegetation of higher conservation significance.

- Topsoil Management and Rehabilitation will be included in the EMPs in liaison with CALM, the DoE and DoIR.

Priority Flora

A number of specific management measures will be implemented as part of the design, construction and operation of the proposed BS4 Project, to minimise the potential impact to Priority flora. Some of the management measures listed above for vegetation communities may also be applied to management of significant flora. Additional management measures to be implemented include:

- Ongoing flora surveys to monitor significant flora and expand on knowledge of their distribution and to identify any additional species in the vicinity of the BS4 Project area.
- Planning of infrastructure locations to avoid Priority flora where feasible to do so.
- The *Ptilotus* sp Brockman population adjacent to the mining area will be strategically fenced off to preclude direct physical impact.
- Provide specific information on the management requirements of *Ptilotus* sp Brockman at inductions for staff and contractors.
- Conduct research into the re-establishment of Priority species in rehabilitated areas, including the harvesting of seed to use in the rehabilitation seed mix.

Weeds

- Weed control measures will be developed and implemented to prevent the introduction or spread of weeds in the BS4 Project area. Weed hygiene will be included in the EMPs in liaison with CALM.
- Control of most of the weed species recorded would be extremely difficult, however the single population of Ruby Dock *Acetosa vesicaria* recorded in the BS4 Project area will be eradicated. Management measures for the remaining species are aimed at limiting their spread.

Surface Hydrology

- Wherever possible, disturbance to surface drainage features will be avoided through mine planning. Where disturbance is unavoidable, sufficient culverts will be installed to maintain surface water flows.
- Drainage works for the new rail spur formation will comprise culverts, off formation drainage works, rock protection and other erosion protection works to reduce the impacts of disturbance and alteration to surface drainage. Similarly every effort will be made to ensure that ponding does not occur up-gradient of linear structures. Surface water management downgradient of culverts will ensure that sheetflow redistribution is maintained.

Groundwater Drawdown

- Groundwater levels will be monitored as part of the Borefield Management Plan. This Plan will include vegetation condition monitoring of susceptible vegetation in areas identified where groundwater levels have declined.

While no significant detrimental impacts are anticipated, Hamersley has committed to a comprehensive groundwater monitoring program (see **Section 8**), and will implement an appropriate response should monitoring indicate action is required. The response to monitoring will be dependent on the extent of any impact. Options would include:

- Rotation of groundwater production bores to assist recharge;
- Reduced pumping from the borefield; and,
- Development of a new borefield.

The Borefield Management Plan, which will be prepared prior to the application for a Groundwater Well Licence(s), will also consider management issues (see Section 7.6).

Dust

- Standard dust suppression measures (principally application of water by truck in active working areas and along trafficked roads) will be implemented across the BS4 Project area during construction and operation in order to minimise effects on surrounding vegetation (refer **Section 7.7**).

Erosion

- The valley containing the Priority 1 *Ptilotus* sp Brockman has been designated an "Environmentally Sensitive Area" by Hamersley Iron, with signposting at either end of the single access track through this area. This track was in place prior to the DRF survey in 2003. Measures have been put in place by Hamersley Iron to prevent more than one vehicle travelling on this access track at one time, so that passing is not required and the track does not become wider than necessary. Subject to detailed mine planning, it is planned to close off the track and re route access around this area. Surface water runoff around this area will be managed to prevent erosion.

Fire

- Prevention of fire is a key priority in all Hamersley Iron operations, especially field activities in the highly flammable Spinifex vegetation. Hamersley Iron will prepare and implement Fire Management as part of the EMPs to minimise the risk of unplanned fires in the BS4 Project area.
- Fire suppression equipment is always on hand at all field sites. Lighting of fires for any purpose is prohibited. Hot-work (welding, grinding) requires a formal permitting under Hamersley Iron's Safety Management System before any such work can commence.

7.2.4 Predicted Outcome

Based on the above, the BS4 Project is considered to meet the EPA objectives for flora and vegetation.

The conservation status of Priority flora will not be adversely impacted upon by the BS4 Project.

7.3 Fauna

7.3.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for management of terrestrial fauna is 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.

Applicable guidelines and standards include:

- *EPA Guidance Statement No. 56: Terrestrial fauna surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b).*
- *EPA Preliminary Position Statement No. 9: Environmental Offsets (EPA, 2004f).*
- *Rio Tinto Environmental Standard, Land Use Stewardship (Rio Tinto, 2003a)*

7.3.2 Potential Impacts

Direct Fauna Habitat Disturbance and Modification

The main impact to fauna from the BS4 Project will be the loss of fauna habitat due to the clearing of vegetation. A key factor in determining the significance of impacts to fauna habitat is the conservation value of the habitat units being disturbed. By assessing fauna habitat significance using the Land System framework, of the seven Land Systems occurring within the BS4 Project area (see **Table 4-2**), the BS4 Project area is considered to have low conservation value for the Boolgeeda, Platform, Robe and Rocklea Land Systems, with the remaining three (described below) being spatially restrictive, or supporting populations of significant fauna species.

- **Newman Land System** – While the BS4 Project area has low conservation value for this Land System, the land snail *Rhagada* sp "Mt Brockman" was recorded from within this Land System. However, as only 0.2 % of the Newman Land System occurs in the BS4 Project area, this Land System will not be significantly affected by the BS4 Project.
- **River Land System** -The BS4 Project area has low conservation value for this Land System. However, the Priority 4 fauna species *Notoscincus butleri* and Australian Bustard *Ardeotis australis* were recorded from vegetation types within this Land System. However, this Land System will not be impacted by the proposed BS4 Project disturbance footprint.
- **Table Land System** - This bioregion occurs as isolated dispersed occurrences in the south of the Pilbara bioregion and also within the Gascoyne bioregion. The 311 ha occurring within the BS4 Project area comprises 1.5 % of that mapped for the Pilbara Bioregion. Calcrete outcroppings have been identified as important for stygofauna and land snail communities. This Land System therefore has a high conservation significance rating within the BS4 Project area. However, this Land System will not be impacted by the proposed BS4 Project disturbance footprint.

Based on the fauna habitat types identified from vegetation mapping (see **Table 4-8**), and the predicted impact on these habitats based on Hamersley Iron's conservative estimation of BS4 Project's disturbance footprint, the primary habitat to be cleared is the 'Triodia hilltops' habitat. However, this habitat type is widespread and abundant in the area, and is not expected to be significantly reduced by the BS4 Project.

Indirect Fauna Habitat Modification

A number of indirect modifications may also occur to fauna habitat as a result of the construction and operation of the mine and rail. These include changes to surface hydrology, increased erosion and weed introduction or weed spread. There are no apparent areas of sheet-flow dependent habitat in the BS4 Project area, however Boolgeeda Creek exists as a broad drainage channel and appropriate culverts will be required. The habitat along sections of Boolgeeda Creek also supported the Priority 4 listed reptile *Notoscincus butleri*. Some areas of vegetation containing Mulga (*Acacia aneura*) are present towards the southern end of the transport corridor. These are not of the grove / intergrove form that is typically associated with surface sheet flow across areas of very low topography.

Loss of Fauna

It is inevitable that there will be some localised loss of fauna due to direct mortality arising from construction activities, including that which may occur during the clearing of habitat. Ongoing impacts may also arise from more frequent vehicle movements, train movements and machinery operation. For all vertebrate and the majority of invertebrate taxa it is very unlikely that the loss of individuals associated with such direct mortalities would be significant enough to affect the overall conservation status of any of the species recorded from the BS4 Project area (death or injury of any significant fauna will be reported to CALM).

Short-range taxa recorded in the BS4 Project area, which have been identified to date, are widely distributed beyond the Project area, with most records outside of the proposed impact areas. It is therefore considered unlikely that the BS4 Project will affect the conservation status/significance of these species. Biota has collected in excess of 240 land snails (from 22 locations) outside the BS4 Project area, many of which appear to be the same species as the *Rhagada* sp "Mt Brockman" that was found within the BS4 Project area (Biota, 2005b; **Appendix E**).

Modifications to Fire Regimes

Track grinding and rail maintenance activities have the potential to cause fire in adjacent areas. The presence of additional personnel and equipment in the area during construction of the rail and mine may also result in unplanned fires in the BS4 Project area.

The consequences of this potential for increased fire frequency would depend on the affected habitats and the fauna species present. Increased fire frequency has been linked with the demise of land snails for particular areas in the Kimberley region of WA (Solem, 1997). All of the land snails recorded within the BS4 Project area were aestivating in the top 5-10 cm of soil beneath large *Triodia* clumps. An increase in the frequency of fires in the BS4 Project area may therefore have a detrimental effect on the conservation status of land snails occurring locally.

Noise and Blasting Impacts

Noise from mining activities, including blasting, train movements and general mining operations, has the potential to impact on fauna. However, no particularly sensitive habitats or communities (e.g. significant bat roosts or breeding populations of birds) were recorded in the BS4 Project area (Biota, 2005b).

Restriction of Fauna Movement

The construction of the proposed rail spur transport corridor has the potential to act as a barrier to the movement of some fauna species and could potentially cause subdivision of populations situated along the rail alignment. The extent to which this would affect the various fauna occurring along the corridor is dependent on a range of factors including but not limited to, design features of the rail (e.g. depth of cut or height of embankment, frequency of culverts, etc.), as well as habitat preferences and dispersal capabilities of the fauna.

Introduction and Spread of Weed Species

Ground disturbance associated with construction and maintenance of the mine and rail provides an opportunity for the infiltration and spread of weeds. The impact of weed infiltration on fauna biodiversity is not well documented.

Dust

Dust generated during the construction and operation of BS4 has the potential to negatively affect surrounding vegetation, but this is considered likely to be a minor impact provided standard dust suppression measures are implemented. The Pilbara is also a naturally dusty habitat and almost all fauna would be well adapted to periods of intense wind-blown dust through natural events.

7.3.3 Management

Hamersley Iron will implement a number of management measures to ensure the impact to terrestrial native fauna species from the BS4 Project is minimised. These measures are outlined below.

Habitat Disturbance and Modification

- Topsoil management and rehabilitation will be addressed in the EMPs in liaison with CALM, the DoE and DoIR. Both topsoil and cleared vegetation will be returned to landforms contoured to resemble the surrounding topography. Rehabilitation of disturbed areas will occur with minimal delay.

Land Snails

- Hamersley Iron has initiated funding of a genetic study to assist in resolving the taxonomy and distribution of *Rhagada* sp "Mt Brockman" from the BS4 Project area and from other locations.

Surface Hydrology

- Wherever possible, disturbance to surface drainage features will be avoided through appropriate mine planning. Where disturbance is unavoidable, sufficient culverts will be installed to maintain surface water flows.

- The design and layout of the rail spur and mine site infrastructure will take into account the location of any habitat units of high conservation value and disturbance to these areas will be avoided where possible. Vegetation clearing will be kept to the minimum necessary for safe construction and operation of the BS4 Project, particularly in areas adjacent to vegetation of higher conservation significance.

Weeds

- Weed control measures will be developed and implemented to prevent the introduction or spread of weeds in the BS4 Project area. Weed hygiene will be addressed in the EMPs in liaison with CALM.

Fire

- Prevention of fire is a key priority in all Hamersley Iron operations, especially field activities in the highly flammable Spinifex vegetation. Hamersley Iron will address fire management as part of the EMPs to minimise the risk of unplanned fires in the BS4 Project area.

Dust

- Standard dust suppression measures (principally application of water by truck in active working areas and along trafficked roads) will be implemented across the BS4 Project area during construction and operation to minimise effects on surrounding vegetation.

7.3.4 Predicted Outcome

Based on the above, the BS4 Project is considered to meet the EPA objectives for fauna, including threatened fauna. Fauna populations, fauna habitat and the conservation status of Specially Protected and Priority fauna will not be adversely impacted upon by the BS4 Project.

7.4 Stygofauna

7.4.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of stygofauna is 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.

Applicable Guidelines include:

- *EPA Guidance Statement No. 54: Consideration of subterranean fauna in groundwater and caves during environmental impact assessment in Western Australia (EPA, 2003b).*

7.4.2 Potential impacts

Stygofauna are found in aquifers and alluvium deposits. At present there are no stygofauna species listed in Schedule 1 under the Wildlife Conservation Act 1950 from the Pilbara mainland.

Stygofauna may potentially be impacted upon through disturbance to habitat in the active mining area. Stygofauna may also potentially be impacted upon as a result of abstraction of groundwater from the borefield for construction and operation purposes.

Further potential impacts may arise as a result of groundwater pollution from surface spills and possible incursion of saline water into the surrounding aquifer from open pits if pits are not backfilled to above the water table. However this is not likely to be an issue as groundwater in the BS4 Project area is fresh with TDS ranging from 180 mg/L to 1,400 mg/L, and in addition the pits will be backfilled to above the water table.

Two phases of sampling for stygofauna in the BS4 Project area have only recorded a single bathynellid specimen. This animal was collected from a bore that is inside the predicted dewatering impact area for the Project in February 2005. Follow-up sampling in April 2005 did not record any stygofauna from the BS4 Project area. A review of geological formations in the study area suggested that the formations in the central impact area are unlikely to support stygofauna. A superficial alluvium formation in the valley to the north of the BS4 Project area may support stygofauna and this will be targeted in future sampling work (see **Section 7.4.3**).

7.4.3 Management

Hamersley Iron has a stygofauna research program that was initiated by the Company in 1998. This has incorporated regular sampling for stygofauna at Hamersley Iron sites, including Nammuldi, Silvergrass, Brockman 2 and Homestead operation areas. The BS4 Project will be incorporated into this research program.

The recommendations arising from the stygofauna assessment (refer to **Appendix F**) will also be implemented, namely:

- An additional sampling phase will be completed in the BS4 Project area. This will be left for a period of not less than six months from the date of the second sampling phase (April 2005), in case time elapsed since bore construction has been a factor in the results observed to date. Current Project timing is such that this final phase of sampling would take place prior to any dewatering commencing for the BS4 Project.
- Additional sampling bores will be installed to target the alluvial creek system in the valley north of the BS4 area and sampled as part of the next phases of work. Groundwater levels will be monitored in the superficial aquifer in these bores, both prior to and during Project dewatering.
- Any additional bores installed will include slotting in the case through superficial formations (particularly where alluvium and calcrete are present), to maximise their suitability for stygofauna sampling.

The results of the BS4 stygofauna sampling program will be collated with other studies of the distribution and ecology of Pilbara stygofauna underway by BHP Billiton Iron Ore and the WA Museum, to determine the conservation status of the species found.

The stygofauna sampling for the BS4 Project was carried out in a manner consistent with the requirements outlined in EPA Guidance Statement Number 54 (EPA, 2003b).

7.4.4 Predicted Outcome

Based on current available information, the conservation status of any stygofauna that may be present in the area is unlikely to be changed as a result of the BS4 Project.

7.5 Watercourses and Surface Water Quality

7.5.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of watercourses is to maintain the integrity, ecological functions and environmental values of watercourses and sheet flow.

The Objective for surface water quality is 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.

Applicable Standards and Guidelines include:

- *ANZECC/ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCAZ, 2000).*
- *EPA Draft Guidance Statement No. 26, Management of Surface Run-off from Industrial and Commercial Sites (EPA, 1999a).*
- *Rio Tinto Environmental Standard, Water Use and Quality Control (Rio Tinto, 2003b).*

7.5.2 Potential Impacts

The haul roads and rail spur will cross ephemeral drainage lines, ranging from a few metres wide to larger seasonal drainages. The construction and operations of the rail spur and mining and processing infrastructure may impact on the hydrology and water quality of watercourses. Impacts to watercourses may include alteration of natural sheet flow, increased erosion and sediment deposition and pollution (e.g. hydrocarbon runoff from workshops etc).

7.5.3 Management

All facilities will be located away from seasonal waterholes and pools, and drainage lines that are crossed by rail or access roads will use culverts where practicable to ensure that down-stream vegetation is not affected by watercourse diversion or obstruction. There will be no requirement for bridges along the rail spur or mining area. This will reduce the possibility of interrupting surface flow and water ponding behind embankments.

Owing to the extreme rainfall events experienced in the Pilbara from time to time, prevention of all runoff entering the environment from the BS4 Project area is almost impossible. Site-specific surface drainage controls will be implemented where required. Sumps will be constructed immediately around ore processing and product stockpiling areas. Drainage from these areas will flow to one or more retention basins installed to contain and settle out sediment from surface runoff. All sumps will be

constructed to fully contain a 1 in 5 year rainfall event. Potentially contaminated runoff from around the process plant will be treated to remove all contaminants prior to discharge to the environment.

Drainage sumps will be inspected regularly and cleaned out before the onset of the wet season each year. Excess surface water runoff will be released to the environment after passing through a retention basin to remove silt.

The heavy vehicle and light vehicle washdown facility will incorporate a sediment trap and oily water treatment plant.

All hydrocarbons and chemicals will be stored according to Australian Standards to minimise contamination (refer to **Section 7.10.3**).

7.5.4 Predicted Outcome

The natural functions and environmental value of watercourses and sheet flow within the Project area and further downstream, will not be adversely affected by the BS4 Project.

No unacceptable adverse impacts to surface water quality will occur.

7.6 Groundwater

7.6.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of groundwater is to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

The EPA objective for the management of ground water quality is 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.

Applicable Guidelines and Standards include:

- *ANZECC/ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCAZ, 2000).*
- *Water and Rivers Commission, Environmental Water Provisions Policy for Western Australia: Statewide Policy No. 5. (Water and Rivers Commission, 2000).*
- *Rio Tinto Environmental Standard, Water Use and Quality Control (Rio Tinto, 2003b).*

7.6.2 Potential Impacts

Water will be sourced for process water, dust suppression and potable water purposes from groundwater production bores and mine dewatering bores. Abstraction of groundwater may lead to short and long-term changes to water table levels and aquifer hydraulics. Unsustainable groundwater abstraction may result in adverse short and long-term impacts to groundwater supplies. The main potential impacts are outlined below.

