COBURN MINERAL SAND PROJECT
PUBLIC ENVIRONMENTAL REVIEW

EPA Assessment No. 1491

July 2005

Prepared for
Gunson Resources Limited




GUNSON RESOURCES LIMITED

URS

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. In accordance with Section 38 of the *Environmental Protection Act* 1986, a Public Environmental Review (PER) has been prepared which describes a proposal by Gunson Resources Limited to develop the Coburn Mineral Sand Project. The PER is available for a public review period of eight weeks from 4 July to 29 August 2005.

Comments from the public and government agencies will assist the EPA to prepare an assessment report in which it will make recommendations to the State Government. If you are able to, the EPA would welcome electronic submissions in particular, emailed to the project assessment officer or via the EPA's Website (see address below).

Where to get copies of this document

Printed copies of this document may be obtained from:

URS Australia
Level 3, 20 Terrace Road
EAST PERTH WA 6004
Phone: (08) 9221 1630

A cost of $10 will be charged per copy.

Copies of the PER are also available from: www.gunson.com.au.

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 each report.

Why Not Join a Group?

If you prefer not to write your own comments, it may be worthwhile joining a group or other groups 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 the names of all of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a Submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.
When making comments on specific proposals in 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 the issues are clear;
- a summary is helpful;
- refer each point to the appropriate sections, chapter or recommendation in the PER;
- if you discuss sections of the PER, keep them distinct and separate, so that there is no confusion as to which section you are considering; and
- attach any factual information you wish to provide and give details of the source. Make sure the information is accurate.

Remember to include:

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

The closing date for submissions is **29 August 2005**.

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

kirsty.quinlan@environment.wa.gov.au

OR

use the submission form on the EPA's website:

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

OR

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

The Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6000

Attention: Kirsty Quinlan

PUBLIC ENVIRONMENTAL REVIEW
COBURN MINERAL SAND MINE
for
Gunson Resources Limited

EXECUTIVE SUMMARY

INTRODUCTION

Gunson Resources Limited (Gunson) proposes to develop the Coburn Mineral Sand Project (the Project) in the Shark Bay district of Western Australia, approximately 250 kilometres (km) north of Geraldton and 84 km southeast of Denham. The Project will comprise the excavation and processing of a major low-grade heavy mineral sand deposit known as the Amy Zone.

The Amy Zone orebody is approximately 35 km long, up to 3 km wide and between 10 and 40 metres (m) thick. The orebody comprises approximately 620 million tonnes of ore hosted in loose, dunal sand with very low clay content. Based on the average grade of 1.1 % Heavy Mineral (HM), over five million tonnes of HM concentrate will be yielded over approximately 20 years. The economic minerals of the Amy Zone include ilmenite, rutile, leucoxene and zircon.

The proposal is being assessed as a Public Environmental Review (PER) under Part IV of the Western Australian Environmental Protection Act 1986. In addition, the proposal is considered to be a "controlled action" under the Environment Protection Biodiversity Conservation Act 1999 (EPBC Act). The controlling provisions are world heritage, listed threatened species and communities and listed migratory species.

The environmental assessment of the proposed Project is being conducted in accordance with the "Agreement between the Commonwealth of Australia and Western Australia under Section 45 of the EPBC Act Relating to the Environmental Impact Assessment (the bilateral Agreement) and in conformance with the Cooperative Arrangements to the Bilateral". This means that the Commonwealth has accredited the WA environmental impact assessment process.

This PER provides a detailed description of the Project and the measures that will be implemented by the Proponent to safeguard the environment.

PROJECT DESCRIPTION

The main components of the proposed Project comprise:

- *ten open-cut mine pits, of which only two would be operational at any one time;*
- *two processing plants (concentrators) that will be relocated as mining progresses northwards;*
- *a borefield;*
- *haul roads and access corridors;*
- *offices, workshops and other supporting infrastructure; and*
- *an accommodation camp.*

The proposed mining and processing operations will be located on the Coburn and Hamelin pastoral leases, whilst the access road traverses the Coburn and Meadow pastoral leases from the North West Coastal Highway. Gunson holds Exploration Licences, mining leases and mining lease applications over the Amy Zone and surrounding area.

Approximately 5,745 ha of land will be cleared as a result of the Project's development. The mine will progress from south to north at a rate of 1-2 km per year, with rehabilitation occurring progressively throughout the expected mine life of 20 years.

Mining of Pits 1-9 is expected to occur over a period of 15-17 years. Although the northernmost pit, Pit 10, is included in the Project for which Gunson is seeking approval, a decision to develop it will not be made until

further technical, hydrogeological and ecological studies are completed and it can be demonstrated that the potential impacts associated with Pit 10 can be managed in an environmentally acceptable manner.

Although studies conducted to date indicate that the potential environmental impacts associated with the development of Pit 10 can be managed effectively, Gunson recognises the environmental sensitivities associated with this area given its proximity to Hamelin Pool and other parts of the SBWHP. Therefore, the company has committed to staging development of the mine such that Pit 10 is dependent upon successful completion of further technical, hydrogelogical and ecological studies.

The key characteristics of the proposed mining developments are summarized in Table ES-1.

ENVIRONMENTAL ISSUES

There would be a number of environmental concerns associated with any mining proposal occurring within the defined Project Area. For example, the Project Area is located adjacent to the south-eastern border of the Shark Bay World Heritage Property (SBWHP) in a floristically diverse transition zone between two botanical districts. In addition, its northern extremity occurs within 5 km of the Hamelin Pool Marine Nature Reserve which was established to protect ancient stromatolites. The region is semi-arid and windy, evaporation is high and rainfall is sporadic and variable: all factors which have the potential to influence rehabilitation success.

Gunson has recognised the environmental concerns of operating in the region, and has commissioned a range of comprehensive studies designed to describe the current state of the environment. These studies have allowed for the identification of a range of mitigation measures designed to mitigate or minimise the effect of mining on the local and regional environment. These measures have been outlined in a detailed Environmental Management Plan (EMP) and Rehabilitation Plan. A Conceptual Closure Plan has also been developed for the Project.

Extensive ongoing consultation with Government Agencies, local Shires, neighbouring pastoralists and the community has been undertaken by the Proponent. The key issues raised during the consultation process have been addressed in the PER and the Proponent believes that all of the environmental issues can be managed. The Proponent will develop, operate and decommission the Project in accordance with the Project's EMP.

Table ES-1
Key Characteristics of the Coburn Mineral Sand Project

Characteristic	Proposed Project
Project Life	20 Years
Number of Pits	Ten. Access to Pit 10 will be dependent on demonstrating that the potential impacts associated with this pit can be managed in an environmentally acceptable manner
Rate of Mining	2,300 tph for the first two years, increasing to 4,600 tph in Year 3 (~15 million tpa for Years 1 and 2, and 30 million tpa for Years 3 to 20).
Mining Method	Bucket-wheel excavators and in-pit screening modules
Estimated Footprint of Disturbance	5,745 ha
Rate of Processing	2,200 tph for the first two years increasing to 4,400 tph in Year 3 (~140,000 tpa of HMC from Year 1 increasing to 280,000 tpa from Year 3).
Estimated Volume of Tailings	2,180 tph for each 2,200 tph concentrator.
Volume of Process Water	Up to 18 GL/annum at full production
Estimated Total Volume of Refined Product	Ilmentite – 2,377 kt HiTi – 658 kt Zircon – 1,000 kt

Note: tph – tonnes per hour, tpa – tonnes per annum, GL/annum - Giga Litres per annum, kt – kilo tonnes.