Groundwater Levels

The main impact on the groundwater system from the BS4 Project will be a reduction in groundwater levels in the area immediately around the mine and water supply borefields and a reduction in groundwater outflow to adjacent areas. This will result both from the abstraction of groundwater for water supply and from mine dewatering. The extent of this cone of depression as predicted by groundwater modelling is illustrated in **Figure 16**.

It is not considered likely there will be significant detrimental impacts related to this water level drawdown for the following reasons:

- Groundwater levels throughout the BS4 Project area are naturally deep and do not support phreatophytic vegetation (with the exception of vegetation type C1 - Coolibah *Eucalyptus victrix* woodlands mainly along Boolgeeda Creek, and possibly vegetation type P1- the Mulga woodlands in the broad drainage area within the valley south of the BS4 range), and there is no indication of shallow water table aquifers within the BS4 Project area;
- There is little evidence to suggest that stygofauna are present;
- There are no existing groundwater users in the area; and,
- The area is characterised by low rates of groundwater recharge and throughflow; as such, a reduction in outflow from the BS4 Project area to adjacent areas affects relatively small volumes of water.

Impacts on Other Groundwater Users

Groundwater is extracted for watering of livestock on Rocklea Station. The amount of water drawn for this purpose is small, and the nearest bore to the BS4 Project area is 10 km to the west of the Boolgeeda Borefield and 15 km north-west of the mine pits. The BS4 Project will not affect abstraction of groundwater for pastoral use.

Groundwater Quality

The potential impacts of the BS4 Project on groundwater quality are twofold:

- Pollution from chemical and hydrocarbon materials and wastewater streams from the operation; and,
- Increases in salinity caused by the concentration of salts by evaporation of water in mined-out pit voids.

7.6.3 Management

Strategies for sustainable management of the borefield will be included in the Borefield Management Plan, which will be prepared prior to the application for Groundwater Well Licences from the DoE. These will include rotation of groundwater production bores to assist recharge.

Groundwater Levels

Mine dewatering and water supply abstraction will be integrated to reduce, where practicable, impacts of groundwater abstraction. It is predicted that the proposed Mine Area water supply borefield will assist dewatering and no excess groundwater production and disposal is anticipated.

Comprehensive groundwater monitoring will take place to ensure water level declines are consistent with those that have been predicted and where required, the groundwater model will be updated with the results of operational monitoring data to confirm that predictions remain valid. The proposed monitoring programme will include recording:

- Regional groundwater levels on a monthly basis;
- Pumping water levels and pumping volumes from abstraction bores on a monthly basis;
- Water quality monitoring in production bores on a 6-monthly basis; and,
- Annual review and assessment of all monitoring data.

Once mining and groundwater abstraction in the BS4 area ceases, water levels are expected to recover to pre-mining conditions and no significant permanent impact will occur. Mine closure strategies including in-pit dumping of waste rock in order to backfill pits to above the regional water table.

Groundwater Quality

Groundwater quality will be managed by:

- Backfilling mined out pits to above pre-mine water table levels to prevent long-term salination of groundwater caused by evaporation;
- Prevention of groundwater pollution and contamination through appropriate waste management practices (refer **Section 7.10.3**); and
- A wastewater treatment plant will be established adjacent to the village and contractor's camp to treat sewage and grey water.

7.6.4 Predicted Outcome

Groundwater drawdown and water quality will be monitored and water abstraction managed in a sustainable fashion. Groundwater levels are expected to recover following the cessation of mining and groundwater abstraction, and it is not expected that there will be unacceptable adverse impacts to groundwater quality.

7.7 Air Quality – Dust

7.7.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of air quality/dust is to ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of peoples and land uses by meeting statutory requirements and acceptable standards.

Applicable Guidelines and Standards include:

- *EPA Guidance Statement No. 18, Prevention of air impacts from land development sites (EPA, 2000b).*
- *Rio Tinto Environmental Standard, Air Quality Control (Rio Tinto, 2003c).*

7.7.2 Potential Impacts

The Project area is an arid environment that is subject to naturally high background dust levels. This is recognised in the discussion paper on a State-wide Air Quality Environmental Protection Policy (EPA, 1999b) that notes airborne dust in the Pilbara (and Goldfields) can be a problem as background levels can be close to or higher than the National Environmental Protection Measure (NEPM) standard.

Dust or particle monitors have a cut-off for the size range of the particles they collect and measure. Three size ranges commonly used are 50 μm, 10 μm and 2.5 μm. The particulate matter (PM) measured is abbreviated as PM_{50}, PM_{10} and $PM_{2.5}$, respectively. PM_{50} is also referred to as Total Suspended Particulates (TSP).

TSP measurements are associated with potential for nuisance or loss of amenity. PM_{10} and $PM_{2.5}$ measurements are associated with the potential for health impacts because particles below these sizes may penetrate the nose and enter the lung. The NEPM Standard values for particulate aim to protect people's health and well-being, through the means of a nationally acceptable ambient standard.

The NEPM standard proposed by the National Environmental Protection Council for dust (particles as PM_{10}) is provided in **Table 7-1**.

Table 7-1 NEPM standard* for particulate emissions

Pollutant	Averaging time	Maximum concentration	Allowed exceedances (10 year goal)
Particles as PM10	24 hours	50 μg/m^3	5 days a year

* National Environment Protection Council, NEPM for Ambient Air Quality, 26 June 1998 and Variation dated 23 May 2003.

Dust may be generated during construction, mining (drilling, blasting), ore handling (loading, unloading, transferring) ore processing and ore transport activities. Stripping and stockpiling of topsoil, waste rock and/or overburden will also generate dust, and a small amount of dust will be generated during transport of ore by rail to the Dampier and Cape Lambert ports.

The Brockman type ore that will be mined has the potential to generate significant quantities of dust when the moisture content is low. The majority of the ore at BS4 (i.e. approximately 80 %) will be mined from above the water table, and is thus expected to be a major source of dust without application of water.

Ore from above the water table will have a moisture content of approximately 3 %. Ore from below the water table is expected to have a moisture content of approximately 8 %, and is not expected to generate significant quantities of dust.

Cleared areas that have not been rehabilitated, such as active waste dumps, will also be a source of dust from the BS4 Project area.

Dust generation may lead to significant impacts on vegetation growth in the BS4 Project area through deposition of dust on plant foliage causing a reduction in the ability of the plant to photosynthesise. In areas where dust generation is high, vegetation may be adversely affected by repeated deposition of dust on the foliage.

Residences are not expected to be significantly impacted by dust from the BS4 Project due to the isolated location of the Project area. The closest residence is Hamersley Station homestead, located 55 km from the Project area.

Asbestiform fibres

Asbestiform fibres occur naturally in iron-based rock types throughout the Pilbara. This material poses a serious occupational health hazard if inhaled. No asbestiform fibres have been encountered during drilling of the BS4 Brockman ore body.

7.7.3 Management

Hamersley Iron will employ all reasonable and practicable measures to minimise dust emissions from the BS4 Project. Hamersley Iron will address dust management in the Construction and Operational EMPs. The following dust management measures will be adopted:

- Maintaining appropriate moisture content of the ore to minimise dust generation. Product moisture has been assumed at 3 % for lump and 8 % for fines;
- Scheduling of blasting activities to coincide with favourable weather conditions;
- Primary, secondary and tertiary crushing will be fitted with a dry bag house type dust collection system. Dust from the bins and screen house will be collected in a bag house and returned to the flow;
- Application of water and possibly dust suppressants to haul roads and highly trafficked areas;
- Enclosure of conveyor transfer points and belts;
- Efficient clean-up of spilt product around transfer points, etc.;
- Wetting down of product contained in rail wagons prior to departure from BS4 for transport to Dampier;
- Encouragement of employees to adhere to speed limits on unsealed roads;
- Progressive rehabilitation to minimise total area remaining exposed;
- Monitoring of vegetation health in dusty areas;
- Minimising vegetation clearing where possible;
- Regular inspections to visually assess dust generation and to ensure correct functioning of dust suppression equipment; and,

- During construction and operation, periodic dust monitoring will be implemented as necessary to quantify the significance of dust emissions and to determine ambient dust levels.

Hamersley Iron will employ water conservation strategies to reduce water consumption. As the majority of water consumed will be used for dust suppression, Hamersley Iron will continue to investigate alternative dust suppression products to reduce the reliance on water where practicable.

7.7.4 Predicted Outcome

The implementation of dust management measures and monitoring will ensure that the BS4 Project will not adversely affect environmental values or human health.

7.8 Greenhouse Gases

7.8.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of greenhouse gases (GHG) is to minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.

Applicable Guidelines and Standards include:

- *EPA Guidance Statement No. 12, Minimising Greenhouse Gas Emissions (EPA, 2002a).*
- *Rio Tinto Environmental Standard, Greenhouse Gas Emissions (Rio Tinto, 2003d).*

7.8.2 Potential Impacts

GHG in the Earth's atmosphere play a role in maintaining global temperature by absorbing infra-red radiation. The International Panel on Climate Change has determined that it is likely that increases in GHG are implicated in observed changes to the Earth's climate.

In 1998, the Australian Government signed the Kyoto Protocol committing Australia to limit GHG emissions in the period 2008 – 2012 to 108 % of 1990 emissions. The Government is yet to ratify that Protocol.

The six GHG specifically covered by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), perfluorocarbons (CF_x), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrous oxide (N_2O) (Commonwealth of Australia, 1998). To compare warming potential of the different gases, their impact is usually expressed in terms of CO_2 equivalents, where the potential of each to lead to heating in the atmosphere is expressed as a multiple of the heating potential of CO_2 (i.e. tCO_{2e}).

The Western Australian EPA has developed a guidance statement to minimise GHG emissions (EPA, 2002a) that requires proponents of new projects to consider the potential impacts of their project and compare this impact with that of similar projects.

In addition to the above, Rio Tinto has adopted a specific set of GHG principles for all its operations and the BS4 Project will adhere to these. In summary, the principles are to:

- Develop, document and maintain knowledge of GHG emissions. This must include an understanding of current and future GHG sources and the factors that affect emission levels from the sources;
- Identify and assess GHG related risks and opportunities for the business or operation. This is to include where applicable, the use of specific or generic emissions abatement cost curves, assessments of emissions trading, offset opportunities and factor in changes as a result of national or international policies and measures;
- Develop and achieve GHG emissions reduction targets to drive improvements in emissions control and reduction. Progress towards the targets must be supported by suitable sets of actions and milestones that are linked to the business planning process;
- Ensure that technical and commercial considerations of GHG emissions issues (including possible costs inferred by government-imposed carbon tax schemes or CO_2 emissions regulations) are included in:
  - Annual business plans and valuations;
  - New project evaluations;
  - Capital expenditure programs; and,
  - Due diligence reviews for divestments and acquisitions.
- Implement and maintain GHG emission control and reduction programs. Upgrade these as the business needs and external requirements change and as there is progress in the understanding of, and responses to, climate change issues;
- Assign clear responsibilities, resources and accountabilities for GHG management. Responsibilities must include progressing established actions for achieving GHG targets;
- Ensure that the appropriate measures are in place for metering, or estimating where appropriate, GHG emissions; and,
- Conduct periodic reviews to identify potential risks and opportunities associated with GHG issues at the business or operation.

With regard to the BS4 Project, the main GHG is carbon dioxide (CO_2). Carbon dioxide emissions from the Project will be generated through:

- Decomposition of cleared vegetation and soil materials (estimated at 13.5 tC/ha over 30 years);
- The combustion of gas at the Dampier Power Station to meet the Project's power requirements;
- The combustion of diesel fuel used in heavy and light vehicles;
- The detonation of explosives used in blasting;
- Decomposition of putrescible solid wastes; and,
- The combustion of diesel fuel during train journeys from the BS4 mine to Dampier and/or Cape Lambert Ports.

The predicted levels of CO_{2e} emissions from the BS4 Project, calculated for the full production rate of 20 Mtpa are provided in **Table 7-2**. This does not take account of offsets from GHG sinks in rehabilitation areas.

- **Table 7-2 Estimate of the BS4 Project's CO_{2e} emissions**

Source	Emissions (per tonne of production per annum)
Vegetation clearing/breakdown	0.20 kg CO_{2e}[+]
On-site emissions - diesel combustion, electricity generation, explosives, solid waste decomposition.	3.80 kg CO_{2e}
Off-site emissions - railing of ore to port(s).	1.59 kg CO_{2e}
Total[++]	**5.59 kg CO_{2e}**

Notes: These CO_2 emission estimates have been taken on a ratio based on the Brockman 2 mine site emissions at maximum production during 2004. NO_x from explosive use and methane from solid waste decomposition will be minor and has therefore not been included.

[+] Assuming the release of CO_2 from vegetation clearing/breakdown occurs uniformly over 30 years.

[++] Does not include CO_{2e} sequestered during rehabilitation.

As shown in **Table 7-2**, assuming the release of CO_2 from vegetation clearing/breakdown occurs uniformly over 30 years, the BS4 Project is estimated to generate approximately 5.60 kg CO_{2e} per tonne of ore per annum, which is similar to that of 6.06 kg CO_{2e} per tonne for Hope Downs (Hope Downs Management Services, 2002) and 6.70 kg CO_{2e} per tonne for Yandicoogina (Hamersley Iron, 2005). The total CO_2 emissions per annum from the BS4 Project are therefore estimated to be 111.8 kt CO_2.

Contextual GHG emission predictions (CO_2 equivalents) are:

- Western Australia's resource industry emission predicted for 2010 is 39.8 Mt; and
- The increase in Western Australia's resource industry emission for 1990-2010 is estimated to be 27.6 Mt.

7.8.3 Management

Annual GHG emissions are estimated for all sites as a result of Rio Tinto being a signatory to the Greenhouse Challenge and by adoption of the principles discussed above. Through Rio Tinto Limited, Hamersley Iron was a founding signatory of the Greenhouse Challenge, and has taken an active role in Challenge programs since then. The BS4 Project will be incorporated into this background and will comply with the Rio Tinto GHG Standard, from which the above principles are taken. Emissions will be estimated on an annual basis and reported to Rio Tinto, which will collate these estimates with other operations and provide the data to the Australian Greenhouse Office (AGO).

Over the life of the BS4 Project, approximately 2,470 ha of vegetation will be cleared. This will result in emissions of approximately 122.38 ktCO_{2e}. The total emissions estimate from clearing has not been adjusted to allow for carbon sequestration during rehabilitation, as progressive rehabilitation will occur, and the areas and rate of growth of vegetation cannot be readily estimated.

Hamersley Iron will minimise vegetation clearing where practicable, thereby assisting to minimise GHG emissions from the BS4 Project. Progressive rehabilitation of open areas will result in partial offsets of GHG emissions over the life of the Project.

The major source of emissions is the conversion of diesel and gas to energy. In response to pressures for cost efficiencies and Hamersley Iron's commitment through Rio Tinto to the Greenhouse Challenge, the Company is committed to investigating alternative fuel options, such as biodiesel, as well as increasing efficiencies in current operations to reduce emissions. Minimising greenhouse gas emissions will be considered further during project design and operation of the BS4 Project. Energy efficiency projects will also be considered during project design. As an example, an overland conveyor is being used to transport ore, which significantly reduces truck numbers and diesel use.

Use of perfluorocarbons, hydrofluorocarbons and sulphur hexaflouride materials at the site will be prohibited.

Any abatement projects will be reported to the AGO through Rio Tinto as part of the Greenhouse Challenge program.

In addition, in the detailed design of the BS4 Project, Hamersley Iron will consider:

- Selection of the most energy efficient technology available where practicable.
- Energy consumption as a criterion in equipment selection.
- The use of renewable energy sources where appropriate i.e. solar panels for heating of water at the village and camp.

7.8.4 Predicted Outcome

Emissions of greenhouse gases from the BS4 Project will be kept as low as practicable.

7.9 Noise and Vibration

7.9.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of noise and vibration is to protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.

Applicable Standards and Guidelines include:

- *EPA Draft Guidance Statement No. 8: Environmental Noise (EPA, 1998).*
- *Environmental Protection (Noise) Regulations 1997.*
- *Preliminary Draft Guidance for EIA No. 14, Road and Rail Transportation Noise (EPA, 2003c).*
- *Rio Tinto Environmental Standard, Noise and Vibration Control (Rio Tinto, 2003e).*

7.9.2 Potential Impacts

The nearest noise sensitive premises to the BS4 Project area will be the BS4 village and contractor's camp, where employees and contractors will be housed for the Project. The current proposed location of the village and camp, which is approximately 10 km from the plant, 2 km from the rail spur and 3 km from the airstrip, should result in negligible noise issues, other than during infrequent adverse weather conditions such as temperature inversions. The Brockman 2 camp (approximately 25 km away) and Hamersley Station homestead (approximately 55 km away) are not expected to be impacted by the BS4 Project due to the separation distance.

Construction and operations will cause periodic increases in noise levels, and this will be similar to that associated with the Brockman 2 operation. The main source of noise will be from blasting which will be conducted during daylight hours.

Occupational Health and Safety exposure levels have been specified that noise levels are not to exceed 85dB(a) at 1 m, except in the immediate vicinity of the primary crusher, and that noise exposure of personnel is not to exceed 85 dB(a) over any 12 hr shift. This will be achieved in the primary crusher area using Personal Protective Equipment.

7.9.3 Management

Hamersley Iron will employ all reasonable and practicable measures to minimise noise emissions from the BS4 Project. Hamersley Iron will address noise management in the BS4 Project EMPs. Noise management measures that may be considered include:

- Purchase of heavy equipment with reduced Sound Pressure Levels;
- Modification of blasting practices to reduce noise emissions;
- Consideration of meteorological data during general operations and blasting; and,
- Design and layout of the mine site (e.g. stockpile locations) to minimise/mitigate noise emissions.

All personnel in areas subject to noise from heavy machinery or other sources will be supplied with appropriate protective equipment.

7.9.4 Predicted Outcome

No unacceptable impacts from noise generated during construction and operation of the BS4 Project.

7.10 Waste and Hazardous Substance Management

7.10.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for waste management is to ensure that waste is contained and isolated from ground and surface water surrounds and treatment or collection does not result in long-term impacts on the surrounding environment.

Applicable Guidelines and Standards include:

- *EPA Position Statement No. 7. Principles of Environmental Protection (EPA, 2004c).*
- *Rio Tinto Environmental Standard, Hazardous Materials Guidance Note (Rio Tinto, 2003f).*
- *Rio Tinto Environmental Standard, Non-Mineral Waste Management (Rio Tinto 2003i).*

7.10.2 Potential Impacts

Incorrect storage and disposal of waste and hazardous substances has the potential to result in contamination of groundwater, surface water and/or soil, impacts to flora and fauna, increased disposal costs, poor visual amenity, and health and safety issues.

General Waste

General waste to be generated by the BS4 Project will include:

- Construction wastes;
- Maintenance wastes (e.g. hydrocarbon and chemical waste, batteries, tyres, scrap metals);
- Sewerage and greywater from site amenities and on-site accommodation facilities; and,
- Miscellaneous wastes (e.g. putrescible wastes, old equipment).

Hazardous Substances

Significant hazardous substances that will be used include:

- Hydrocarbons; and,
- Explosives.

7.10.3 Management

General Waste

A Waste Management Plan (for non-mineral waste) has been developed for all Hamersley Iron sites and the principles of this will be applied to waste management at BS4. This Plan incorporates the Reduce, Reuse, Recycle principle for waste management. Waste management practices and requirements will be outlined during Environmental Inductions, and a module on waste management will be included in the site Environmental Awareness training program.

Reduce

Hamersley Iron will aim to reduce Project waste where possible. This will be achieved through:

- Purchase of stock in bulk to reduce packaging;
- Purchase of stock in refillable containers;
- Purchase of stock packaged in recyclable packaging; and,
- Minimising the use of consumables in disposable containers.

Reuse

Reuse may be achieved through refilling of containers such as bulka-boxes containing oil and lubricants, refilling of printer cartridges, mulching of vegetative waste, reuse of treated sewage to irrigate vegetation and potential repair and reuse of conveyor belt.

Recycle

Recyclable materials will include:

- Scrap metal;
- Batteries;
- Waste oil and oil filters;
- Paper and cardboard;
- Aluminium and tin cans, aluminium foil;
- Plastic containers/bottles numbered 1, 2 or 3; and,
- Glass.

All of the above listed materials will be stored in dedicated areas on-site while awaiting removal from site by a licensed contractor for recycling.

Waste to Landfill

Non-hazardous, non-reusable and non-recyclable wastes will be disposed of to an on-site landfill. These wastes will include:

- Used conveyor belt (if non-repairable) and tyres (to be buried in a designated rubber area unless a suitable recycling option becomes available); and,
- Concrete.

The landfill will be approved by the DoE and operated in accordance with relevant legislation and standards.

Hazardous Substances

The transport of hazardous substances to the mine will be undertaken in accordance with the Dangerous Goods (Transport) (Road and Rail) Regulations 1999 and the Australian Code for the Transport of Dangerous Goods by Road and Rail.

During construction and operations, Hamersley Iron will ensure hydrocarbons and chemicals are stored according to Australian Standards, and will minimise the risk of contamination at all times. Storage of bulk fuel will be in above ground tanks, either within impermeable, bunded enclosures, or in double-skinned tanks that do not require bunding.

Storage of explosives will be in remote magazines in accordance with the Explosives and Dangerous Goods Act 1961.

Hamersley Iron will incorporate Hazardous Substances Management into the EMPs for the BS4 Project, and procedures will be in place for correct handling, spill management and clean-up.

Hydrocarbon and chemical waste will be removed from site by a licensed contractor for disposal to an approved facility in accordance with the requirements of the controlled waste regulations.

Sewage and Greywater

Sewage and greywater from the mine operations buildings, plant and accommodation camp will be treated on-site using package sewage treatment plants, before being discharged to the environment through spray irrigation of native vegetation. Where feasible, greywater will be used to irrigate landscaped areas around the village and camp.

7.10.4 Predicted Outcome

Appropriate management of waste that has the potential for contamination of soil, surface water and groundwater minimised. No adverse impacts to soil, surface water or groundwater quality are expected.

7.11 Overburden and Waste Rock

7.11.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for waste management is to ensure that waste is contained and isolated from ground and surface water surrounds and treatment or collection does not result in long-term impacts on the surrounding environment.

The objective is to clearly identify potentially acid forming material, selectively handle this material, and store the material so that leachate is not generated.

Applicable Guidelines and Standards include:

- *Department of Minerals and Energy. Guidelines for Mining in Arid Environments. June 1996.*
- *Rio Tinto Environmental Standard, Mineral Waste Management (Rio Tinto, 2003g).*
- *Rio Tinto Environmental Standard, Acid Rock Drainage Prediction & Control (Rio Tinto, 2003h).*

7.11.2 Potential Impacts

Overburden and Waste Rock

Approximately 415 Mt of overburden and waste rock will be removed prior to and during mining and stockpiled in waste dumps, which if not appropriately engineered could result in unstable landforms and erosion, and present health and safety issues.

Pyritic Black Shale

Rock containing sulfide minerals (e.g. pyrite) can react with air and water to produce acidic drainage water. The environmental consequences of the reaction include acid generation, release of heavy metals, contamination of groundwater and surface water and vegetation dieback.

The BS4 orebody contains a section of pyritic black shale on the southern boundary. Whilst the pyritic black shale extends the length of the proposed pits, it is not intended that this material will be mined or exposed during the mining operation (see **Figure 12**). As such, it is not expected that there will be any issues of acid rock drainage from the pit walls or from the waste dumps.

7.11.3 Management

Overburden and Waste Rock

Hamersley Iron has, and will continue to, endeavour to minimise the overall footprint of the BS4 Project, and understands that this will reduce the overall environmental impact, and also the amount of mine rehabilitation required. As there is obviously an economic driver to avoid double handling of overburden, Hamersley Iron will make use of the opportunities to directly backfill voids (without sterilising minable ore) as they occur.

Initially, overburden and waste rock will be placed in purpose built stockpiles, until a mined out pit void is ready to receive backfill. The purpose built waste dumps will be constructed to industry standards, will be stable and non-eroding and will be contoured to blend in with the surrounding topography. If the waste dump is to remain after mine closure, it will be capped with topsoil and re-vegetated.

As space becomes available, waste rock and overburden material will be used to backfill pits to above the water table. The waste dumps will be contoured to create a post-mining landform and rehabilitated.

Rehabilitation and Decommissioning is covered in **Section 7.13**.

Pyritic Black Shale

Hamersley Iron has a Black Shale Management Plan that is specific to its Mt Tom Price operation. Under this Plan, potentially acid-generating material is encapsulated in waste dumps to minimise the likelihood of acidic components leaching from the waste rock and into the water table or surface water bodies.

As a contingency measure, Hamersley Iron will adopt the principles of this Plan for the BS4 Project, and address acid rock drainage in the Construction and Operational EMPs.

7.11.4 Predicted Outcome

Overburden and waste dumps will be safe, stable and non-polluting, and material that is potentially acid-generating is not expected to be mined or exposed.

7.12 Visual Amenity, Landscape and Geoheritage

7.12.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of visual amenity is to ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape to as low as reasonably practicable.

The EPA objective for the management of landscape and geoheritage is to maintain and protect any significant landscape and geoheritage values and maintain the integrity, ecological functions and environmental values of the soil and landform.

Applicable Guidelines include:

- *Tasmanian Parks and Wildlife Service, Concepts and Principles of Geoconservation (2002).*

7.12.2 Potential Impacts

Activities or aspects of the proposal that may potentially affect landform include:

- Earthworks which include removing topsoil, overburden and ore during mining which will create voids in the landscape;
- Placement of stockpiles and waste dumps to form new raised landforms; and,
- Placement of infrastructure temporally altering the appearance of the natural environment.

Visual Amenity

A mining operation has the potential to significantly impact on visual amenity, and subsequently on industries such as the tourism industry. However, in the case of the BS4 Project, due to the isolated location of the Project area, there is not expected to be any significant adverse impacts to visual amenity. The BS4 mine site is not overlooked by or adjacent to populated or sensitive areas such as scenic outlooks, settlements or National Parks. Access to the Project area is limited, and can only be approached from the south via the White Quartz Road. There are no known plans for future tourism ventures in the immediate vicinity.

The landscape of the BS4 Project area is not considered to be unique, with similarly elevated areas and landforms occurring elsewhere in the Pilbara region, including the Karijini National Park (see **Figure 10**).

Landscape and Geoheritage

The Tasmanian Parks and Wildlife Service (2002) define ‘geodiversity’ and ‘geoconservation’ as follows:

> Geodiversity is the natural diversity of geological, landform and soil features, and processes. Geoconservation is 'the conservation of geodiversity for its intrinsic, ecological and (geo)heritage values.

The Canadian Geoheritage Committee (*www.carleton.ca/~jadonald/friends.html*) defines a geoheritage site as a site that meets one or more of the following criteria:

- It exposes a unique or critical record of natural history;
- It contributes to understanding the natural history of the region;
- It is scientifically important, or of significant educational utility; or,
- It offers distinct aesthetic and cultural values.

There are no places of natural heritage listed on the Department of Environment and Heritage database and no features or values of significant geoheritage or landscape value have been identified within the BS4 Project area, and hence there is not expected to be any significant impacts.

7.12.3 Management

The BS4 Project will meet the EPA objective for visual amenity and landscape due to it being remote from public roads, recreation areas, towns and other public areas. However, Hamersley Iron will further minimise visual impacts through minimising vegetation clearing and, as far as is safe to do so, use colours on infrastructure that blend with the surrounding landscape. During rehabilitation, surfaces will be contoured to create a post-mining landform, resembling as close as possible the pre-mining landscape.

7.12.4 Predicted Outcome

No significant impact on visual amenity, landscape or geoheritage as a result of the BS4 Project.

7.13 Rehabilitation and Decommissioning

7.13.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of rehabilitation and decommissioning is to ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.

Applicable Standards and Guidelines include:

- *Strategic Framework for Mine Closure (ANZMEC & Minerals Council of Australia, 2000)*
- *Mine Void Water Resource Issues in Western Australia (Water and Rivers Commission, 2003).*
- *Rio Tinto Closure Standard (Rio Tinto, 2004).*

7.13.2 Potential Impacts

The BS4 Project will disturb approximately 2,470 ha of land. If these areas are not appropriately decommissioned and rehabilitated, it could result in unstable landforms, contamination of groundwater, surface water or soil, impacts to flora and fauna, poor visual amenity or health and safety issues. In addition, poor closure planning may result in insufficient allocation of funds/resources for closure, particularly in the event of unforeseen closure.

7.13.3 Management

A Preliminary Rehabilitation and Closure Management Plan has been developed for the BS4 Project (see **Appendix G**). The development of this Plan is based on the Rio Tinto Closure Standard (Rio Tinto, 2004). The Plan addresses the knowledge base, closure strategy, closure inventory, closure costs and closure schedule and review for the BS4 Project, and has been developed largely on the basis of the methodology and strategies used for closure plans at other Hamersley Iron mine sites.

The Preliminary Rehabilitation and Closure Management Plan will be reviewed and updated regularly throughout the life of the operation, with a final Rehabilitation and Closure Management Plan to be

submitted at least two years prior to mine closure. Accounting methods will be used for managing financial closure provisions.

Hamersley Iron's specific closure planning objectives are as follows:

- To describe Hamersley Iron's approach to decommissioning, rehabilitation and closure;
- Ensure that Rio Tinto operations are closed in accordance with good industry practice;
- Provide a plan of closure measures required so that all parties have a clear vision of what will be required to achieve adequate closure;
- Estimate the total closure costs with an accuracy of ± 20 %;
- Identify any closure methods that will require investigation to confirm their effectiveness;
- Assist in identifying potential liabilities that could be reduced by adopting appropriate management practices during the life of the operation;
- Ensure that any programs required to facilitate closure are initiated early enough in the life of the operation to meet the closure requirements; and,
- Engage the community in the closure planning process.

The final Rehabilitation and Closure Management Plan will address rehabilitation and closure planning for the following facilities/areas:

- Rail spur;
- Mine pits;
- Waste dumps;
- Processing plants; and,
- Associated infrastructure.

The Plan will also addresses post-closure environmental monitoring and reporting requirements.

The rehabilitation measures to be adopted for the BS4 Project are summarised in **Table 7-3**.

Table 7-3 Rehabilitation measures to be adopted for the BS4 Project

Rehabilitation Measure	Description of Measure
Abandonment Bund	An abandonment bund constructed around the perimeter of an open voids and mine pits to 2 m height and 5 m width (base) consistent with statutory requirements.
Ballast Removal	Removal and disposal of rail ballast.
Exotic Vegetation	Removal and disposal of exotic vegetation.
General Waste	Loose debris, litter and other non-hazardous materials will be collected, removed and disposed of to landfill or a salvage yard as appropriate.
Landfill Capping	Capping of landfill with at least 1m of inert waste rock material. This measure also applies for footings left after removal of infrastructure, which will be covered with a minimum of 1 m of inert waste rock material.
Re-contouring	Re-contouring of shaped areas to remove all windrows and other impediments to run-off and prevent ponding.
Reshaping	Extensive earthworks and reshaping of non-waste dump areas.
Ripping and Seeding	Deep ripping (maximum 1 m depth) along contour and seeding.
Slope Battering	Battering of waste dump slopes from angle of repose to 20 degrees.
Paddock Dumping	Paddock dumping of waste material over surface of waste dump.
Topsoil and mulch placement	Topsoil and timber mulch will be spread over all reconstructed landforms (excluding haul roads and access tracks) to a maximum depth of 100 mm.
Pit Backfilling	Backfilling of pit and open voids to groundwater level.
Ripping	Deep ripping (maximum 1 m depth) along contour.
Seeding	Seeding with mechanical spreader.

As Hamersley Iron is already progressively rehabilitating its existing mine sites in the Pilbara (e.g. Brockman 2, Mt Tom Price), the lessons learnt and successes from these programs will be applied to the future rehabilitation and closure of the BS4 Project area. The lessons learnt to date include the importance of sound topsoil management, deep ripping, progressive rehabilitation, timing of rehabilitation and creation of fauna habitats.

7.13.4 Predicted Outcome

Rehabilitation will minimise the impacts of land disturbance, resulting in safe, stable and functioning landforms consistent with the surrounding landscape.

7.14 Aboriginal and European Heritage

7.14.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for Aboriginal heritage is to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations, and comply with relevant heritage legislation.

The EPA objective for European heritage is to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations, and comply with relevant heritage legislation.

Applicable Guidelines include:

- *EPA Guidance Statement No. 41: Assessment of Aboriginal Heritage (EPA, 2004h).*

7.14.2 Potential Impacts

Aboriginal Heritage

Ethnographic surveys conducted thus far in the BS4 Project area have not identified any sites of ethnographic significance. Hence, it is anticipated that the BS4 Project will not adversely impact on any areas of Aboriginal ethnographic heritage significance.

A total of 27 Aboriginal archaeological heritage sites have been located to date within the BS4 Project area. With future surveys to be undertaken, additional archaeological sites can be expected to be recorded. As shown in **Table 4-12**, the majority of recorded sites to date are rock shelters but they also include artefact scatters, water sources and scarred trees. While Hamersley Iron will endeavour to avoid Aboriginal heritage sites where practicable, a number of the identified Aboriginal heritage will need to be either disturbed or actively managed in order for the BS4 Project to proceed.

The two sites of significance located along the White Quartz Road will not be affected by the upgrading of the road.

European Heritage

A search of the State Register of Heritage Places showed no sites of European heritage significance are located within the Project area, and none are known to Hamersley Iron. The BS4 Project is therefore not expected to have any impact on any sites of European heritage significance.

7.14.3 Management

Aboriginal Heritage

At a State level, Aboriginal heritage sites are protected under the Aboriginal Heritage Act 1972.

ATAL currently operates under the auspices of a Heritage Protocol with the Pilbara Native Title Service (as representative body of the PKKP people), and an Indigenous Land Use Agreement (ILUA) with the Eastern Guruma people. These two agreements describe the manner in which Aboriginal heritage work is conducted with the respective groups.

Hamersley Iron will consult with Native Title claimant groups on the management of Aboriginal heritage sites within the BS4 Project area.

Where disturbance of an Aboriginal heritage site is unavoidable, Hamersley Iron will apply to obtain clearance from the Minister for Indigenous Affairs under the Aboriginal Heritage Act 1972 prior to the commencement of construction activities that may affect these sites. Support from the relevant Aboriginal group will be sought for this process. Once the Minister for Indigenous Affairs has received advice from the Aboriginal Cultural Material Committee (ACMC), a determination will be forwarded to the applicant. The applicant will be required to comply with whatever conditions are attached to the relevant permit(s).

The ACMC would normally require that any archaeological sites to be disturbed be salvaged by professional archaeologists. This might entail the collection of surface artefact scatters and the detailed excavation of relevant rock shelters.

Aboriginal heritage and cultural sensitivity issues will be addressed in all site Environmental Inductions.

Further Aboriginal heritage surveys will also be completed in the BS4 Project area during 2005. At present, these surveys will cover the rail corridor, power/water corridor, transport corridor, airstrip, camp, water bores and plant area.

European Heritage

As there are no known sites of European heritage significance within the BS4 Project area, Hamersley Iron considers that the BS4 Project will meet the EPA objective for this factor.

7.14.4 Predicted Outcome

Subject to receiving the necessary approvals, some Aboriginal heritage sites will be disturbed following appropriate consultation. No impact to European heritage.

7.15 Economic and Social Impacts

7.15.1 Management Objective and Applicable Standards and Guidelines

The EPA objective for the management of economic and social impacts is to ensure that there is a net social and economic benefit from the BS4 Project.

Applicable Guidelines include:

- *Department of Environment, Interim Industry Guide to Community Involvement, December 2003.*
- *EPA Position Statement No. 7. Principles of Environmental Protection (EPA, 2004c).*

7.15.2 Potential Impacts

The regional setting is described in **Section 4.10**. The BS4 Project area is remote, with the closest residential premise being Hamersley Station homestead, located 55 km north-east of the Project area. The closest towns are Tom Price and Paraburdoo, located 65 and 90 km from the Project area respectively. The Brockman 2 mine accommodation camp is located approximately 25 km from the mining area.