Most of the environmental concerns identified to date relate to the potential impacts on the SBWHP from development of the northernmost pit (Pit 10). For this reason, Gunson will not commence development of this pit unless it can be demonstrated that mining this pit will not cause unacceptable environmental impacts.

The most significant environmental issues associated with the proposed Project are summarised below.

Soils and Rehabilitation

A reconnaissance of the soils and landforms of the Amy Zone was undertaken in March 2004. The Amy Zone comprises a complex dune system with high local relief and lower relief dunes with rolling terrain, with the soils dominated by sand throughout the profile. All soil samples contain a small percentage of fines, but some of these fines are expected to be lost from the reconstructed profile due to the mineral processing operations.

Field observations of the moisture retention capability of the soil profiles indicate that the moisture retention increases with increasing depth. Soil studies also indicate that some of the material found at depth is dispersive and is therefore not stable.

The Proponent will remove the top 1 m of the soil profile prior to mining, and replace it directly onto the reshaped tailings, thereby recreating the subsoil and topsoil profile. This top 1 m of the profile has been identified as the predominant zone utilized by vegetation roots. Experience from other mineral sand mines elsewhere indicates that such an approach maximises revegetation success.

The loss of some fine materials during the mining process is expected to decrease the moisture holding ability of the sand tailings. However, the loss of some of this material and the soil fabric from the lower soil profile is not expected to impact greatly on the moisture retention ability of the soil profile. A monitoring plan will be implemented by Gunson to compare the particle size distribution, density, and soil moisture in undisturbed analogue sites and the reconstructed profile. The Proponent also intends to classify all soil as to its dispersive nature prior to mining. This will ensure that any dispersive soils encountered are returned to the base of the mine pit.

Given the high wind speeds associated with the region, wind erosion has been identified as a potential environmental issue associated with site rehabilitation. However, given the total lack of soil erosion at other disturbed sites within the region, and the mitigation measures implemented by the Rehabilitation Plan and EMP, wind erosion is not expected to be a factor in site rehabilitation.

Gunson has obtained independent peer advice from three specialists in rehabilitation. The advice received is that rehabilitation of the mine is possible and can be managed to ensure successful revegetation of mined areas.

Dust

Dust modelling studies have indicated that there is potential for off-site impacts from atmospheric dust, particularly given the strong southerly winds that occur during much of the year. This is mainly of potential when mining the northernmost pit (Pit 10), where modelling has indicated that the southern shores of Hamelin Pool are likely to receive a very low level of dust settlement ($1g/m^2$/month).

Concern has been raised regarding the effect of such dust settlement on algal mats and stromatolites located around Hamelin Pool. It is anecdotally reported that dust occurs in the region naturally as a result of the persistent strong winds. It is also known that stromatolites near the tourist viewing area have been exposed to high levels of dust episodically from vehicles travelling the gravel road prior to its relatively recent sealing. However, the effect of dust on these communities is not known.

Gunson proposes to collect baseline data on dust levels and monitor the success of dust management measures. Monitoring dust levels will be undertaken at pre-determined locations throughout the mine site and adjacent areas (SBWHP and Hamelin Pool). Once data have been collected, the atmospheric model will be re-run for operation in the northernmost pit (Pit 10).

Gunson recognises that dust management will be an essential component of site environmental performance, and will undertake a range of preventative measures to minimise fugitive dust sources as part of its daily operations, and provide ongoing monitoring of deposited dust

levels. Given the implementation of these control measures, the impact of atmospheric dust on nearby land users and the environment is predicted to be low.

Groundwater

The effect of the proposed mining developments on the groundwater of the Project Area and the surrounding region has been identified as one of the most important issues associated with the Project. The key impacts to be considered are summarised in Table ES-2.

The disposal of sand and slimes in slurry form is expected to cause mounding of the water table. These mounds are likely to be above the Toolonga basement contact and will flatten quickly away from the pit area. This water mounding will only be significant where they might lead to water levels less than about 5 m from the surface.

Water mounding beneath the backfilled pits is unlikely to affect adjacent undisturbed vegetation as the majority of their roots occur in the top 1 m of the soil profile and generally well above the predicted mounded water table. However, several areas of thin superficial sand cover have been identified at the southern and northern ends of the Amy Zone. The vegetation in these areas may be particularly susceptible to rising water table levels, therefore these areas will undergo specific monitoring of both water levels and vegetation health.

A series of confined and unconfined aquifers occur beneath the Project Area and surrounding environs. It is proposed that process water supplies for the Project (up to 18 GL/annum) be abstracted from these confined aquifers. Groundwater modelling programmes suggest that the large scale abstraction of water from these aquifers for use in mining operations is likely to be greater than the recharge rate. Apart from one bore on Hamelin Station, none of the existing artesian bores are likely to stop flowing. However, the pressures of artesian bores within 20 km of the mine site are likely to be reduced during the latter stages of the mine's life

Table ES-2
Summary of Potential Impacts on Groundwater

IMPACT	SOURCE
Local	
Mounding	
Mounding of the water table in the superficial formations and within the root zones of vegetation stands	Disposal of sand and slimes tailings in slurry form
Residual process water mounding and discharging through shallow aquifers into the Nilemah Embayment with some portion of the discharge ultimately reaching Hamelin Pool	Disposal of sand and slimes tailings in slurry form
Drawdown	
Drawdown impacts within the superficial formations	Pit dewatering in the northern Project Area
Regional	
Drawdown	
Removal of groundwater from the regional confined aquifer systems	Large-scale abstractions at rates exceeding the estimated recharge and throughflow beneath the Project Area
Temporary deficits in recharge compared to abstraction	Large-scale abstractions of groundwater from storage in unconfined zones of the regional aquifer systems
Drawdown impacts within the confined aquifer systems on other users of groundwater	Large-scale abstractions from the Birdrong Sandstone and Kopke Sandstone
Propagation of drawdown impacts from the regional confined aquifer systems vertically upwards into the water table aquifer	Large-scale abstractions from confined aquifers

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In addition, the groundwater abstraction is highly unlikely to affect the algal mats or stromatolites along the shoreline of Hamelin Pool given that they, and the near-shore shallow groundwater system, are reliant on the saline water in Hamelin Pool for water level and nutrients. No changes as a result of the Project to either the water quality or groundwater hydraulics are likely to reach the Hamelin Pool shoreline as there is no hydraulic connection between the aquifers beneath the Project Area and Hamelin Pool.

Other issues relating to groundwater mounding and abstraction include the eventual discharge of tailings water through shallow aquifers into the Nilemah Embayment and Hamelin Pool, and the drawdown impacts within the superficial formations. Both these issues are predominantly related to the mining of Pit 10. Due to the proposed conditional approval of this pit, these issues will not arise due to mining operations. However, both these environmental issues will be further assessed after detailed information has been obtained during the mining of pits 1-9.

A range of mitigation strategies and commitments has been proposed by Gunson in the Groundwater Management Plan and Groundwater Resource Impact Assessments. These strategies, and the proposed conditional approval of Pit 10, lead to the conclusion that the potential for adverse environmental impacts caused by the water use of the mining operation is low.

Vegetation and Flora

Four field surveys were undertaken over a 15 month period within the Project Area and surrounds to describe and map the vegetation communities and the flora within them. Of the 18 described vegetation communities, 14 may be considered as regionally significant, and a further 12 communities as locally significant. Nine Priority Flora species were located in the Project Area during these surveys.

These significant vegetation community classifications are primarily due to their high abundance of Priority Flora and unknown distribution in the broader geographic region.

No Declared Rare Flora (DRF) were identified during the surveys. However, another survey will be undertaken during the public review period to conduct additional searches for DRF and further determine the extent and range of these vegetation communities within the region.

In addition, mine planning has allowed for the total protection of the most significant vegetation assemblages (communities S5 and S10) and the disturbance of no more than 8.5% of the total area of the two other particularly significant communities (S8 and S9). It is expected that some Priority Flora will be affected by mining operations, but no Declared Rare Flora will be disturbed and no plant species will be lost as a result of the disturbance.

Fauna

Three comprehensive vertebrate fauna surveys have been conducted for the proposed Project. Most of the vertebrate species recorded during the surveys have a widespread distribution throughout the semi-arid region and are not restricted to individual habitats. The most likely impact on the fauna in the Project Area will come from the loss of 5745 ha of fauna habitat due to clearing.

*The predominant issues of concern are the presence of Malleefowl (*Leipoa ocellata*), and possible presence of the Hamelin Skink (*Ctenotus zasticus*) within the Project Area. Both species are listed as Vulnerable under the EPBC Act and Threatened under the Wildlife Conservation Act.*

Malleefowl were not observed during the surveys, but their presence was recorded by their footprints and nest sites. Due to their mobility, the mining process is unlikely to result in the death of individual animals. However, the Vertebrate Fauna Management Plan proposes a range of mitigation measures aimed at increasing Malleefowl populations outside the Project Area, and increasing the rate of Malleefowl repatriation to disturbed areas.

A survey was undertaken in September 2004 with the specific aim of determining the presence of the Hamelin Skink within the Project Area. Only one vegetation community within the surveyed area was considered to be similar to the currently known Hamelin Skink habitat. This vegetation community will not be affected by the mine and thus the Hamelin Skink is unlikely to be affected by the proposed mining operations.

Overall, impacts on the regional vertebrate fauna values is expected to be minor considering that most vertebrate fauna found in the Project Area are generally widespread in distribution throughout the semi-arid region.

Other Environmental Issues

The Project's EMP addresses the environmental issues discussed above associated with the Project. In addition, the EMP also addresses:

- *Liquid and Solid Waste Management;*
- *Hydrocarbon Management;*
- *Radiation Management;*
- *Weed Management;*
- *Fire Management; and*
- *Aboriginal Heritage Management.*

Conclusion

Overall, the disturbance caused by mining operations is expected to impact upon the local biodiversity values. In mitigation for this loss of biodiversity values in the Project Area, Gunson proposes to implement a range of measures designed to improve biodiversity values on a regional scale. For example, Gunson plans to de-stock the Coburn pastoral lease for several years, or longer if permission can be obtained from the Pastoral Board, to remove feral goats and to undertake baiting to reduce introduced predators such as foxes and cats. Subsequently, and for fire management reasons, the property will be re-stocked but at a level well below the accepted carrying capacity of the land. These actions should substantially improve biodiversity values over the remainder of the property in the mid to long term and act to compensate for the loss of biodiversity values in the Project Area.

Realisation of the Project will provide a significant economic boost to the local economy as well as provide employment in a region where unemployment is high.

It is therefore concluded that as long as the various management plans and rehabilitation plans committed to by the Proponent are competently implemented, the Project will not result in a significant long-term adverse effect on regional biodiversity values. To the contrary, the proposed mitigation measures are likely to enhance regional biodiversity values.

In addition, Gunson's commitment to conduct additional technical and environmental investigations prior to developing the northernmost pit (Pit 10) markedly reduces the minor risk posed to the values of the Nilemah Embayment and Hamelin Pool. Gunson will have some 15 years experience and monitoring data on which to clarify the impact of developing Pit 10, and will only develop this pit if it can demonstrated that no unacceptable impacts on the SBWHP will occur.

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1.1 THE PROPOSAL

Gunson Resources Limited (Gunson) proposes to develop the Coburn Mineral Sand Project (the Project) in the Shark Bay district of Western Australia, approximately 250 kilometres (km) north of Geraldton and 84 km southeast of Denham (Figure 1.1). The Project will comprise the excavation and processing of a major low-grade heavy mineral sand deposit known as the Amy Zone. The heavy mineral concentrate (HMC) produced at the site will be trucked to Geraldton.

Figure 1.1: Regional Location Map

The Amy Zone orebody is approximately 35 km long, up to 3 km wide and between 10 and 40 metres (m) thick. The orebody comprises approximately 620 million tonnes of ore hosted in loose, dunal sand with very low clay content. Based on the average grade of 1.1 % Heavy Mineral (HM), over five million tonnes of HMC will be yielded over approximately 20 years. The economic minerals of the Amy Zone include ilmenite, rutile, leucoxene and zircon.

The proposed Project includes:

- ten open-cut mine pits, of which only two would be operational at any one time;
- two processing plants (concentrators) that will be relocated as mining progresses northwards;
- a borefield;
- haul roads and access corridors;
- offices, workshops and other supporting infrastructure; and
- an accommodation camp.

The Project Area is located on the Hamelin, Coburn and Meadow pastoral leases, immediately east of the Shark Bay World Heritage Property (SBWHP) as shown on Figure 1.2. These leases are used for grazing sheep and goats.

The proposed Project is being assessed under the Western Australian *Environmental Protection Act* 1986 (EP Act) and the *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act). A bilateral agreement is in place between the Commonwealth and WA governments that accredits the State environmental impact assessment process. This means that a single assessment process can be carried out to satisfy both State and Commonwealth requirements. This Public Environmental Review (PER) serves as the environmental assessment document under both the State EP Act and the Commonwealth EPBC Act.