There is not expected to be any significant adverse economic and social impacts arising from the BS4 Project. However, the employment of a fly-in fly-out (FIFO) workforce may have some affect on the regional development and local involvement in the Shire of Ashburton, in particular, the town of Tom Price. The BS4 Project may also contribute to a predicted strain on local services/businesses as a result of the forecast increase in mining development in the Pilbara region over the next few years. However, the use of FIFO is unavoidable because Tom Price cannot sustain the additional workforce.

There are also potential detrimental impacts of FIFO on personal affairs, family life and relationships. However, FIFO is a personal decision, with many individuals preferring the flexibility provided by FIFO e.g. it allows families to decide where they will live, and what schools their children attend.

There will be significant positive economic benefits as a result of the BS4 Project. These include:

- A number of indirect employment opportunities will arise through the use of local businesses and services, mostly in the nearby towns of Tom Price and Paraburdoo;
- Increased opportunities for local indigenous communities, including employment and vocational training opportunities as part of existing Hamersley Iron programmes; and,
- Increased revenue to government from taxes.

7.15.3 Management

Hamersley Iron will continue to operate a community consultation program within the Shire of Ashburton. This will ensure any economic and social impacts that may arise at a later date are identified and addressed, with feedback provided to the community.

The BS4 Project is likely to benefit the local community by increasing support for services in the towns of Tom Price and Paraburdoo, and by increasing the number of indigenous training and employment opportunities.

A Tom Price Community Advisory Group was established in August 2003, and is comprised of key representatives from different parts of the Tom Price community. The Group meets monthly, with the meetings being chaired by the General Manager Mine Operations, Pilbara Iron.

The Group currently includes representatives from the:

- St John's Ambulance;
- Shire of Ashburton;
- Tom Price community;
- Tom Price Senior High School; and,
- Youth Advisory Council.

Other community initiatives being implemented and facilitated by Hamersley Iron include:

- 'The Inlander' - bi monthly newsletter published by Pilbara Iron. This is posted directly to all residents and businesses in Tom Price and Paraburdoo.
- 'The Communicator' is an independent community newsletter for Tom Price and Paraburdoo produced in Tom Price. Hamersley Iron utilise this when appropriate for communicating to the wider community in addition to communication through The Inlander. A recent initiative of the Community Advisory Group was to begin submitting an update from the Group (summary of each meeting) in The Communicator and The Inlander.

- Pilbara Iron has a notice board in Tom Price that is used to advertise local job vacancies and notices to the community.
- Letter mail outs to all residents and businesses are carried out when deemed necessary by External Affairs to address a particular issue.
- Community Liaison Officer roles have been established by Mine Operations in both Tom Price and Paraburdoo. These roles are closely linked to the Pilbara Iron Community Affairs Division.

The stakeholder consultation programme and issues raised is described in **Section 5**.

Fly-In Fly-Out

Hamersley Iron is cognisant of the need to manage FIFO to minimise potential impacts by finding the optimal balance of workday's on-site (including days-on, travel time, night shift rotation) and rest days at home that support long term involvement in FIFO work patterns.

7.15.4 Predicted Outcome

Positive contribution to the social and economic status of the region.

7.16 Summary of Environmental Management

The BS4 Project will be managed in accordance with numerous regulatory and other management instruments to ensure an integrated environmental management approach.

Table 7-4outlines the controls that will be in place to ensure environmental compliance and appropriate management of the BS4 Project in regard to each relevant environmental factor and issue.

Table 7-4 Environmental compliance and management controls for BS4 Project

Factor	Topic / aspect	Ministerial Conditions	Construct EMP	Ops EMP	Decomm. & Rehab. Plan	Works Approval	DoE Licence	Licence to Take Water	Rio Tinto Standard	NOI
Landform	Extent of ground disturbance	√		√						√
Water	Dewatering for mining	√	√	√				√		√
	Groundwater abstraction for administration, village supply		√	√				√		√
	Closure water issues	√		√	√					√
	Monitoring of surface water and groundwater	√	√	√			√	√		√
	Monitoring of groundwater in mining area	√	√	√		√		√		√
	Drainage management – mine		√	√		√				√
	Prevention of surface water contamination	√	√	√		√	√		√	√
	Drainage management – rail spur	√	√	√						√
	Water use minimisation		√	√					√	
Flora and fauna	Extent of clearing	√		√		√				√
	Protection of areas not approved to be cleared		√	√		√				√
	Protection of P11 habitat (including Priority 1 flora)	√	√	√						√
	Weed management		√	√						√
	Fire management		√	√						√
	DRF survey of the rail spur and White Quartz Road	√	√	√						
	Further study of short range endemics		√	√						
	Funding genetic study of *Rhagada* sp (land snails)		√	√						
	Ongoing study on stygofauna		√	√						
	Rehabilitation		√	√	√					√
Greenhouse gases	Emission reductions		√	√					√	√
	Reporting		√	√						√
Air quality	Dust	√	√	√		√	√		√	√

Factor	Topic / aspect	Ministerial Conditions	Construct EMP	Ops EMP	Decomm. & Rehab. Plan	Works Approval	DoE Licence	Licence to Take Water	Rio Tinto Standard	NOI
	Other air quality issues			√					√	
Noise	Noise management		√	√		√			√	√
Waste management	Overburden	√	√	√	√					√
	Operational liquid wastes		√	√			√			√
	Solid waste disposal (landfill)	√	√	√		√	√			√
	Sewage (including treatment facility)	√	√	√		√	√			√
Hazardous materials	Hydrocarbon management	√	√	√		√				√
	Hazardous substances / dangerous goods storage		√	√		√	√		√	√
Aboriginal heritage	Disturbance of sites	√	√	√						**Section 18 application**[+]
	Protection of sites / Aboriginal heritage values	√	√	√					√	√
	Archaeological and ethnographic surveys	√	√	√						√
Closure	Decommissioning and Rehabilitation Plan for the BS4 Project prepared to the satisfaction of DoE and DoIR	√		√	√				√	√
Rehabilitation	Rehabilitate disturbed areas	√		√	√	√				√
	Decommissioning and Rehabilitation Plan for the BS4 Project prepared to the satisfaction of DoE and DoIR	√		√	√				√	√

[+] **Under the Aboriginal Heritage Act 1972**

8. Environmental Management Commitments

The environmental management commitments made by Hamersley Iron for the BS4 Project are given in **Table 8-1**.

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Table 8-1 Proponent Environmental Management Commitments

Topic	Objective	Commitments	Timing	Advice from
Environmental Management System	Manage environmental impacts of the BS4 Project.	1. Incorporate the Project into the existing Hamersley Iron Environmental Management System.	Prior to operation.	
Environmental Management Plan (EMP)	Manage environmental impacts of the BS4 Project.	2. Prepare and implement separate EMP's for construction and operation of the BS4 Project that addresses relevant environmental issues for the Project, including: ■ Flora (including Priority spp.); ■ Fauna (including stygofauna); ■ Weeds; ■ Topsoil; ■ Fire; ■ Dust; ■ Noise; ■ Waste (non-mineral and mineralised waste); ■ Hydrocarbons; ■ Water (surface and groundwater); ■ Acid rock drainage; ■ Greenhouse gases; ■ Rehabilitation; ■ Aboriginal heritage; and, ■ Reporting and auditing procedures.	Prior to construction and operation.	DoE, CALM
Terrestrial Flora	Identify and manage rare and threatened flora species.	3. Carry out DRF and Priority flora surveys of all BS4 Project areas not already surveyed.	Prior to ground disturbance.	
Land Snails	Gain further information on the distribution and population diversity of land snails found in the Project area.	4. Fund a taxonomic, biogeographic and genetic study on the *Rhagada* sp land snails found in the BS4 Project area.	Within six months of commissioning.	
Groundwater Quality	Prevent the formation of pit lakes derived from groundwater.	5. Backfill mined out pits to above pre-mine water table levels.	Ongoing during operations phase, closure and decommissioning.	DoIR and DoE

Topic	Objective	Commitments	Timing	Advice from
Rail Spur Drainage	Ensure rail spur drainage design appropriate.	6. Consult with CALM on detailed design plans for rail spur drainage.	Prior to construction.	CALM
Aboriginal Heritage	Protect/manage Aboriginal heritage sites in accordance with the Aboriginal Heritage Act 1972.	7. Complete Aboriginal heritage surveys of all areas not yet surveyed within the BS4 Project area, and avoid any Aboriginal heritage sites identified where practicable.	Pre-construction.	Aboriginal Groups DIA
Rehabilitation and Decommissioning	Ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform consistent with the surrounding landscape.	8. Prepare a Final Rehabilitation and Decommissioning Plan covering BS4 Project area.	Within two years of closure of the operation.	DoIR, CALM

DoE - Department of Environment; CALM – Department of Conservation and Land Management; DoIR – Department of Industry and Resources; DIA – Department of Indigenous Affairs

9. References

ANZMEC and MCA (2000). *Strategic Framework for Mine Closure*. Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia, August 2000.

ANZECC and ARMCAZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environmental Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Camberra, ACT, 2000.

Aquaterra (2005). Brockman 4 Hydrogeology Pre-Feasibility Report. Unpublished Report for Hamersley Iron.

Atkins K. J. (2005). *Declared Rare and Priority Flora List for Western Australia*. Department of Conservation and Land Management.

Beard, J. S. (1975). *Pilbara. Explanatory Notes and Map Sheet 5, 1:1,000,000 Series Vegetation Survey of Western Australia*. Univ. West. Aust. Press: Nedlands.

Biota Environmental Sciences and M. E. Trudgen (2002). *Hope Downs Rail Corridor, Port Hedland to Weeli Wolli Creek – Vegetation and Flora Survey.* Unpublished Report for Hope Downs Management Services.

Biota Environmental Sciences (2004a). *Hope Downs Rail Corridor, Hamersley Range Extension – Vegetation and Flora Survey.* Unpublished Report for Hope Downs Management Services.

Biota Environmental Sciences (2004b). *Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor.* Unpublished Report for Fortescue Metals Group.

Biota Environmental Sciences (2004c). *Vegetation and Flora Survey of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas.* Unpublished Report for Fortescue Metals Group.

Biota Environmental Sciences (2005a). *A Vegetation and Flora Survey of the Brockman Syncline 4 Project Area, near Tom Price*. Unpublished Report to Hamersley Iron, July 2005. Project No. 271.

Biota Environmental Sciences (2005b). *Fauna Habitats and Fauna Assemblage of the Brockman Syncline 4 Project Area, near Tom Price*. Unpublished Report to Hamersley Iron, July 2005. Project No. 271.

Commonwealth of Australia, Australian Greenhouse Office, Canberra (1998). *The National Greenhouse Strategy. Strategic Framework for Advancing Australia's Greenhouse Response.*

Department of Agriculture, Western Australia (2002). *Land Systems Mapping of the Pilbara region, WA.* Draft mapping.

Department of Environment (2003). *Interim Industry Guide to Community Involvement*, December 2003.

Department of Minerals and Energy (1996). *Guidelines for Mining in Arid Environments*.

Environment Australia (2000). *Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1, Summary Report*. Environment Australia, November 2000.

Environmental Protection Authority (1998). *Draft Guidance Statement No. 8: Environmental Noise. June 1998.*

Environmental Protection Authority (1999a). *Draft Guidance Statement No. 26: Management of Surface Run-off from Industrial and Commercial Sites. March 1999*.

Environmental Protection Authority (1999b). *Ambient Air Quality National Environment Protection Measure (NEPM) Implementation Environmental Protection Plan* (in development).

Environmental Protection Authority (2000a). *Position Statement No. 2: Environmental Protection of Native Vegetation in Western Australia*. December 2000.

Environmental Protection Authority (2000b). *Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites*. March 2000.

Environmental Protection Authority (2000c). *Preliminary Draft Guidance Statement No. 14 – Road and Rail Transportation Noise (Version 3).* May 2000.

Environmental Protection Authority (2002a). *Guidance Statement No. 12 for Minimising Greenhouse Gas Emissions*. October 2002.

Environmental Protection Authority (2002b). *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection*. March 2002.

Environmental Protection Authority (2003a). Assessment Levels for Soil, Sediment and Water: Version 3 Draft for Public Comment. Department of Environment.

Environmental Protection Authority (2003b). *Guidance Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves During Environmental Impact Assessment in Western Australia.* December 2003.

Environmental Protection Authority (2004a). *Guidelines for Preparing a Public Environmental Review/Environmental Review and Management Programme*. Version 2 (1 November 2004).

Environmental Protection Authority (2004b). *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*. June 2004.

Environmental Protection Authority (2004c). *Position Statement No. 7: Principles of Environmental Protection.* August 2004.

Environmental Protection Authority (2004d). *Guide to EIA Environmental Principles, Factors and Objectives.* Version 2 (1 November 2004).

Environmental Protection Authority (2004e). *Position Statement No. 6: Towards Sustainability*. August 2004.

Environmental Protection Authority (2004f). *Preliminary Position Statement No. 9: Environmental Offsets*. July 2004.

Environmental Protection Authority (2004g). *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. June 2004.

Environmental Protection Authority (2004h). *Guidance Statement No. 41: Assessment of Aboriginal Heritage*, April 2004.

Ernst and Young (2004a). *The Application of the Sustainable Development Methodology to the Brockman 4 Project.* Unpublished Report to Pilbara Iron.

Ernst and Young (2004b). *The Application of the Sustainable Development Methodology to the Workforce Delivery Model at the Brockman 4 Project.* Unpublished Report to Pilbara Iron.

Fortescue Metals Group (FMG) (2005). Pilbara Iron Ore and Infrastructure Project Stage B East-West Railway and Mine Sites Public Environmental Review. Prepared by Environ Australia Pty Ltd.

Gentilli. J. (1972). *Australian Climate Patterns*. Nelson.

Government of Western Australia (2003). *Hope for the Future: The Western Australian State Sustainability Strategy.*

Halpern Glick Maunsell (1999a). *Nammuldi/Silvergrass Soils, Vegetation and Flora Survey.* Unpublished Report for Hamersley Iron Pty Limited. Report ES995117A.

Halpern Glick Maunsell and Biota (2000). *Austeel Biological Survey, Cape Preston.* Unpublished Report for Austeel, Perth.

Hamersley Iron (2005). Yandi Junction South East Expansion Project. Environmental Protection Statement. Prepared by Strategen.

Harvey, M.S. (2002). *Short-range Endemism Among Australian Fauna: some Examples from Non-marine Environments*. *Invertebrate Systematics* 16: 555-570.

Hope Downs Management Services (HDMS) (2002). *Hope Downs Iron Ore Project: Rail and Port. Public Environmental Review*. Prepared by Halpern Glick Maunsell.

Hoffman, R. L. (2003). *A New Genus and Species of Trigoniuline Millipede from Western Australia (Spirobolidae: Pachybolidae: Trigoniulinar). Rec. West. Aust. Mus. 22:17 - 22.*

Humphreys, W.F. (1999). *Relict Stygofaunas Living in Sea Salt, harsh and Calcrete Habitats in Arid, north-western Australia Contain Many Ancient Lineages. In The Concentration and Biodiversity of Invertebrates.* Trans. Roy. Soc. NSW. Mosman 2088.

Humphreys, W.F. (2000). *Groundwater calcrete aquifers in the Australian arid zone: the context to an unfolding plethora of stygal biodiversity.* Records of the Western Australian Museum Supplement 64: 63-83.

Johnstone R. E. and Storr, G. M. (1998). *Handbook of Western Australian Birds. Volume 1 - Non-passerines (Emu to Dollarbird).* West. Aust. Mus. Perth WA.

Kendrick P. (2001). Pilbara 3 (PIL3 – Hamersley subregion). In May J.E. and N.L. McKenzie (2004). *A Biodiversity Audit of Western Australia's Biogeographical Subregions in 2002.* Department of Conservation and Land Management, Perth WA.

Marchant S. and P.J. Higgins (1993). *Handbook of Australian, New Zealand & Antarctic Birds,* Volume 2: Raptors to Lapwings. Oxford University Press, South Melbourne.

Marmonier, P., Vervier, P., Gibert, J. and Dole-Olivier, M.J. (1993). *Biodiversity in groundwaters.* TREE 8(11): 392-395.

Menkhorst (2001). *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne, Australia.

Northcote, K. H. (1979). *A Factual Key for the Recognition of Australian Soils.* 4th ed. Rellim: Glenside, South. Aust.

Payne, P. L., Mitchell, A. A. and Holman, W. F. (1988). *An Inventory and Condition Survey of the Rangelands in the Ashburton River Catchment, Western Australia.* Tech. Bull. No. 62. West. Aust. Dept of Agric.

Pells Sullivan Meynink Pty Ltd (2005). *Brockman 4 Pre-feasibility Geotechnical Study.* Unpublished Report for Hamersley Iron Pty. Limited. Vols 1 and 2.

Ponder, W. F. (1997). *Conservation Status, Threats and Habitat Requirements of Australian Terrestrial and Freshwater Mollusca*. *Mem. Mus. Vict.* 56:421-430.

PPK Environment & Infrastructure Pty Ltd. (1999). *Nammuldi/Silvergrass East. Hydrogeological Investigations. Final Report.* Report for Hamersley Iron Pty. Limited. Vols 1 and 2.

Rio Tinto (2003a). Environmental Standard - Land Use Stewardship. Version 1.0.

Rio Tinto (2003b). Environmental Standard - Water Use and Quality Control. Version 1.

Rio Tinto (2003c). Environmental Standard - Air Quality Control. Version 1.0.

Rio Tinto (2003d). Environmental Standard - Greenhouse Gas Emissions. Version 1.0.

Rio Tinto (2003e). Environmental Standard - Noise and Vibration Control. Version 1.0.

Rio Tinto (2003f). Environmental Standard - Hazardous Materials and Contamination Control. Version 1.0.

Rio Tinto (2003g). Environmental Standard - Mineral Waste Management. Version 1.0.

Rio Tinto (2003h). Environmental Standard - Acid Rock Drainage Prediction and Control. Version 1.0.