1.2 THE PROPONENT

The proponent for the Coburn Mineral Sand Project is:

Gunson Resources Limited
Level 2, 33 Richardson Street
WEST PERTH WA 6005
ABN: 32 090 603 642

Contact:

Mr Alan Luscombe, General Manager
Email: alan@gunson.com.au
Phone: (08) 9226 3130

Gunson is a Perth-based Australian mineral exploration company that was first listed on the Australian Stock Exchange in May 2000. The Coburn Mineral Sand Project is one of six of Gunson's assets. The other assets, all of which comprise mineral exploration properties, are:

- Mount Gunson Copper Project (South Australia);
- Shell Lakes Nickel and Diamond Project (Western Australia);
- Burkin Nickel Project (Western Australia);
- Tennant Creek Gold – Copper Project (Northern Territory); and
- Fowler's Bay Nickel Project (South Australia).

Gunson's Sustainability Policy is provided as Figure 1.3.

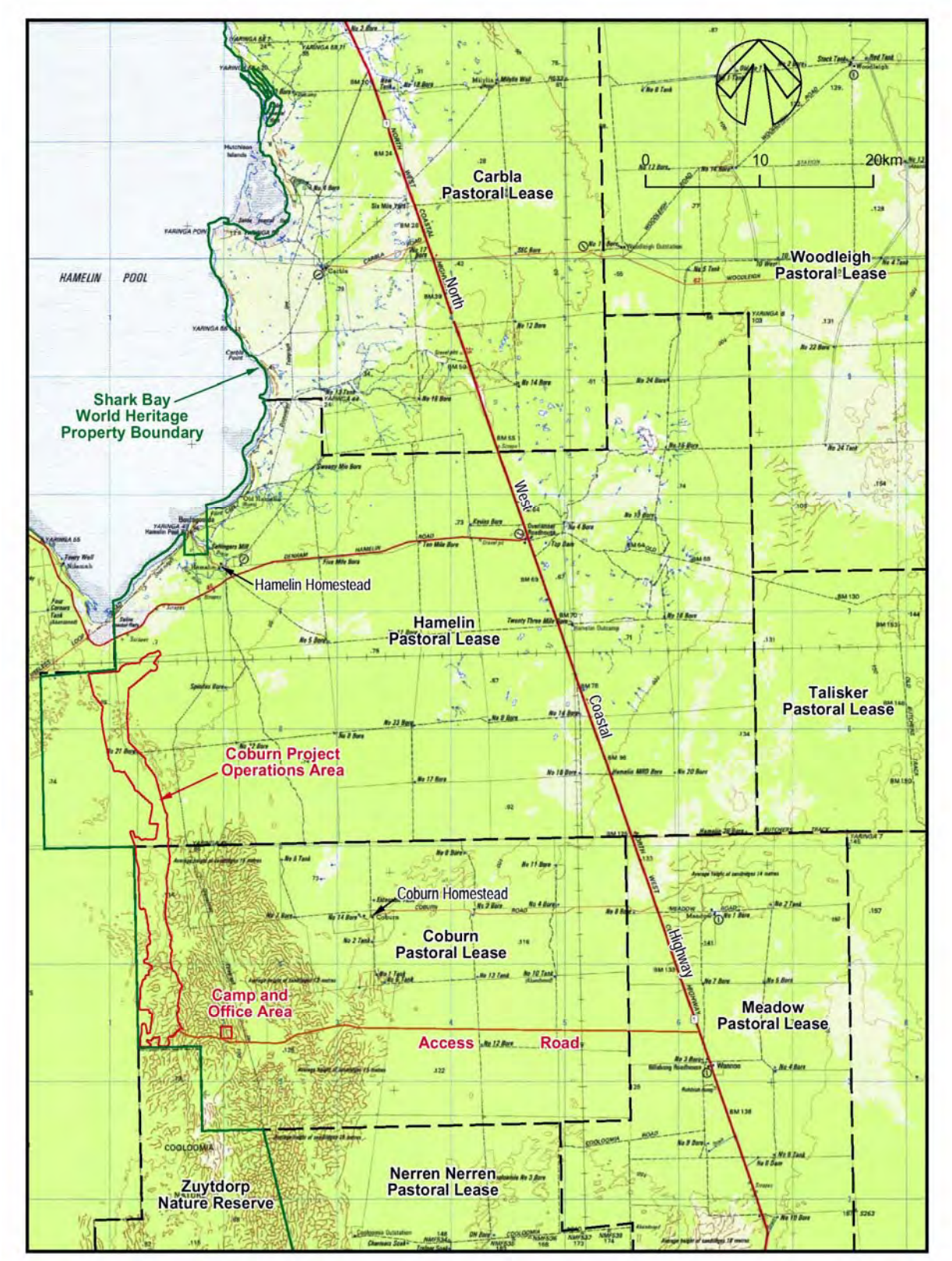

Figure 1.2: Locality Map

GUNSON RESOURCES LIMITED

ABN 32 090 603 642

SUSTAINABILITY POLICY

GUIDING PRINCIPLE

The Company firmly believes that its opportunity to continue to contribute to and thrive in Australia must be earned through a demonstrated commitment to sustainable development. Sustainable development is defined as *development that meets the needs of the present without compromising the ability of future generations to meet their needs.*

POLICY

Accordingly, our actions must demonstrate a responsible approach to social, economic and environmental performance that is aligned with the evolving priorities of our communities of interest.

We use the term 'communities of interest' to include all individuals and groups who have, or believe they have, an interest in the management decisions about our operations that may affect them. This includes employees, contractors, Aboriginal peoples, mining community members, suppliers, customers, environmental organisations, governments, the financial community and shareholders.

Our actions must reflect our values that we share with our employees and communities of interest, including honesty, transparency and integrity. They must underscore our ongoing efforts to protect employees, communities, customers and the natural environment.

We will demonstrate leadership and sustainable practice by:

- Involving communities of interest in the design and implementation of our operations;
- Proactively seeking, engaging and supporting dialogue regarding our operations;
- Conducting all facets of our business with excellence, transparency and accountability;
- Contributing to initiatives to promote production, use and recycling of metals and minerals in a safe and environmentally responsible manner;
- Seeking to minimise the impact of our operations on the environment and biodiversity;
- Practicing continuous improvement through the application of new technology, innovation and best practices in our operations for the benefit of future generations; and
- Compliance with laws and regulations in each state in which we operate and apply the standards reflecting our adherence to our guiding principle and our adherence to best international practices.

Level 2, 33 Richardson Street West Perth WA 6005
PO Box 1217 West Perth WA 6872
Telephone: (08) 9226 3130 Facsimilie: (08) 9226 3136
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Figure 1.3: Gunson's Sustainability Policy

1.3 PURPOSE AND STRUCTURE OF THE PER

The objectives of the PER are to:

- place the proposed Project in the context of the regional and local environment with a social and cultural perspective;
- adequately describe all components of the proposal;
- identify key environmental issues that may occur as a result of the proposed Project;
- provide the basis of the Proponent's environmental management programme, which shows that the environmental impacts resulting from the proposal (including any cumulative impacts) can be managed in an acceptable manner;
- communicate clearly with the public (including government agencies), so that informed public comment can be obtained to assist in providing advice to the Western Australian Minister for the Environment and the Commonwealth Environment Minister; and
- clearly set out the reasons why the proposal should be considered to be environmentally acceptable.