Rio Tinto (2003i). Environmental Standard - Non-Mineral Waste Management. Version 1.0.

Rio Tinto (2004). Rio Tinto Closure Standard.

SKM - Sinclair Knight Merz (2005). *Rio Tinto Iron Ore Brockman 4 Preliminary Engineering Study, Main Report.* March 2005.

Solem A. (1986) *Pupilloid Land Snails from the South and Mid-west Coasts of Australia*. *J. Malacological Soc. Aust*. 7(3-4): 95-124.

Solem A. (1997). *Camaenid Land Snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae).* VII Taxa from Dampierland through the Nullarbor. *Rec. West Aust. Mus. Suppl.* 50.

Storr G M. Smith, L.A. and Johnstone, R. E.. (1999). *Lizards of Western Australia. I. Skinks*. West. Aust. Mus.

Tasmanian Parks and Wildlife Service (2002). *Concepts and Principles of Geoconservation*. Published electronically on the Tasmanian Parks & Wildlife Service website (Version 3), September 2002.

Thackway, R. and Cresswell, I. D. (1995). *An Interim Biogeographic Regionalisation for Australia: a Framework for Setting Priorities in the National Reserves System Cooperative Program*. Australian Nature Conservation Agency, Canberra.

Thoma, E. and Joder, A. (2003). *Brockman 4 Rare Flora Survey*. Hamersley Iron Pty Limited Environmental Division. Unpublished Report, June 2003.

Trudgen, M. E. and Casson, N. (1998). *Flora and Vegetation Surveys of Orebody A and Orebody B in the West Angelas Hill Area, an Area Surrounding Them, and of Rail Route Options Considered to Link Them to the Existing Robe River Iron Associates Rail Line.* Unpublished Report for Robe River Iron Associates.

Trudgen M. E., Morgan, B. R. and Griffin, E. A. (2002). *A Flora and Vegetation Survey of the Proposed Mine Areas and Access Road for the Panorama Project.* Volumes 1-3. Unpublished Report for Astron Environmental by M.E. Trudgen and Associates.

Water and Rivers Commission (2000). *Statewide Policy No. 5 Environmental Water Provisions Policy for Western Australia (Reviewed 2005).*

Water and Rivers Commission (2003). *Mine Void Water Resource Issues in Western Australia*. Hydrogeological Record Series, Report No. HG 9, 2003.

Watts, C.H.S. and Humphreys, W.F. (1999). *Three new genera and five species of Dytiscidae (Coleoptera) from underground waters in Australia*. Records of the South Australian Museum 32: 121-142.

World Commission on Environment and Development (WCED) (1987). *Our Common Future.* Brundtland, G. (ed.) Oxford University Press.

10. Glossary

Abstraction/dewatering	Removal of groundwater from aquifer system
Alluvial	Materials transported and deposited by the action of rivers or streams, in recent geological times
Aquifer	A permeable rock formation which stores and transmits groundwater
Asbestiform	Having a fibre-like crystal form similar to that of asbestos minerals e.g. chrysolite or crocidolite
Banded Iron Formation	Tabular rock body usually consisting of alternating bands of quartz and iron rich minerals
Borefield	Series of holes that are drilled into an aquifer for the purpose of withdrawing water
Bund	An earth, rock or concrete wall constructed to prevent the inflow or outflow of liquids
Catchment	Surface area from which runoff flows to a river or any other collecting reservoir
Confluence	Joining of two or more drainage systems
Copepod	Any small aquatic crustacean of the Class Copepoda
Cut-to-fill	Where material from cuts is used in areas needing fill –resulting in flat terrain for infrastructure
Dendritic	Type of drainage pattern which has fanning-out appearance
Ephemeral	Water course that flows on only few occasions in a year
Detrital	Material derived from the weathering of pre-existing rocks
Fines	That portion of iron ore product that is sized less than 6mm
Goethite	An iron mineral consisting of oxides and hydroxides or iron
Hydrogeology	The geology of groundwater
Hydraulic gradient	Slope of the water table over distance. Change is static head per unit of distance in a given direction
Impermeable	Material that does not allow a particular substance to pass through it
Lump	That portion of iron ore product that is sized greater than 6mm
Mineralisation	The outcome of the introduction of valuable elements into rock material
Overburden	Soil and rock overlying a mineral deposit that must be removed before the deposit can be mined
Permeability	The extent to which fluids can pass through rock
Potable water	Fresh and marginal water generally considered suitable for human consumption
Putrescible	Waste material that has potential to rot, such as food matter
Recharge	The process where water penetrates soil to a temporary or permanently saturated zone
Riverine	Habitat around large drainage lines
Stratigraphic	Formation, composition and occurrence of stratified rocks
Storativity	Volume of water an aquifer can release from or takes into storage per unit surface area
Stripping ratio	The ratio of overburden to ore mined
Stygofauna	Invertebrates (mostly) that are adapted to inhabiting subterranean aquatic environments
Syncline	A large scale geological fold structure where the centre of the fold is lower than the exposed eroded edges
Tailings	Material remaining after the processing of ground/crushed ore
Through-flow	Amount of water that passes through a given area
Thrust fault	A reverse fault of low angle, with older strata displaced horizontally over newer
Transmissivity	Rate of water can be transmitted through material
Void	An open structure or pit that remains after ore has been removed by mining
Water table	Top surface of the groundwater, whether above or below ground level

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Figures

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LEGEND

- Brockman Iron Formation
- Marra Mamba Iron Formation
- Mine
- Railway
- Main road
- Other road

550000 mE

600000 mE

650000 mE

7500000 mN

7450000 mN

Nammuldi

Brockman 2

Brockman access road

Brockman Syncline 4 (BS4) Orebody

White Quartz Road

Tom Price Nanutarra - Wittenoom Rd

Tom Price Town

Mt Tom Price

Wittenoom

Munjina - Wittenoom Road

Auski

KARIJINI NATIONAL PARK

Karijini Drive

Marandoo

Nanutarra - Wittenoom Road

Paraburdoo Tom Price Road

Paraburdoo Town

Paraburdoo

Eastern Range

Overland conveyor

Channar

Dampier

Map Area

Newman

Perth

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project Location Map Figure 1

SCALE 1:500 000

0 5 10 15 20km

Projection: MGA94 Zone 50

Datum: GDA94

Compiled: GRB

Date: Oct 2004

Plan No. RP110545V1

LEGEND

- Pit outline
- High grade stockpile
- Rail spur alignment
- Access road
- Powerline
- Water pipeline
- Hamersley Iron tenement
- Proposed addition to AML70/4
- Miscellaneous Licence Appln
- General Purpose Lease Appln
- Existing Brockman 2 railway
- Road / track
- Storage tank
- Production bore
- Pastoral Station production bore
- Low grade stockpile
- Topsoil stockpile
- Waste dump area
- Native title boundary
- Pastoral station

530000 mE
540000 mE
550000 mE
520000 mE
7520000 mN
7510000 mN
7500000 mN

E47/1054
M47/372
M47/370
M47/369
LGE G848898
LGE G848902
LGE G848901
LGE G848909
L47/139 Miscellaneous Licence Appln
Brockman Camp
Airstrip
Powerline
Brockman 2 railway
No 40 Bore
Black Stump
L47/151 Miscellaneous Licence Appln
Access road
L47/140 Miscellaneous Licence Appln
ML4SA Sec 107
ML4SA Sec 108
ML4SA Sec 241
ML4SA Sec 239
ML4SA Sec 242
ML4SA Sec 112
ML4SA Sec 110
ML4SA Sec 109
ML4SA Sec 113
Brockman 2 mine
L47/152 Miscellaneous Licence Appln
ML4SA Sec 240
Hamersley L3114 / 1277 Gregory Loc 99
Boolgeeda borefield 10 bores
Pipeline from borefield
L47/141 Miscellaneous Licence Appln
ML4SA Sec 106
WC01_005 PUUTU KUNTI KURRAMA & PINIKURA
WC97_089 EASTERN GURUMA
ML4SA Sec 243
ML4SA Sec 115
ML4SA Sec 116
ML4SA Sec 117
Dampier to Paraburdoo 220kV powerline
ML4SA Sec 105
L47/143 Miscellaneous Licence Appln
Village borefield 2 bores
G47/1226 General Purpose Lease Appln
Pipeline from borefield
Rail spur alignment
ML4SA Sec 104
Storage tank
Camp
Rocklea L3114 / 1166 Gregory Loc 77
E47/31
ML4SA Sec 103
Proposed Sec 256
L47/153 Miscellaneous Licence Appln
Access road
Existing Airstrip
Proposed Airstrip
ML4SA Sec 118
Wyloo L398 / 782 Gregory Loc 124
G47/1227 General Purpose Lease Appln
Stockpiles
Plant
Access road
G47/1228 General Purpose Lease Appln
E47/53
G47/1225 General Purpose Lease Appln
Conveyor
ML4SA Sec 120
ML4SA Sec 119
Pipeline from borefield
ML4SA Sec 123
ML4SA Sec 122
ML4SA Sec 121
E47/1037
Mine dewatering 7 bores
Proposed Sec 245
Proposed Sec 244
E47/48
ML4SA Sec 124
E47/783
ML4SA Sec 125
ML4SA Sec 162
ML4SA Sec 163
ML4SA Sec 166
ML4SA Sec 164
ML4SA Sec 165
ML4SA Sec 126
Brockman Syncline 4
Proposed Sec 246
Southern borefield 6 bores
Proposed Sec 247
ML4SA Sec 167
L47/144 Miscellaneous Licence Appln
White Quartz Road
Unallocated Crown Land

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Proposed Tenure and Infrastructure
Figure 2

SCALE 1:125 000

0 1 2 3 4 5km

Projection: MGA94 Zone 50
Datum: GDA94

Compiled: GC
Date: May 2005

Plan No. RP110545V1

LEGEND

- Pit outline
- High grade stockpile
- Low grade stockpile
- Topsoil stockpile
- Waste dump stockpile
- Rail spur alignment
- Access road
- Powerline
- Water pipeline
- Storage tank
- Production bore
- Existing Brockman 2 railway

525000 mE

530000 mE

535000 mE

7520000 mN

7515000 mN

Brockman 2

Powerline

Pipeline from borefield

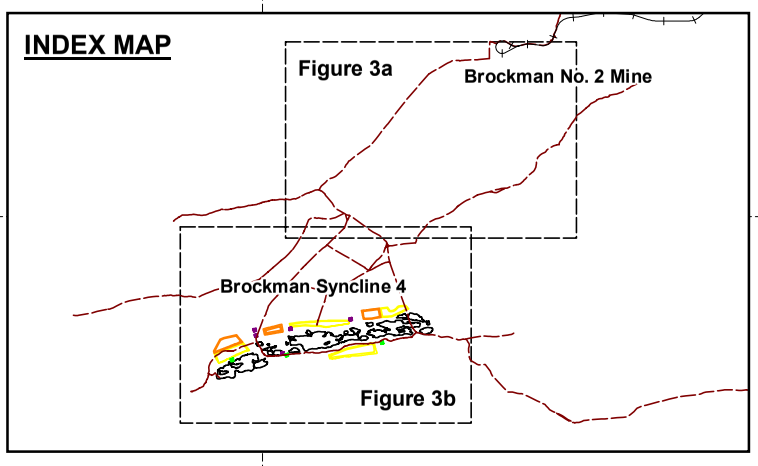
Rail spur alignment

Pipeline from borefield

Storage tank

Camp

INDEX MAP



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Resource Development - Perth

BS4 Project Aerial Photograph and Project Layout Figure 3a

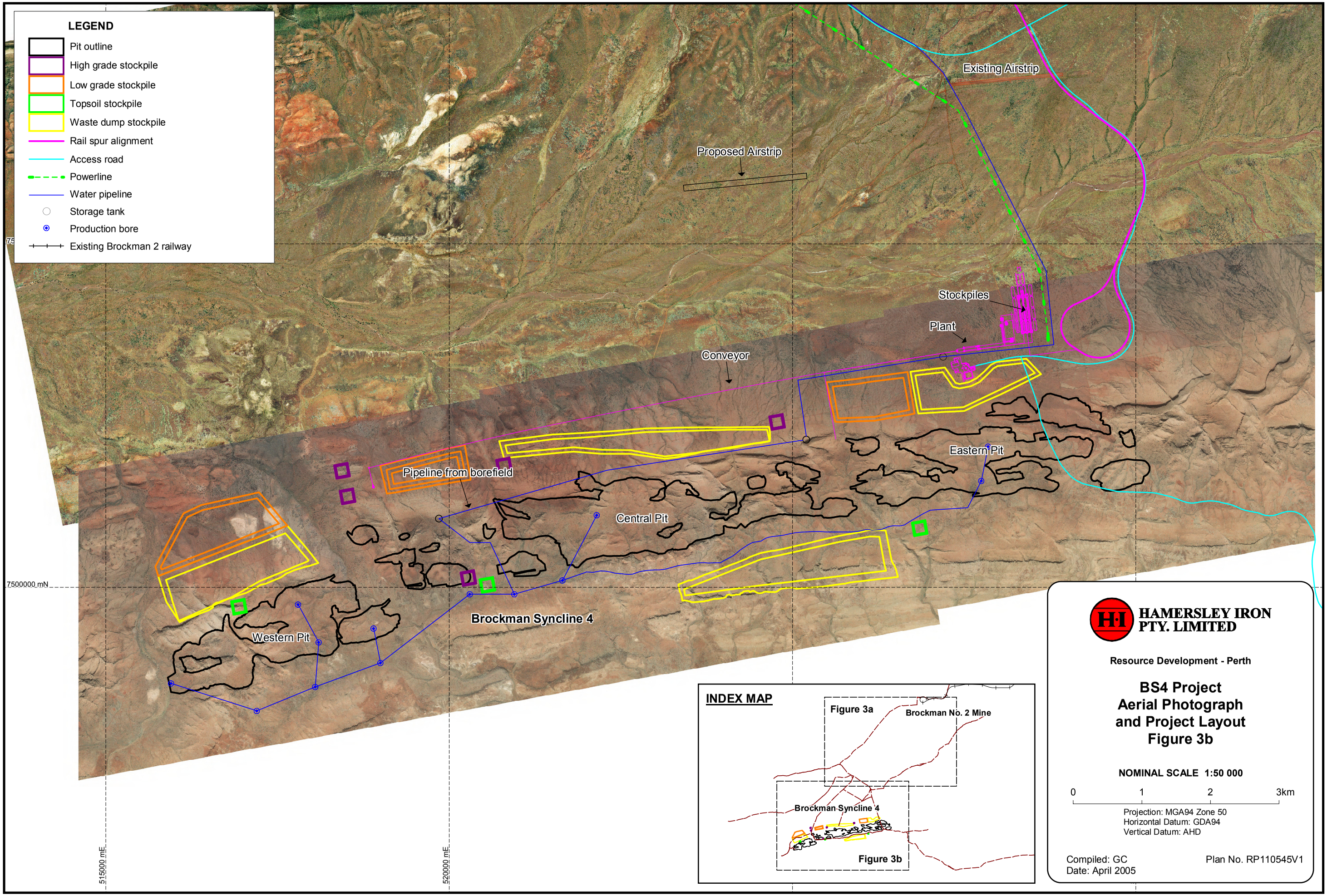
NOMINAL SCALE 1:50 000

0 1 2 3km

Projection: MGA94 Zone 50
Horizontal Datum: GDA94
Vertical Datum: AHD

Compiled: GC
Date: April 2005

Plan No. RP110545V1



INDEX MAP

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project Aerial Photograph and Project Layout Figure 3b