The PER document is structured as follows:

1. **Introduction**: Introduces the proposed Project and the Proponent, and provides background information relevant to the environmental assessment of the Project.
2. **Project Description**: Describes the proposal in detail including construction, operation, rehabilitation and closure of the mine. This section also provides information on the alternative development options considered for the Project.
3. **Project Justification**: Provides information on the benefits of the proposed Project, and outlines the consequences of not proceeding.
4. **Existing Environment**: Describes the physical, biological and social characteristics and values of the regional area and the Project Area.
5. **Stakeholder Consultation**: Describes the community and government consultation undertaken during the preparation of this PER, the consultation programme proposed for the public review period and consultation that Gunson will conduct following proposal implementation.
6. **Identification of Relevant Environmental Factors:** Identifies key environmental issues that could arise as a result of proposal implementation and a summary of the ability of the Project to satisfy the environmental objectives for each issue.
7. **Biophysical Issues and Management:** Identifies biophysical issues and potential impacts associated with the proposed Project and the proposed management of the impacts.
8. **Pollution Issues and Management:** Identifies pollution issues and potential impacts associated with the proposed Project and the proposed management of the impacts.
9. **Social Issues and Management:** Identifies social issues and potential impacts associated with the proposed Project and the proposed management of the impacts.
10. **Assessment of Commonwealth MNES**: Identifies Commonwealth Matters of National Environmental Significance (MNES), potential impacts on these matters and proposed environmental management of the impacts.
11. **Summary of Environmental Management Commitments**: Summarises the Proponent's environmental management commitments.
12. **Conclusion**: Provides a concluding statement of the potential environmental costs and benefits of the proposed Project and a case outlining why the proposal should be allowed to proceed.
13. **Acknowledgements**: Acknowledges the study team, organisations and other people who have contributed to the report.
14. **References**: Provides a list of references cited in this PER.
15. **Abbreviations**: Lists the abbreviations used in this PER.

Additional information to support the PER is provided in the Appendices.

1.4 LAND TENURE

The Project Area traverses three pastoral leases (Figure 1.2). The proposed mining and processing operations will be located on the Coburn and Hamelin pastoral leases, whilst the access road traverses the Coburn and Meadow pastoral leases from the North West Coastal Highway.

Gunson holds Exploration Licences, mining leases and mining lease applications over the Amy Zone and surrounding area, as shown in Figure 1.4.

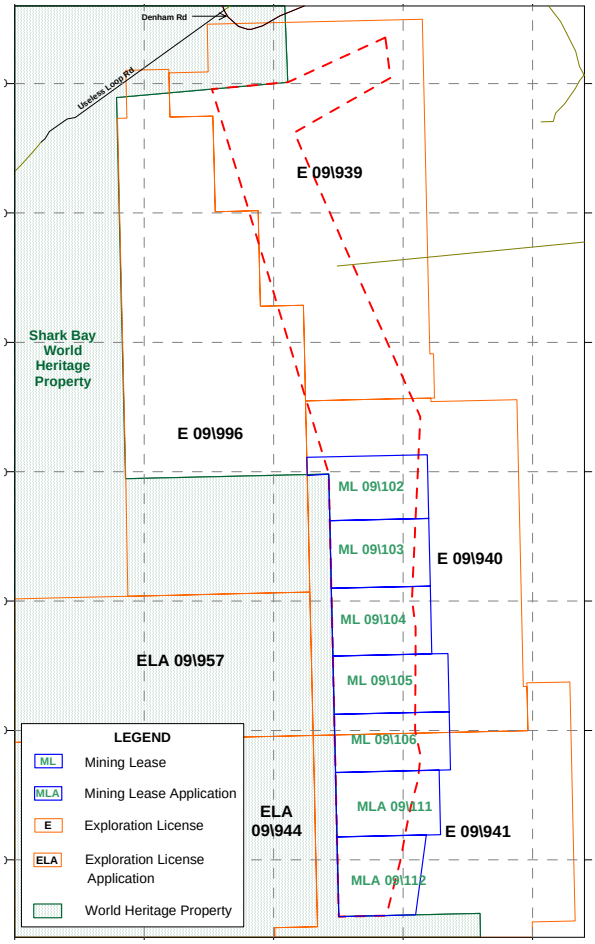

Figure 1.4: Land Tenure

A mining agreement with the Nanda Aboriginal people, whose native title claim covers the southern part of the Amy Zone, was finalised on 20 September 2004. This confidential agreement covers a range of financial, cultural and heritage provisions and will bring financial benefits to the community. More importantly, it provides a framework for an ongoing relationship that will be of benefit to both Gunson and the Nanda people. Gunson is committed to building relationships with the local Aboriginal people that recognise their connection with the land and provide opportunity for economic and social development.

Discussions regarding a mining agreement with the Malgana Aboriginal people, whose native title claim covers the northern part of the Amy Zone, are in progress. An agreement similar to that concluded with the Nanda people is envisaged.

1.5 RESPONSIBLE AUTHORITIES

The primary agencies involved in the assessment and management of the Project are:

- The Commonwealth Department of Environment and Heritage (DEH), which administers the EPBC Act and the EPBC Regulations.

- The WA Environmental Protection Authority (EPA), which is an independent statutory authority and the key provider of the independent advice to Government. The EPA's objectives are to protect the environment, and to prevent, control and abate pollution.

- The Department of Environment (DoE), which is responsible for administering the EP Act on behalf of the Minister for the Environment, for considering and initiating measures for the conservation, protection and management of the environment, and for the prevention, control and abatement of pollution.

  Since merging with the Waters and Rivers Commission (WRC), the DoE has also administered the *Water and Rivers Commission Act* 1955 and other relevant legislation, such as the *Waterways Conservation Act* 1976 and parts of the *Rights in Water and Irrigation Act* 1914 to ensure that the State's water resources are managed to support sustainable development and conservation of the environment for the long term benefit of the community.

- The Department of Conservation and Land Management (CALM), which manages lands and waters for the conservation of biodiversity at ecosystem, species and genetic levels. CALM administers the *Conservation and Land Management Act* 1950 and *Wildlife Conservation Act* 1950 and assists the Conservation Commission, the Marine Parks and Reserves Authority, and the Marine Parks and Reserves Scientific Advisory Committee to carry out their statutory functions.

- The Department of Indigenous Affairs (DIA), which administers the *Aboriginal Heritage Act* 1972 and supports the Aboriginal Land Trust.

- The Shire of Shark Bay, which manages the local laws, policies, strategic plans and the local Town Planning Scheme for Shark Bay.

- The Department of Industry and Resources (DoIR) which administers the *Mining Act* 1978, *Mines Safety and Inspection Act* 1994 and the *Mines Safety and Inspection Regulations* 1995.

1.6 ENVIRONMENTAL ASSESSMENT PROCESS

1.6.1 Assessment under the WA *Environmental Protection Act* 1986

The environmental assessment process in WA is designed to provide information to the EPA, DoE and other regulatory authorities, as well as the public, about proposed developments with the potential to impact on the natural and social environment. The main stages of this process are illustrated in Figure 1.5.

In September 2003, Gunson submitted an Environmental Referral document to the WA EPA to 'trigger' the environmental assessment process for the Coburn Mineral Sand Project. The proposal referred to the EPA comprised:

- the Amy Zone Operation, in the Shark Bay region; and
- a Mineral Separation Plant (MSP), in the Geraldton area.

Following review of the Environmental Referral, the EPA determined that the Amy Zone Operation (hereafter referred to as the Project) and the MSP would be assessed as two separate projects due to differences in the geographic setting and environmental sensitivity of the proposed locations, with the proposed mining operation being located adjacent to the SBWHP and the MSP to be located within an existing industrial estate.

The level of assessment for the proposed Project was set at a PER, with an eight-week public review period.

A Scoping Document required under Section 6.1 of the Environmental Impact Assessment Administrative Procedures 2002 was submitted to the EPA in October 2004 to allow the EPA to review the scope of work proposed for the preparation of this PER. The scope of work was finalised after EPA comment and advice incorporated and is provided as Appendix A. The environmental factors that the EPA, in consultation with key regulatory authorities, believes should be addressed in the PER are listed in this scope of work.

The PER is a public document and will be subject to an eight-week public review period. During this time, government agencies, private organisations, community groups and the public are invited to make submissions to the EPA. The EPA will then assess the proposed Project with consideration of:

- issues raised by the public during the public review period;
- the Proponent's response to the issues raised by the public;
- specialist advice from government agencies;
- the EPA's own research; and
- research undertaken by other specialist agencies or parties, if required.

Following its assessment of the proposed Project, the EPA will prepare and submit its report and recommendations to the WA Minister for the Environment. This document will comprise the EPA's report on the environmental acceptability of the proposal and its recommendations regarding the environmental conditions that should apply if the proposed Project is to proceed.

The EPA will publish its report and the public may appeal against the content of the report or its recommendations.

The decision on whether the proposed Project may proceed will then be made by the Minister for the Environment. Only after the Minister has set the environmental conditions of approval may WA regulatory authorities issue other environmental approvals.

1.6.2 Assessment under the *Commonwealth Environment Protection and Biodiversity Conservation Act* 1999

Under the EPBC Act, an action requires approval from the Commonwealth Environment Minister if the action has, will have, or is likely to have a significant impact on a MNES. The MNES are:

- World Heritage properties;
- National Heritage places;
- Ramsar wetlands of international significance (the result of a wetlands treaty signed in Ramsar, Iran, in 1971);
- nationally listed threatened species and ecological communities;
- listed migratory species;
- Commonwealth marine areas; and
- nuclear actions.

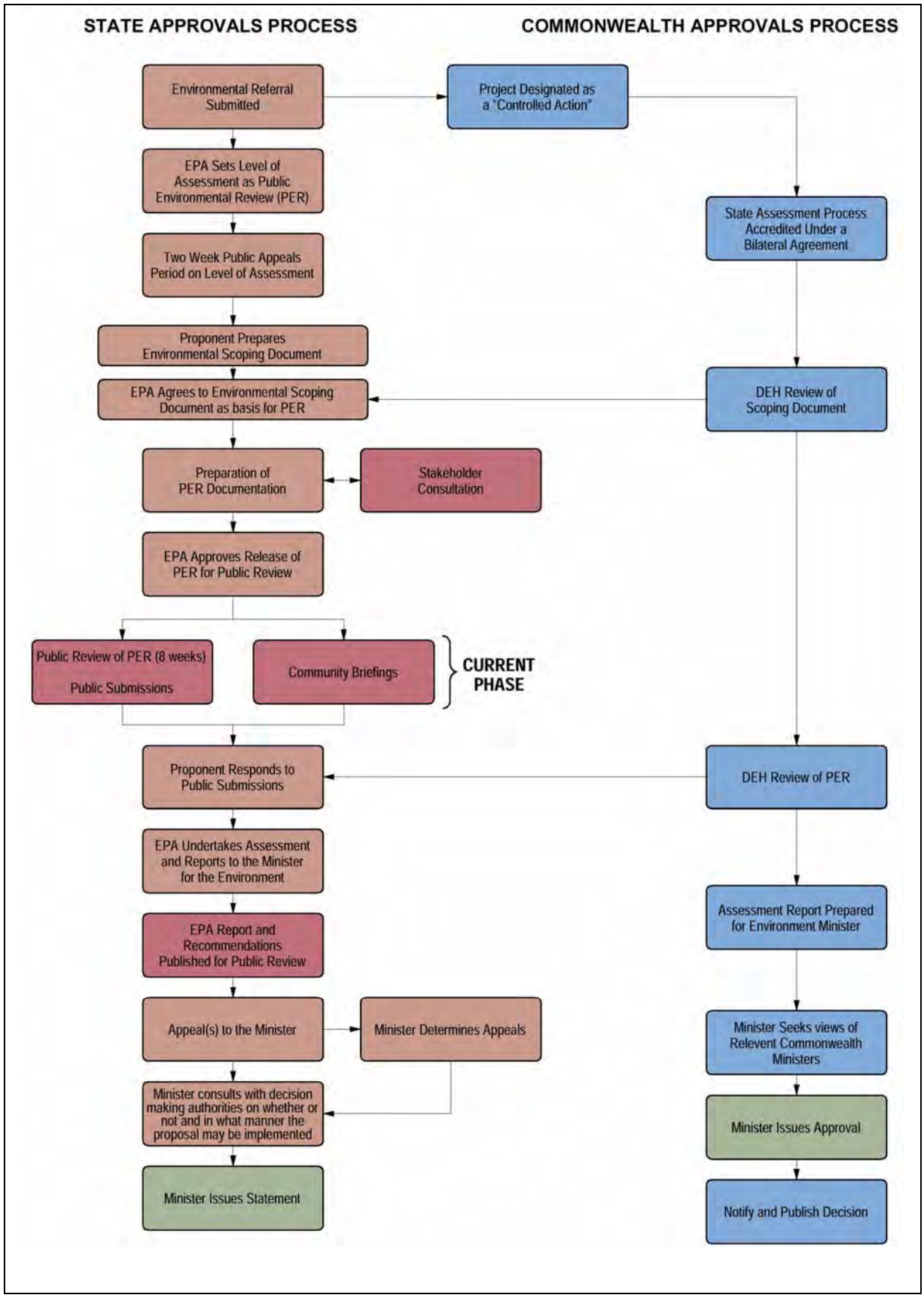

Figure 1.5: Environmental Impact Assessment Process

In September 2003, Gunson referred the Project to the DEH as the Project Area may impact on the SBWHP, (which is a world heritage property and a national heritage place), and the following listed threatened and/or migratory species:

- Hamelin Ctenotus (*Ctenotus zastictus*);
- Western Spiny-tailed Skink (*Egernia stokesii badia*);
- Slender-billed Thornbill (*Acanthiza iredalei iredalei*);
- Thick-billed Grasswren (*Amytornis textiles textiles*);
- Malleefowl (*Leipoa ocellata*);
- White-bellied Sea Eagle (*Haliaeetus leucogaster*); and
- Beard's Mallee (*Eucalyptus beardiana*).