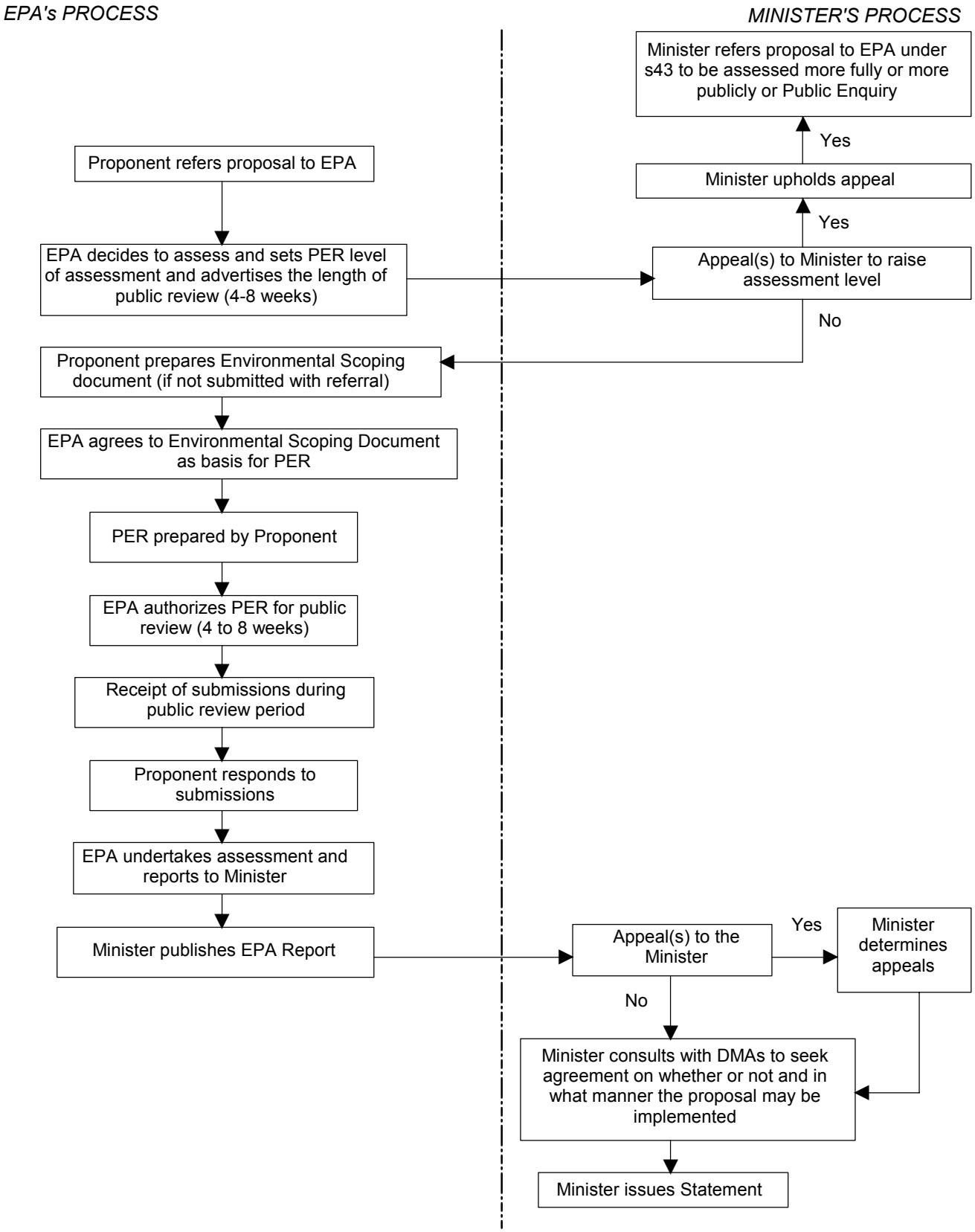
NOMINAL SCALE 1:50 000

0 1 2 3km

Projection: MGA94 Zone 50
Horizontal Datum: GDA94
Vertical Datum: AHD

Compiled: GC
Date: April 2005

Plan No. RP110545V1



HAMERSLEY IRON PTY. LIMITED

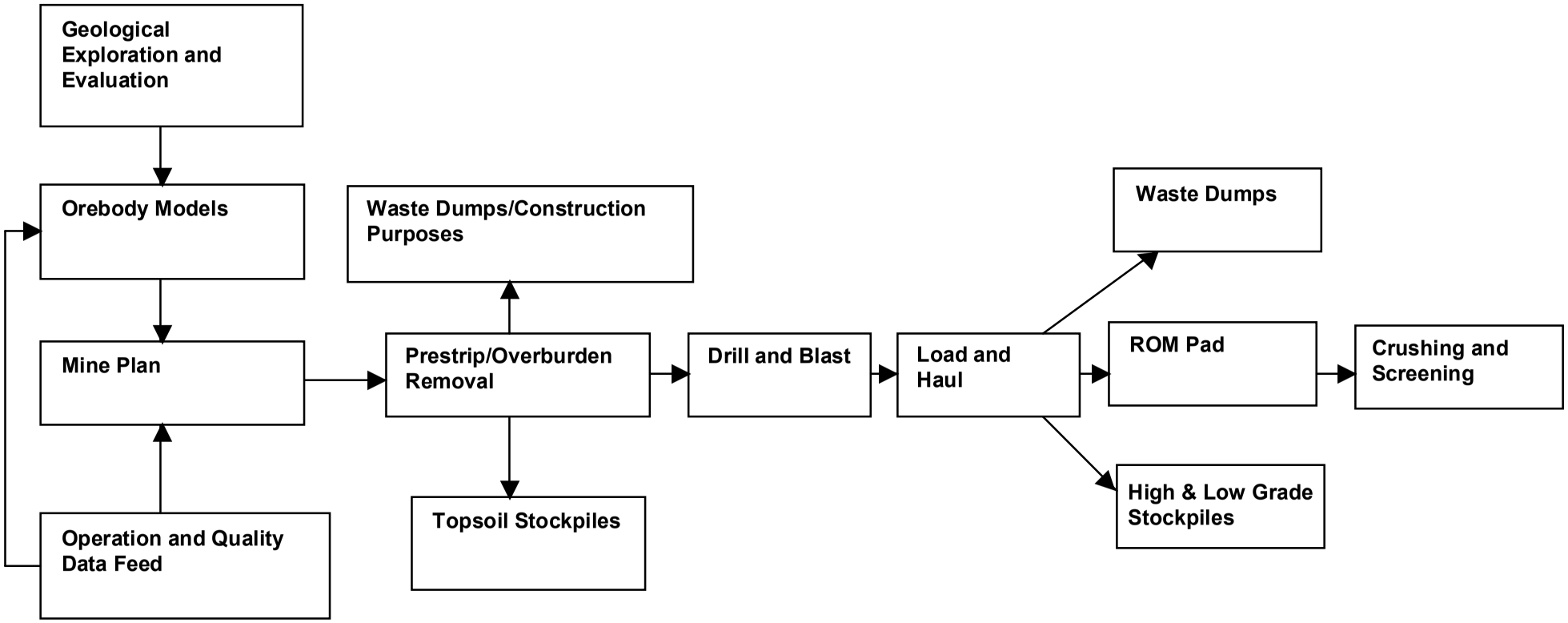
Resource Development - Perth

BS4 Project
Approvals Process for PER
Figure 4

Compiled: GC
Date: April 2005

Plan No. RP110545V1

Source: EP Act 1986: Environmental Impact Assessment Part IV Division 1) Administrative Procedures 2002



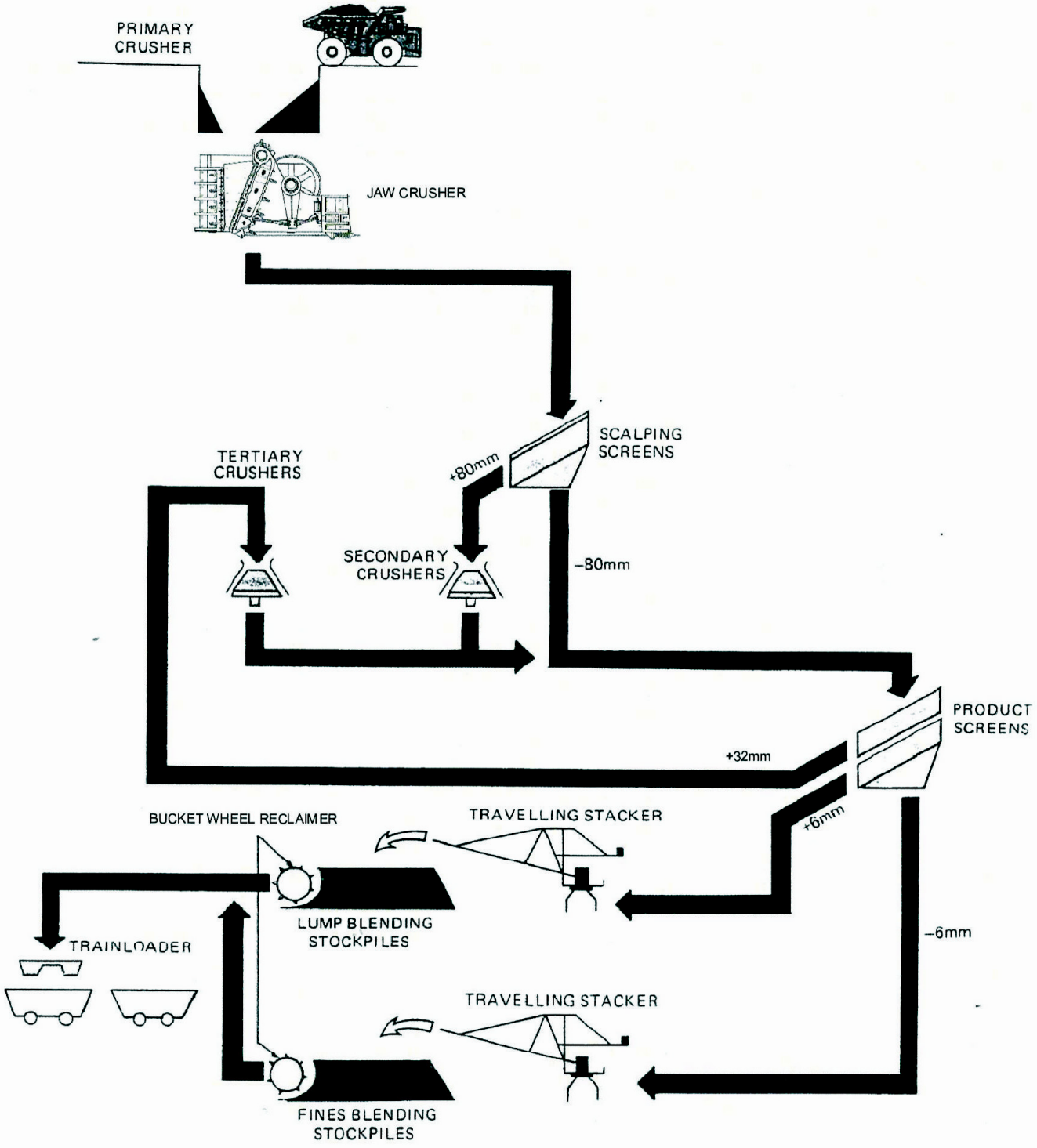
HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Mining Process
Figure 5

Compiled: GC
Date: May 2005

Plan No. RP110545V1



HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Process Flow Diagram
Figure 6

Compiled: GC
Date: May 2005 Plan No. RP110545V1

LEGEND

- Rail spur alignment
- Access road
- Powerline
- Water pipeline
- Existing Brockman 2 railway
- Pit outline
- Catchment area

Access Road

Powerline

Brockman 2 railway

Brockman 2 mine

Pipeline from borefield

Rail spur alignment

Access Road

Pipeline from borefield

Storage tank

Camp

Existing Airstrip

Proposed Airstrip

Access Road

Creek

Conveyor

Pipeline from borefield

Boolgeeda

River

Brockman Syncline 4 Deposit

Beasley

7510000 mN

7500000 mN

510000 mE

520000 mE

530000 mE

540000 mE

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Surface and Subsurface Water Movements
Figure 7

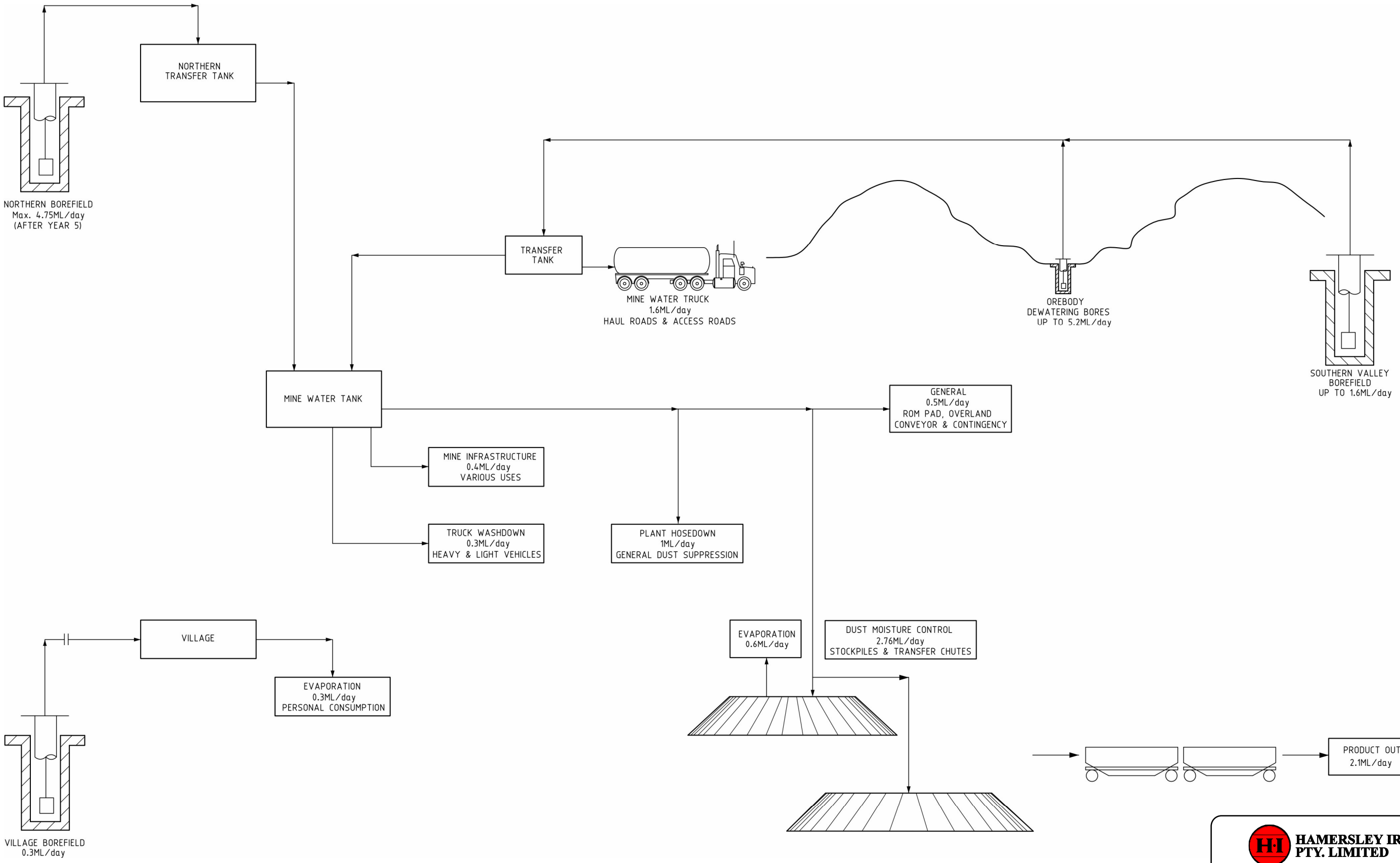
SCALE 1:125 000

0 1 2 3 4 5km

Projection: MGA94 Zone 50
Datum: GDA94

Compiled: GC
Date: May 2005

Plan No. RP110545V1



HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Water Balance
Figure 8

Compiled: GC
Date: May 2005

Plan No. RP110545V1

520000 mE
530000 mE
540000 mE
550000 mE
560000 mE
570000 mE
7530000 mN
7520000 mN
7510000 mN
7500000 mN
To Dampier
Existing Hamersley Iron Railway
Brockman 2
Camp & Airstrip
Existing Brockman Railway
Rosella Siding
Brockman 2
To Yandi
To Brockman
To Paraburdoo
Brockman Syncline 4 Rail Spur
Road
Village
Wittenoom
Proposed Airstrip
Nanutarra
Plant Site
Brockman Syncline 4
White Quartz Road

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Proposed Rail Spur & Existing Rail Infrastructure