Following referral of the proposal to the DEH, it was determined that the proposed project is a "controlled action", which means that approval is required under the EPBC Act.

A Preliminary Information Document was submitted in July 2004 to allow the level of assessment required under the EPBC Act to be set by the Commonwealth Environment Minister. It was subsequently determined that the environmental assessment of the proposed Project would be conducted in accordance with the "Agreement between the Commonwealth of Australia and Western Australia under Section 45 of the EPBC Act Relating to the Environmental Impact Assessment (the bilateral Agreement) and in conformance with the Cooperative Arrangements to the Bilateral". This means that the Commonwealth has accredited the WA environmental impact assessment process.

Following review of the PER and associated documentation, the DEH prepares an assessment report for the Environment Minister. In considering whether to approve the proposal, the Minister will seek the views of relevant Commonwealth ministers. If the Environment Minister decides to approve the proposal, the Proponent is notified and the decision is published.

The Commonwealth Environment Minister's approval is a separate approval to the one issued by the State Minister for the Environment. Consequently, if approved, the proposed Project will need to comply with two Ministerial approvals.

1.7 RELEVANT LEGISLATION, POLICIES AND GUIDELINES

In addition to obtaining approval from the WA Minister for the Environment and the Commonwealth Environment Minister, the Proponent will need to comply with a range of legislation and regulations administered by State and Federal Government agencies. Relevant legislation includes those Acts and Regulations listed in Appendix B. This appendix also lists a range of policies and guidelines applicable to the Project.

2.1 OVERVIEW

The proposed Project comprises the construction, operation, rehabilitation and closure of:

- a series of open pit mines which will be backfilled with tailings;
- processing plants (concentrators);
- haul road and access corridors;
- an accommodation camp;
- office buildings, workshops and support facilities;
- a borefield; and
- supporting infrastructure such as a power plant, reverse osmosis desalination plant, power lines and pipelines.

The key characteristics of the proposed Project are summarised in Table 2.1. Indicative site layouts are provided as Figures 2.1 and 2.2.

Table 2.1
Key Characteristics of the
Coburn Mineral Sand Project

Characteristic	Proposed Project
Project Life	20 Years
Number of Pits	Ten pits. Access to Pit 10 will be dependent on demonstrating to the satisfaction of the Minister for the Environment that the potential impacts associated with this pit can be managed in an environmentally acceptable manner.
Rate of Mining	2,300 tph for the first two years, increasing to 4,600 tph in Year 3 (~15 million tpa for Years 1 and 2, and 30 million tpa for Years 3 to 20).
Mining Method	Bucket-wheel excavators and in-pit screening modules
Estimated Footprint of Disturbance	5,745 ha
Rate of Processing	2,200 tph for the first two years increasing to 4,400 tph in Year 3 (~140,000 tpa of HMC from Year 1 increasing to 280,000 tpa from Year 3).
Estimated Volume of Tailings	2,180 tph for each 2,200 tph concentrator.
Volume of Process Water	Up to 18 GL/annum at full production
Estimated Total Volume of Refined Product	Ilmentite – 2,377 kt HiTi – 658 kt Zircon – 1,000 kt

Note : tph – tonnes per hour, tpa – tonnes per annum, GL/annum - Giga Litres per annum, kt – kilo tonnes.

Mining of the Amy Zone will be carried out using a conventional dry strip mining method. Mining infrastructure will be progressively relocated as mining proceeds at one to two kilometres per annum.

Two 2,300 tph bucketwheel excavators will be used for mining the ore and overburden in Years 1 and 2. The mined material will be conveyed to an in-pit screening module for the removal of oversize and roots before the sand is mixed with water and pumped to a concentrator. When necessary, booster pumps will be used to transport the slurry to the concentrator, and return the tailings to the mine void. This mining system will be duplicated from Year 3 of the mine life, with the duplication of the mining and concentrator equipment.

Initially, the plant throughput will be 2,200 tph and increase with the addition of a second concentrator to 4,400 tph from Year 3. The concentrators comprise a primary concentration circuit, a secondary concentration circuit and a non-magnetic upgrade circuit.

The concentrators will be built around banks of spirals that remove silica and other lighter specific gravity minerals, allowing valuable heavy minerals to become concentrated. This process of pumping the ore and water over spirals will be repeated until the final concentrate is more than 90% HMC.

The HMC will be trucked approximately 300 km to Geraldton as two separate product streams, as follows:

- Wet High Intensity Magnetic Separator (WHIMS) magnetics HMC, which consist primarily of ilmenite with minor amounts of leucoxene; and
- Non-magnetic HMC, which contains a mixture of weathered (secondary) ilmenite, leucoxene, rutile, zircon and minor levels of waste minerals.

Approximately 140,000 tonnes of HMC per annum (or around 400 tonnes per day) will be trucked to Geraldton, increasing to 280,000 tonnes per annum (or around 800 tonnes per day) from Year 3 of the mine life.

Sand tailings and clay fines (slimes) from the on-site concentrator(s) will be returned to the mined-out area(s) as the mining operation moves forward. Water recovered from the tailings will be recycled to the slurry unit or when necessary stored in a lined dam at the concentrator.

The rehabilitation programme will be conducted progressively. In order to obtain the maximum regrowth from the surface vegetation, it will be removed from areas ahead of the pit and placed on prepared tailings areas behind the pit in a continuous removal/replacement cycle.