Figure 9

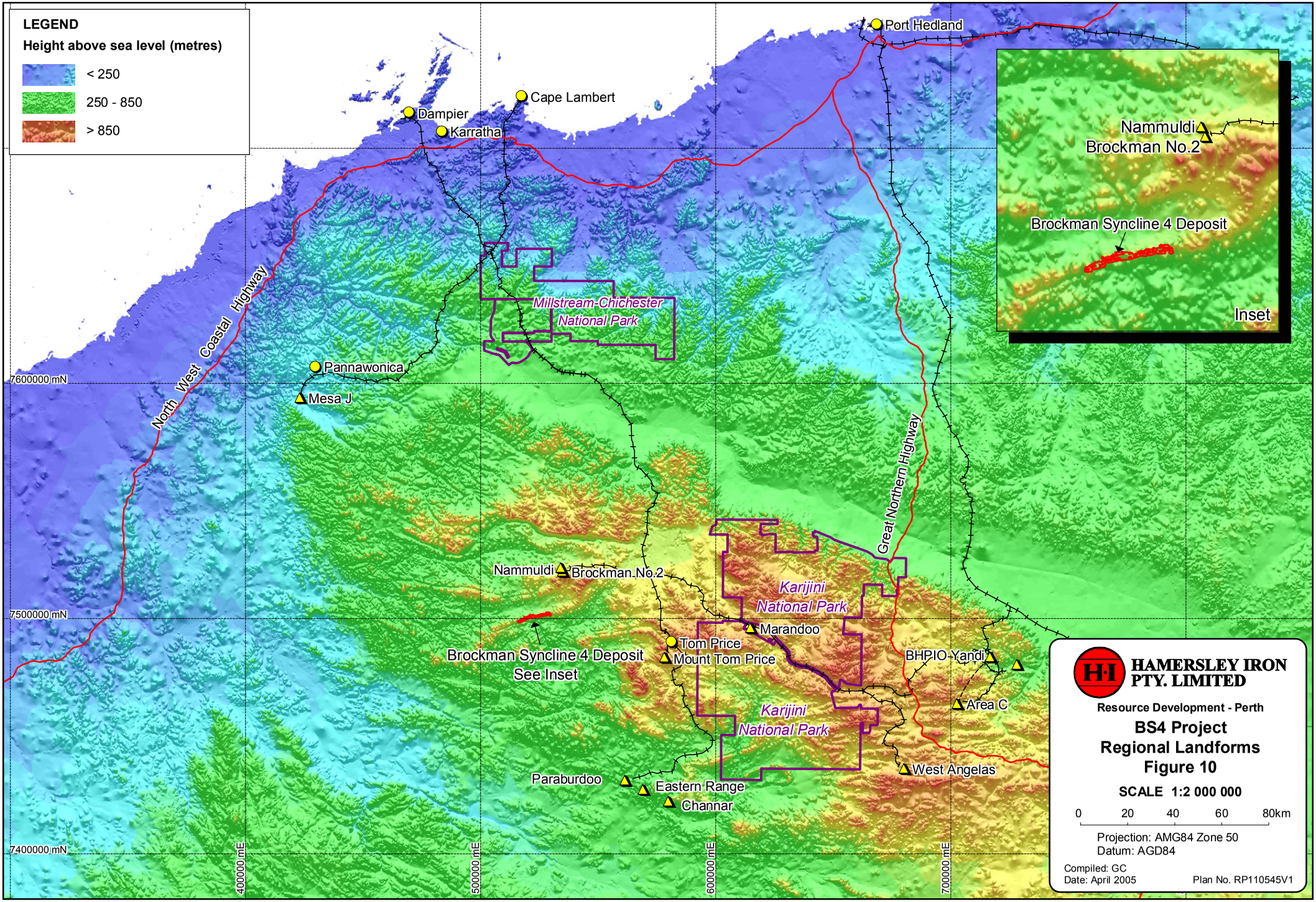
SCALE 1:150 000

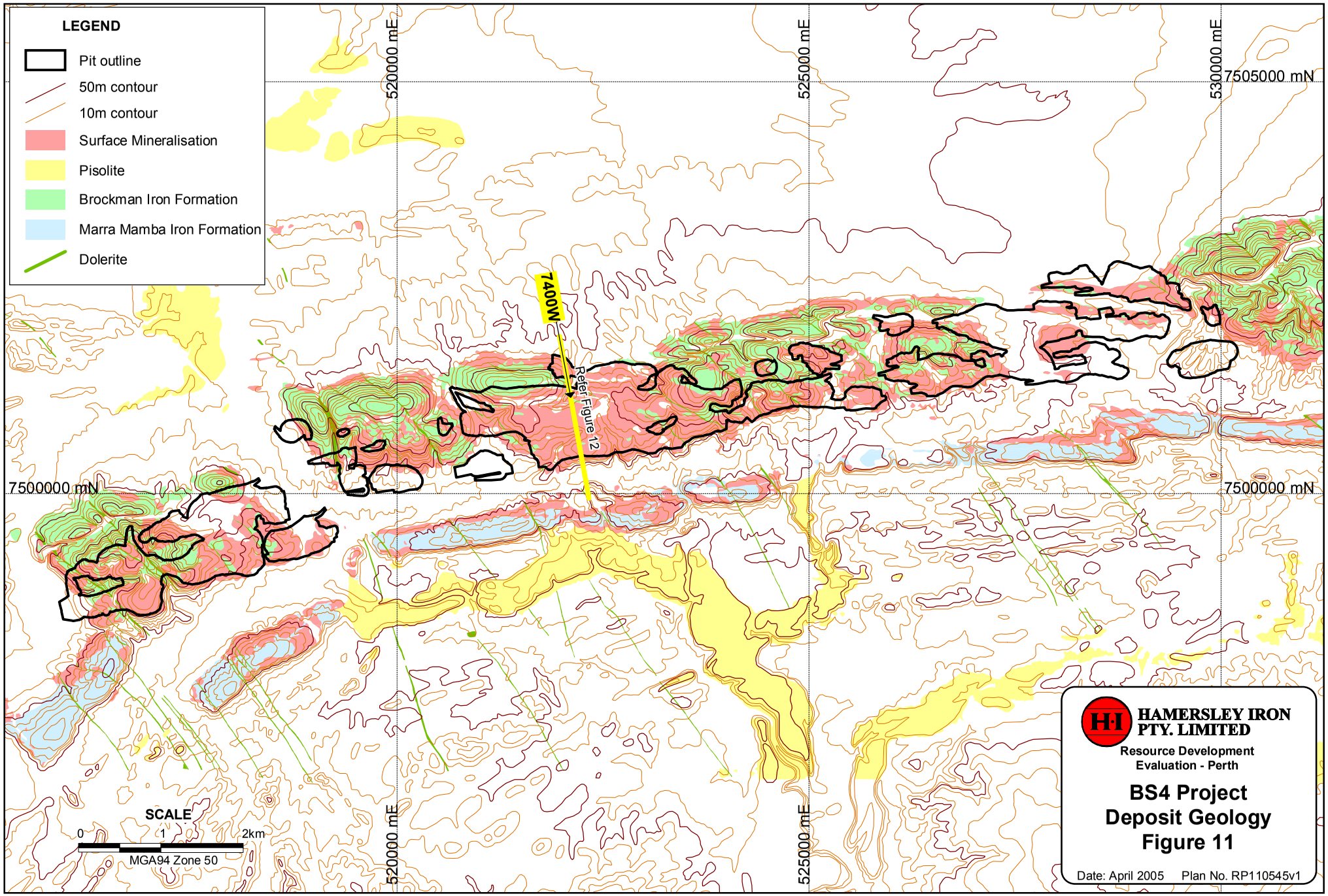
0 1.5 3 4.5 6km

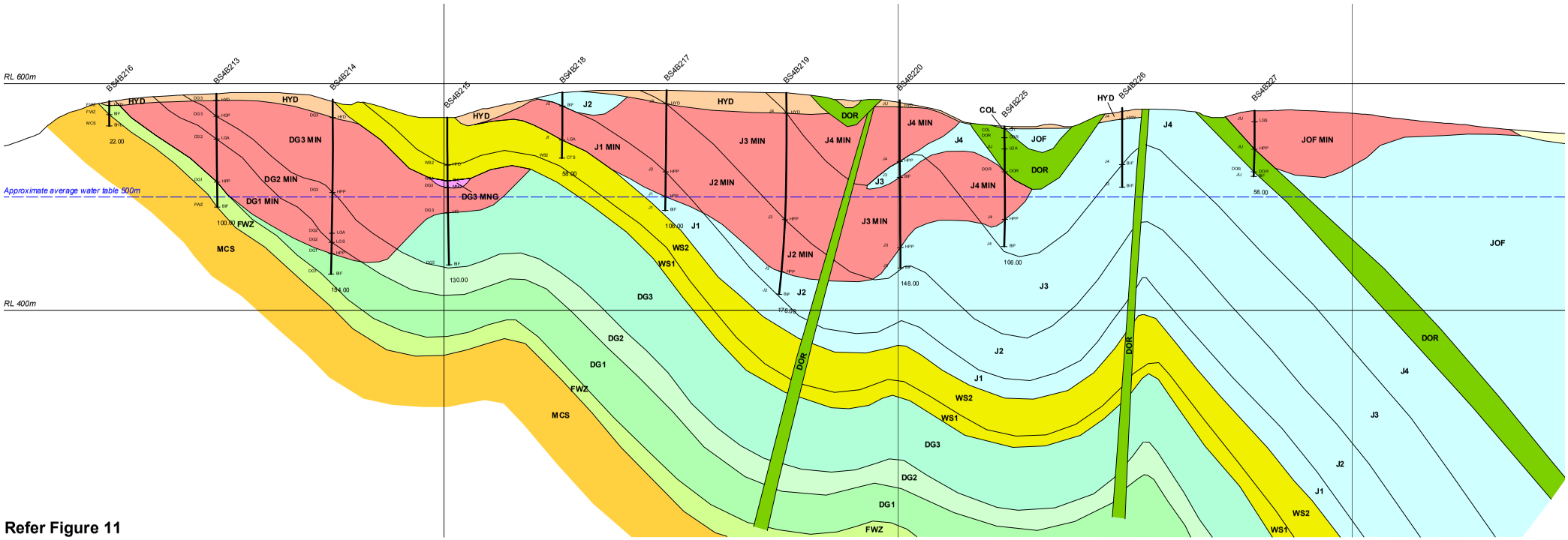
Projection: MGA94 Zone 50
Datum: GDA94

Compiled: GC
Date: May 2005

Plan No. RP110545V1


LEGEND
Height above sea level (metres)
< 250
250 - 850
> 850
Port Hedland
Cape Lambert
Dampier
Karratha
Nammuldi
Brockman No.2
Brockman Syncline 4 Deposit
Inset
Millstream-Chichester
National Park
North West Coastal Highway
Pannawonica
Mesa J
7600000 mN
Great Northern Highway
Nammuldi
Brockman No.2
Karijini
National Park
7500000 mN
Marandoo
Tom Price
Mount Tom Price
Brockman Syncline 4 Deposit
See Inset
BHPIO-Yandi
Area C
Karijini
National Park
West Angelas
Paraburdoo
Eastern Range
Channar
7400000 mE
400000 mE
500000 mE
600000 mE
700000 mE
HAMERSLEY IRON
PTY. LIMITED
Resource Development - Perth
BS4 Project
Regional Landforms
Figure 10
SCALE 1:2 000 000
0 20 40 60 80km
Projection: AMG84 Zone 50
Datum: AGD84
Compiled: GC
Date: April 2005
Plan No. RP110545V1


LEGEND
Pit outline
50m contour
10m contour
Surface Mineralisation
Pisolite
Brockman Iron Formation
Marra Mamba Iron Formation
Dolerite
520000 mE
525000 mE
530000 mE
7505000 mN
7500000 mN
7400W
Refer Figure 12
SCALE
0
1
2km
MGA94 Zone 50
HAMERSLEY IRON PTY. LIMITED
Resource Development
Evaluation - Perth
BS4 Project
Deposit Geology
Figure 11
Date: April 2005
Plan No. RP110545v1



Refer Figure 11

LEGEND

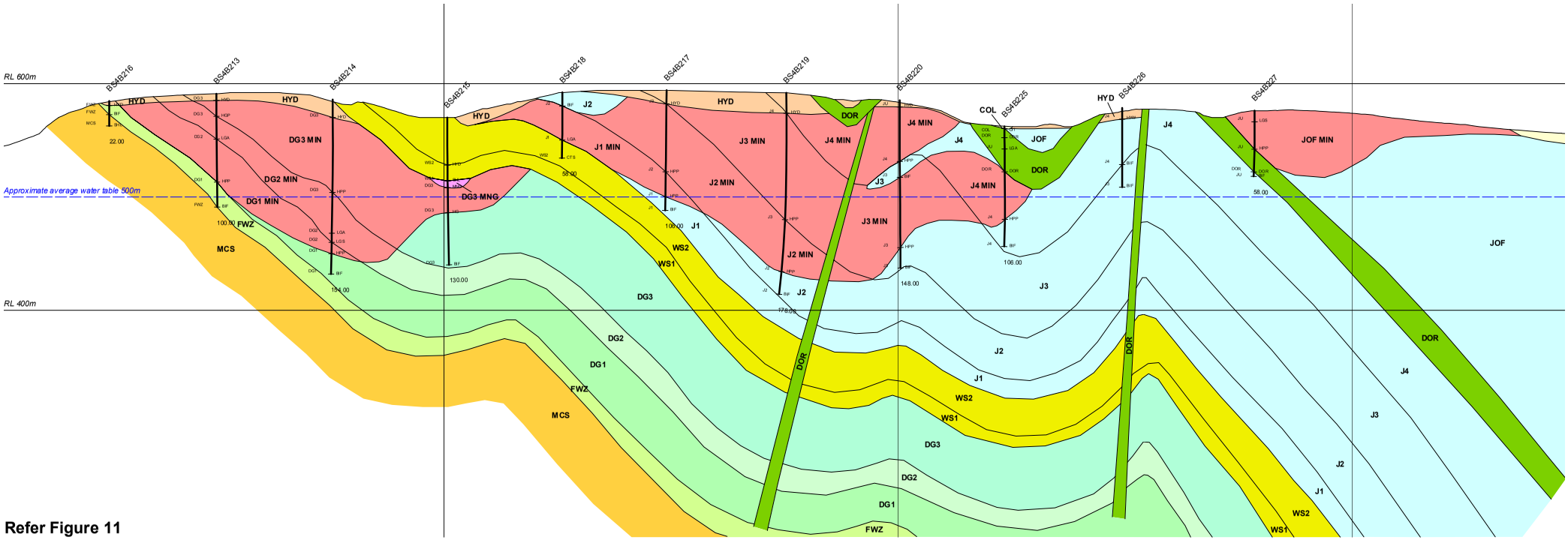
	(MCS)	McRae Shale Formation (contains oxidised shales and black shales some of which are pyritic and potentially acid generating)
	(FWZ)	Footwall Zone Member (shaley)
	(DG1)	Dales Gorge 1 Member (non-shaley)
	(DG2)	Dales Gorge 2 Member (shaley)
	(DG3)	Dales Gorge 3 Member (non-shaley)
	(WS1 and WS2)	Whaleback Shale 1 and 2 (shaley)
	(J1 to J4)	Joffre 1 to 4 Members (even numbers non-shaley, odd shaley)
	(DOR)	Dolerite (intrusive igneous dykes and sills)
	(HYD)	Hydrated Material (surficial weathering of underlying geological units)
	MIN	Mineralised envelope (denoted by a MIN suffix on the geological unit abbreviation)

HAMERSLEY IRON PTY. LIMITED

Resource Development
Evaluation - Perth

BS4 Project
Typical Cross Section 7400W (Looking West)
Figure 12

Date: April 2005 Plan No. RP110545v1



Refer Figure 11

LEGEND

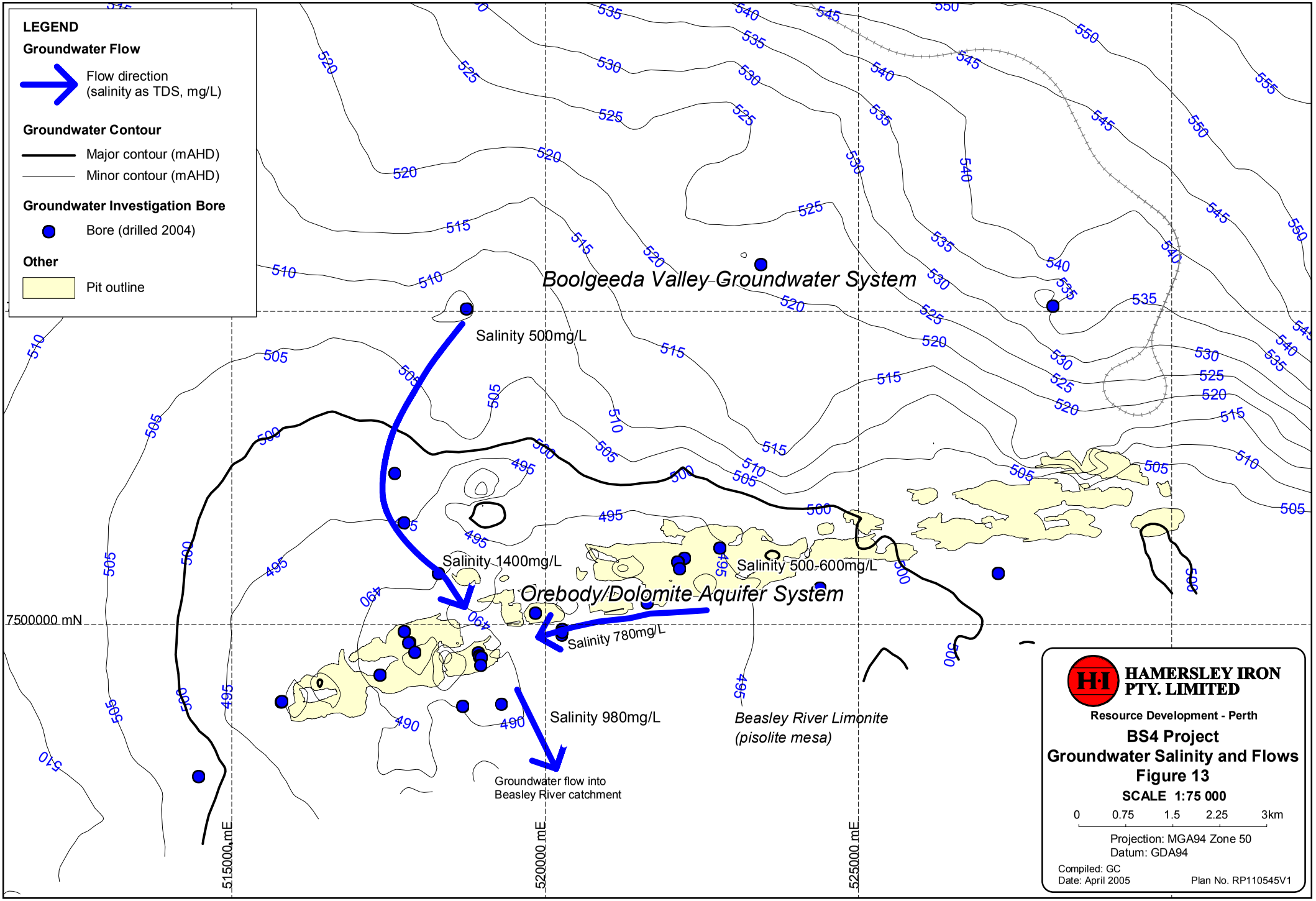
	(MCS)	McRae Shale Formation (contains oxidised shales and black shales some of which are pyritic and potentially acid generating)
	(FWZ)	Footwall Zone Member (shaley)
	(DG1)	Dales Gorge 1 Member (non-shaley)
	(DG2)	Dales Gorge 2 Member (shaley)
	(DG3)	Dales Gorge 3 Member (non-shaley)
	(WS1 and WS2)	Whaleback Shale 1 and 2 (shaley)
	(J1 to J4)	Joffre 1 to 4 Members (even numbers non-shaley, odd shaley)
	(DOR)	Dolerite (intrusive igneous dykes and sills)
	(HYD)	Hydrated Material (surficial weathering of underlying geological units)
	MIN	Mineralised envelope (denoted by a MIN suffix on the geological unit abbreviation)

HAMERSLEY IRON PTY. LIMITED

Resource Development
Evaluation - Perth

BS4 Project
Typical Cross Section 7400W (Looking West)
Figure 12

Date: April 2005 Plan No. RP110545v1


LEGEND
Groundwater Flow
Flow direction
(salinity as TDS, mg/L)
Groundwater Contour
Major contour (mAHD)
Minor contour (mAHD)
Groundwater Investigation Bore
Bore (drilled 2004)
Other
Pit outline
Boolgeeda Valley Groundwater System
Salinity 500mg/L
Salinity 1400mg/L
Salinity 500-600mg/L
Orebody/Dolomite Aquifer System
Salinity 780mg/L
Salinity 980mg/L
Beasley River Limonite
(pisolite mesa)
Groundwater flow into
Beasley River catchment
7500000 mN
515000 mE
520000 mE
525000 mE
HAMERSLEY IRON PTY. LIMITED
Resource Development - Perth
BS4 Project
Groundwater Salinity and Flows
Figure 13
SCALE 1:75 000
0 0.75 1.5 2.25 3km
Projection: MGA94 Zone 50
Datum: GDA94
Compiled: GC
Date: April 2005
Plan No. RP110545V1

Vegetation of Stony Hills

H1 *Corymbia hamersleyana* scattered trees over *Cassia pruinosa* open shrubland over *Triodia wiseana* hummock grassland

H2 *Eucalyptus leucophloia* scattered low trees over *Acacia atkinsiana* open shrubland over *Triodia wiseana* mid-dense hummock grassland

H3 *Eucalyptus leucophloia* scattered low trees over *Acacia maitlandii* shrubland to open heath over *Triodia wiseana* mid-dense hummock grassland

H4 *Acacia hamersleyensis* tall open shrubland over *Triodia wiseana* closed hummock grassland

H5 *Eucalyptus leucophloia* scattered low trees over *Acacia exilis (A. bivenosa)* open shrubland over *Triodia wiseana* mid-dense hummock grassland

H6 *Acacia pruinocarpa* tall open shrubland over *Acacia stowardii* open shrubland over *Acacia exilis* low shrubland over *Triodia wiseana* mid-dense hummock grassland

H7 *Acacia stowardii* low open woodland over *Eremophila exilifolia* scattered shrubs over *Triodia epactia* mid-dense hummock grassland

H8 *Acacia ancistrocarpa* open heath to tall open shrubland over *Triodia wiseana* mid-dense to closed hummock grassland

H9 *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* tall shrubland over *Triodia wiseana* mid-dense hummock grassland

H10 *Eucalyptus leucophloia* low open woodland over *Acacia bivenosa* open shrubland over *Triodia brizoides, T. epactia* hummock grassland and *Themeda* sp. Mount Barricade, *Cymbopogon ambiguus* open tussock grassland

H11 *Eucalyptus leucophloia* scattered low trees over *Gossypium robinsonii, Dodonaea pachyneura (Acacia maitlandii)* open shrubland over *Triodia epactia* mid-dense hummock grassland

H12 *Eucalyptus leucophloia* low open woodland over *Acacia hamersleyensis* open shrubland over *Triodia brizoides, Triodia epactia* mid-dense hummock grassland and *Themeda triandra, Eriachne mucronata* open tussock grassland

H13 *Corymbia ferriticola, Eucalyptus leucophloia* scattered low trees over *Acacia hamersleyensis* scattered tall shrubs over *Dodonaea pachyneura* open shrubland over *Eriachne mucronata, E. tenuiculmis, Cymbopogon ambiguus* open tussock grassland and *Triodia epactia* open hummock grassland

H14 *Eucalyptus leucophloia* scattered low trees over *Triodia wiseana* mid-dense hummock grassland

H15 *Eucalyptus leucophloia* scattered low trees over *Triodia epactia* mid-dense hummock grassland

H16 *Eucalyptus leucophloia* scattered low trees to low open woodland over *Astrotricha hamptonii, Ficus brachypoda* scattered tall shrubs over *Themeda* sp. Mt Barricade, *Eriachne mucronata* open tussock grassland and *Triodia brizoides, T. epactia* open hummock grassland

Vegetation of Plains

P1 *Acacia* aff. *aneura* (narrow fine veined; site 1259), *A. ayersiana, Acacia tetragonophylla* tall shrubland over *Eremophila forrestii, Acacia bivenosa* shrubland over *Triodia epactia* mid-dense hummock grassland

P2 *Acacia ayersiana* low open forest/woodland over *Eremophila forrestii* open shrubland over *Triodia epactia, T. wiseana* hummock grassland

P3 *Eucalyptus leucophloia* scattered low trees over *Acacia aneura* (various forms), *A. ayersiana* tall open shrubland over *Triodia epactia, T. wiseana* mid-dense hummock grassland

P4 *Acacia xiphophylla, A. aneura* (flat curved; MET 15,548) low woodland to tall open shrubland over *Eremophila cuneifolia, Rhagodia eremaea* low open shrubland over *Triodia wiseana* open to mid-dense hummock grassland

P5 *Acacia xiphophylla, A.* aff. *aneura* (narrow fine veined; site 1259) tall shrubland over *Triodia brizoides, T. epactia* open hummock grassland

P6 *Corymbia deserticola* scattered low trees over *Acacia atkinsiana, A. exilis* tall open shrubland over *Triodia wiseana* closed hummock grassland

P7 *Corymbia deserticola* low open woodland over *Acacia atkinsiana* shrubland to tall shrubland over *Triodia epactia, T. wiseana* mid-dense hummock grassland

P8 *Eucalyptus xerothermica* low open woodland over *Eremophila fraseri* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland

P9 *Eucalyptus socialis* low open woodland over *Triodia wiseana* open hummock grassland

P10 *Eucalyptus leucophloia, E. xerothermica* scattered low trees over *Acacia bivenosa, A. exilis* open shrubland to tall open shrubland over *Triodia wiseana, T. angusta* mid-dense hummock grassland

P11 *Acacia synchronicia* scattered shrubs over *Triodia angusta* mid-dense hummock grassland

P12 *Acacia synchronicia, A. bivenosa, Cassia pruinosa, Cassia luerssenii* mixed shrubland over *Triodia brizoides* closed hummock grassland

P13 *Acacia ancistrocarpa, A. bivenosa, A. synchronicia* open shrubland over *Triodia epactia* mid-dense hummock grassland

P14 *Acacia inaequilatera, A. exilis, A. bivenosa* open shrubland over *Triodia epactia* mid-dense hummock grassland

P15 *Acacia bivenosa, A. exilis, A. ancistrocarpa* open shrubland over *Triodia wiseana* mid-dense hummock grassland

P16 *Triodia angusta, T. longiceps* mid-dense hummock grassland

Vegetation of Drainage Areas

C1 *Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma, Pluchea dentex* very open herbland

C2 *Acacia pyrifolia, A. ancistrocarpa, Petalostylis labicheoides* shrubland over *Bonamia rosea, Tephrosia rosea* var. *glabrior* low open shrubland over *Triodia epactia* hummock grassland and *Themeda triandra* very open tussock grassland

C3 *Eucalyptus xerothermica* scattered low trees over *Acacia citrinoviridis, Stylobasium spathulatum* tall shrubland over *Ptilotus obovatus* var. *obovatus* scattered shrubs over *Themeda triandra, Chrysopogon fallax* very open tussock grassland

C4 *Acacia citrinoviridis* tall closed scrub over **Cenchrus ciliaris* closed tussock grassland

C5 *Eucalyptus xerothermica, Corymbia hamersleyana* scattered low trees over *Acacia bivenosa, A. cowleana, A. elachantha, A. exilis* tall shrubland over *Triodia epactia* hummock grassland and *Eulalia aurea* open tussock grassland

C6 *Eucalyptus xerothermica* scattered low trees over *Gastrolobium grandiflorum* open heath over *Chrysopogon fallax, Eulalia aurea* tussock grassland

C7 *Corymbia hamersleyana, Eucalyptus xerothermica* scattered trees over *Acacia bivenosa* open heath over *Triodia angusta* open hummock grassland and *Themeda triandra* very open tussock grassland

C8 *Corymbia hamersleyana* low open woodland over *Triodia epactia* hummock grassland and *Eriachne tenuiculmis, E. mucronata, Themeda* sp. Mount Barricade open tussock grassland

C9 *Corymbia hamersleyana, Eucalyptus leucophloia* low woodland over *Grevillea wickhamii* tall shrubland over *Gossypium robinsonii* open shrubland over *Themeda* sp. Mount Barricade, *Eulalia aurea* and *Paraneurachne muelleri* open tussock grassland and *Triodia epactia* open hummock grassland

C10 *Eucalyptus leucophloia, Corymbia deserticola* scattered low trees over *Acacia tumida* var. *pilbarensis* tall open scrub over *Triodia epactia, T. wiseana* open hummock grassland

C11 *Acacia citrinoviridis, A. ancistrocarpa* tall open shrubland to tall closed scrub over *Triodia epactia* mid-dense hummock grassland

C12 *Acacia monticola, A. maitlandii, A. atkinsiana* tall open shrubland over *Triodia epactia, T. wiseana* mid-dense to open hummock grassland

C13 *Corymbia hamersleyana, Eucalyptus gamophylla* low open woodland over *Acacia monticola, A. ancistrocarpa, A. bivenosa, Rulingia luteiflora* tall closed scrub over *Triodia epactia* hummock grassland

C14 *Eucalyptus leucophloia* low woodland over *Acacia citrinoviridis, Acacia monticola, Dodonaea pachyneura* tall shrubland over *Triodia epactia* mid-dense hummock grassland

C15 *Stylobasium spathulatum* shrubland over *Triodia epactia* hummock grassland

C16 *Corymbia hamersleyana* scattered low trees over *Acacia bivenosa, Petalostylis labicheoides* shrubland over *Triodia epactia* hummock grassland

C17 *Acacia aneura* low woodland to low open forest over *Chrysopogon fallax, Triodia epactia* open tussock / hummock grassland

C18 *Eucalyptus victrix, E. xerothermica* low open woodland over *Acacia citrinoviridis* tall open shrubland over *Themeda triandra, Chrysopogon fallax* tussock grassland

C19 *Corymbia hamersleyana* scattered low trees over *Acacia atkinsiana* tall shrubland over *Triodia epactia* hummock grassland

C20 *Acacia* aff. aneura (narrow fine veined; site 1259) low open forest over *Acacia citrinoviridis* tall open shrubland over *Triodia epactia* open hummock grassland

C21 *Petalostylis labicheoides* shrubland over *Triodia epactia* mid-dense hummock grassland

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Legend for Figures 14a & 14b

Compiled: Land Assets Date: May 2005

LEGEND

- Pit outline
- High grade stockpile
- Low grade stockpile
- Topsoil stockpile
- Waste dump area
- Rail spur alignment
- Access road
- Powerline
- Water pipeline
- Fauna trapping site
- Land Snail location
- Existing Brockman 2 railway
- Road / track
- Storage tank
- Production bore

525000 mE

530000 mE

535000 mE

7515000 mN

7510000 mN

Brockman 2 mine

Boolgeeda borefield
10 bores

BRO30

BRO32

BROF

BRO36

BRO37

Pipeline from borefield

Rail spur alignment

Storage tank

Camp

airstrip

Village borefield
2 bores

INDEX MAP

Figure 14a

Brockman No. 2 Mine

Brockman Syncline 4

Figure 14b

Scale: 1:50 000

0.5 0 0.5 1 1.5 2 2.5km

Projection: MGA94 Zone 50
Datum: GDA94

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project Vegetation Types, Fauna Trapping Sites and Land Snails Figure 14a

Compiled: Land Assets
Date: April 2005

Plan No. RP110545v1

LEGEND

- Pit outline
- High grade stockpile
- Low grade stockpile
- Topsoil stockpile
- Waste dump area
- Rail spur alignment
- Access road
- Powerline
- Water pipeline
- Fauna trapping site
- Land Snail location
- Existing Brockman 2 railway
- Road / track
- Storage tank
- Production bore

520000 mE

525000 mE

530000 mE

7500000 mN

Boolgeeda Creek

BRO36

BRO10

BRO46A

BROSB

BRO04

BRO13E

BRO25E

BROHT

BRO13A

BRO25

BRO19

936

BRO21

BROMD

Dist

INDEX MAP

Figure 14a

Brockman No. 2 Mine

Brockman Syncline 4

Figure 14b

Scale: 1:50 000

0.5 0 0.5 1 1.5 2 2.5km

Projection: MGA94 Zone 50
Datum: GDA94

HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project Vegetation Types, Fauna Trapping Sites and Land Snails Figure 14b

Compiled: Land Assets
Date: April 2005

Plan No. RP110545v1

LEGEND

- Pit outline
- High grade stockpile
- Low grade stockpile
- Topsoil stockpile
- Waste dump area
- Rail spur alignment
- Access road
- Powerline
- Storage tank
- Water pipeline
- Road/track
- Production bore

Priority Flora

- Ptilotus sp. Brockman (Priority 1)
- Abutilon trudgenii ms (Priority 3)
- Sida sp Wittenoom (Priority 3)
- Eremophila magnifica (Priority 4)
- Goodenia stellata (Priority 4)

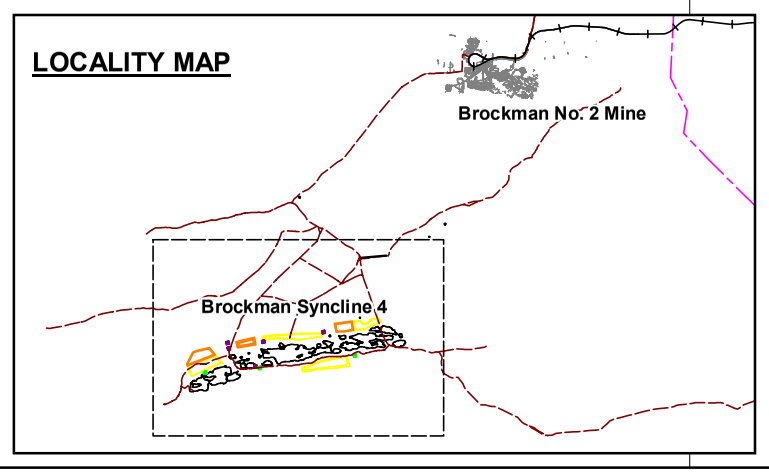
525000 mE

530000 mE

7505000 mN

7500000 mN

LOCALITY MAP



Scale: 1:50 000

0.5 0 0.5 1 1.5 2 2.5km

Projection: MGA94 Zone 50
Datum: GDA94

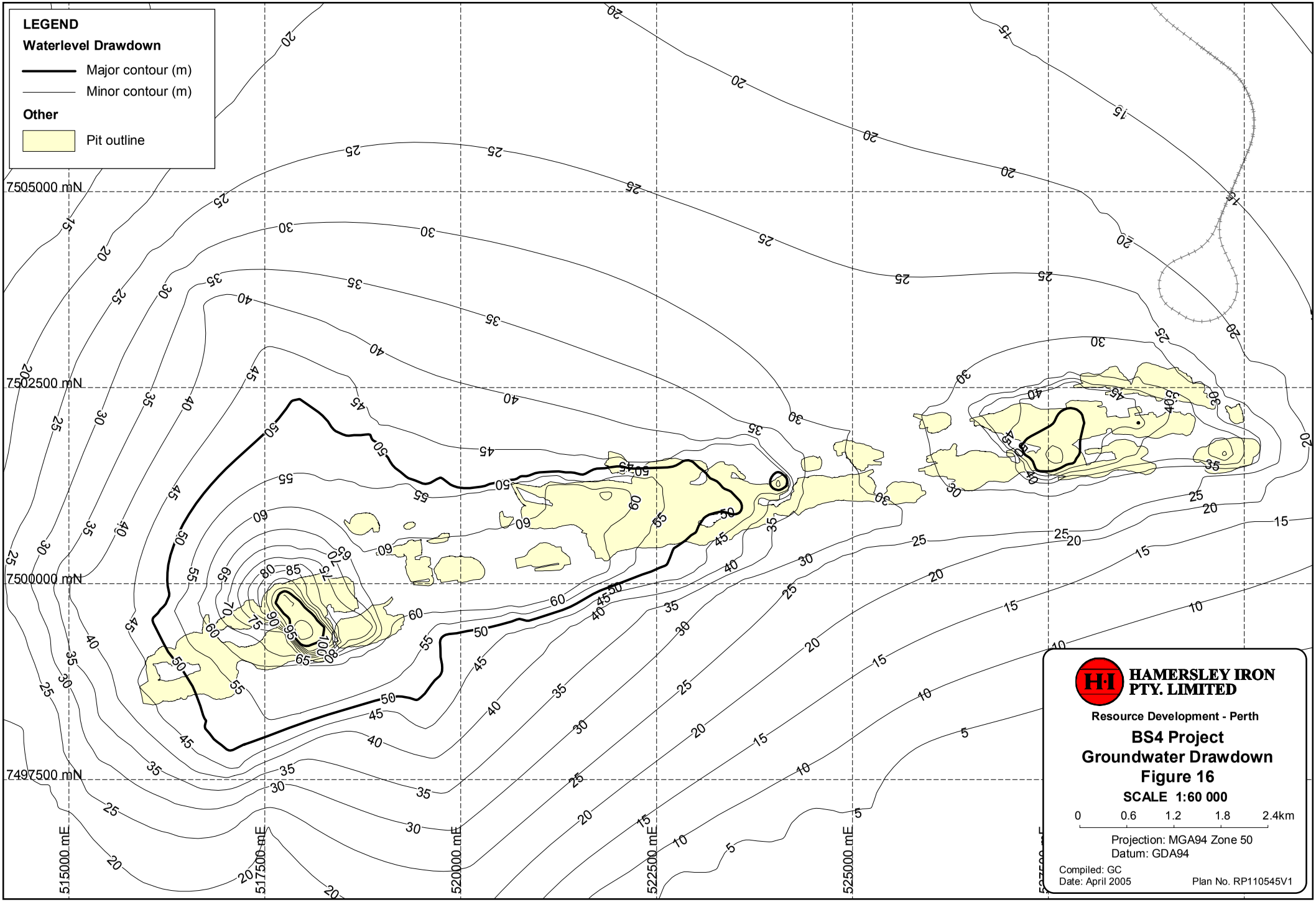
HAMERSLEY IRON PTY. LIMITED

Resource Development - Perth

BS4 Project
Priority Flora near Proposed Mine
Figure 15

Compiled: Land Assets
Date: April 2005

Plan No. RP110545v1


LEGEND
Waterlevel Drawdown
Major contour (m)
Minor contour (m)
Other
Pit outline
7505000 mN
7502500 mN
7500000 mN
7497500 mN
515000 mE
517500 mE
520000 mE
522500 mE
525000 mE
HAMERSLEY IRON PTY. LIMITED
Resource Development - Perth
BS4 Project
Groundwater Drawdown
Figure 16
SCALE 1:60 000
0 0.6 1.2 1.8 2.4km
Projection: MGA94 Zone 50
Datum: GDA94
Compiled: GC
Date: April 2005
Plan No. RP110545V1

Appendices

List of Appendices (contained on attached CD-ROM)

A Environmental Scoping Document

B Breakdown of Clearing by Tenement

C Hydrogeological Report

D Vegetation and Flora Survey Report

E Fauna Survey Report

F Stygofauna Sampling Report

G Preliminary Rehabilitation and Closure Management Plan

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HAMERSLEY IRON

A member of the Rio Tinto Group