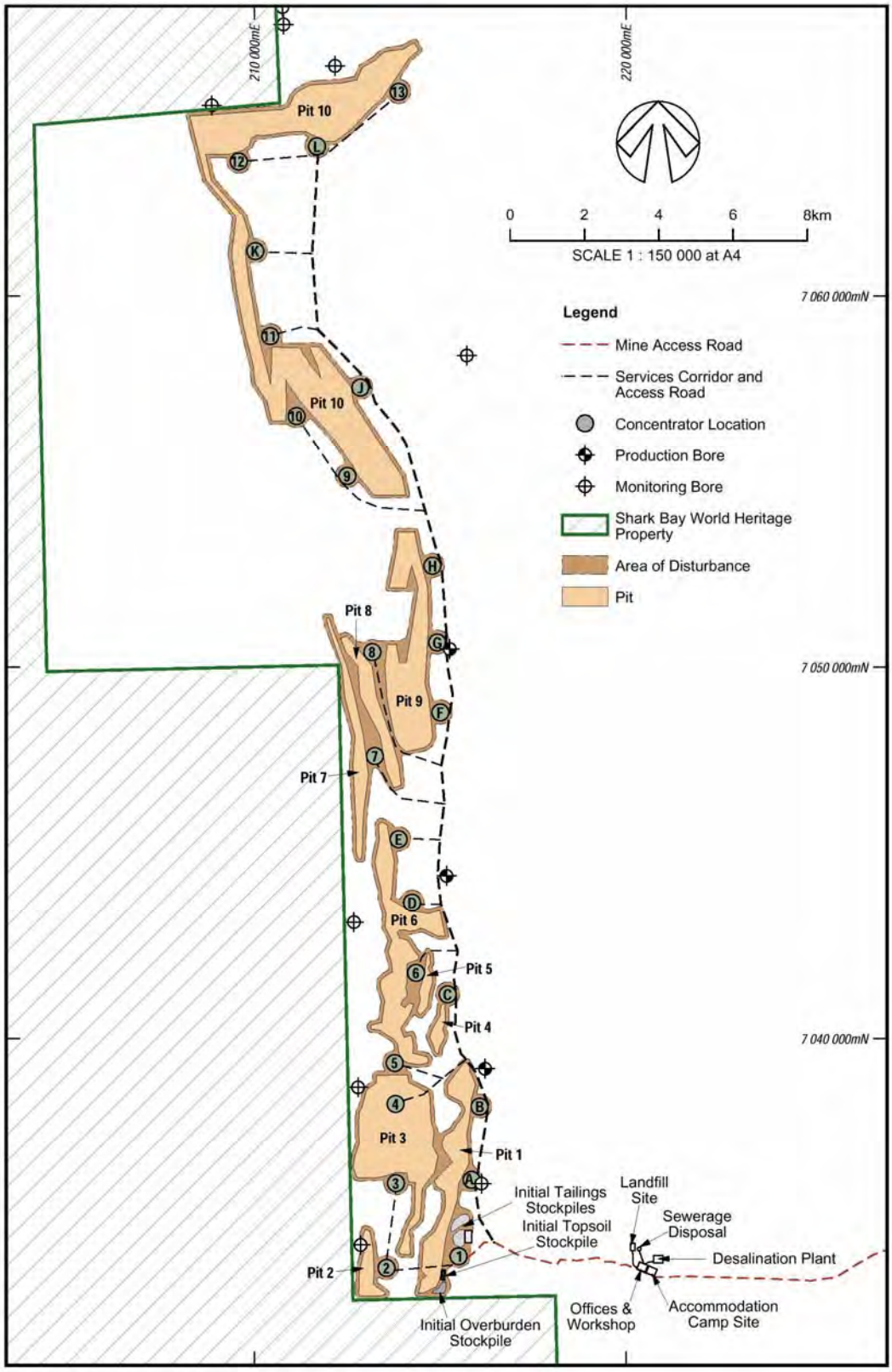

Figure 2.1: Proposed Layout of Amy Zone Operations of the Coburn Mineral Sand Project

NOTE: The path of the first concentrator is marked by numbers, eg. ①
The path of the second concentrator is indicated by letters, eg. Ⓐ

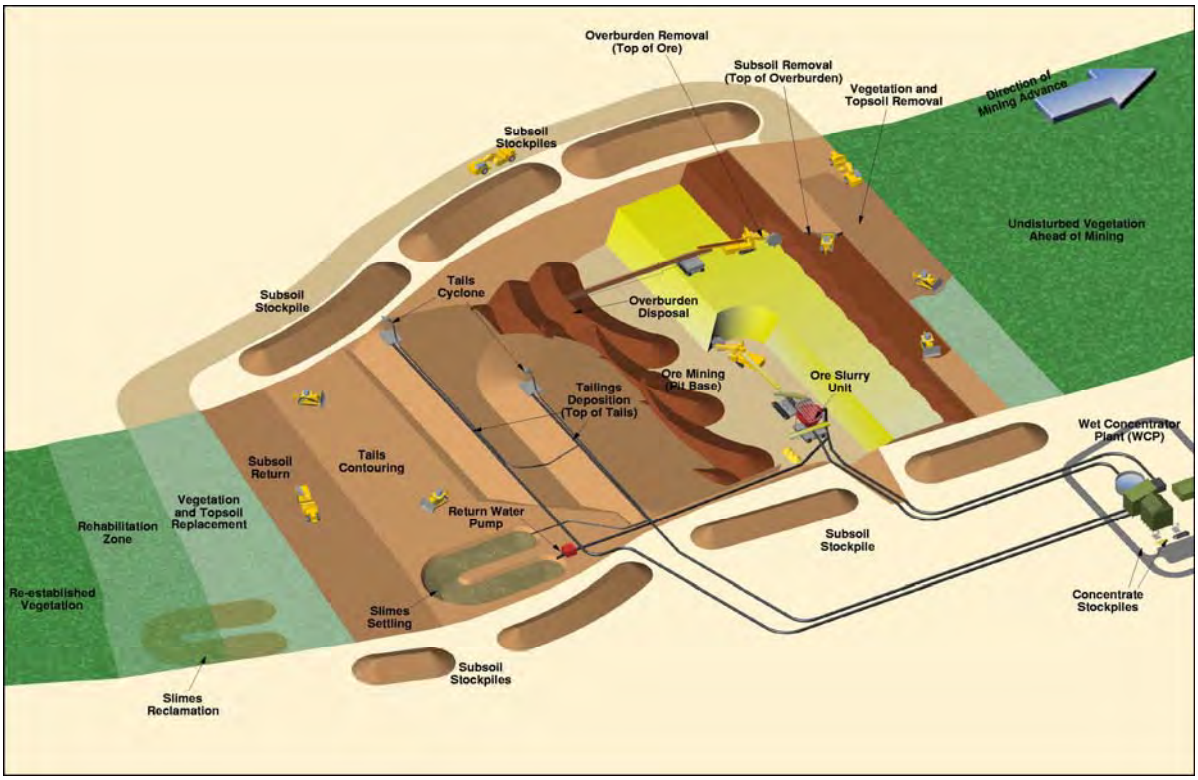

Figure 2.2: Schematic of the Conceptual Pit Layout

Process water will be sourced from groundwater. Water demand for Years 1 and 2 will be approximately 5.9 GL/annum. Total water demand could be up to 18 GL/annum under full production, allowing conservation, reuse or recycling of water. Potable water for the camp and mine office will be processed through a reverse osmosis system to bring the brackish bore water to a potable standard.

2.2 CONSTRUCTION

2.2.1 Initial Construction Activities

Construction activities will comprise:

- installing an access road to the minesite;
- constructing internal haul roads required for the first year of production;
- clearing of vegetation;
- stripping of topsoil;
- stockpiling of initial topsoil, vegetation, subsoil and overburden;
- establishment of the concentrator required for Pit 1; and
- initial borefield development.

Construction will commence with the establishment of the 45 km access road connecting the North West Coastal Highway to the initial processing plant site adjacent to the first mine pit.

Water supply bores and pipelines will also be constructed at an early stage to connect a reliable water supply to the camp and wet concentrator construction site. Construction of the accommodation camp will commence upon completion of the access road.

Field construction activities including installation of pipelines, booster pump stations, tailings cyclones, electrical transmission lines and cables will be conducted concurrently with plant construction. Plant construction is described in Section 2.2.4.

2.2.2 Clearing Activities

Pre-production earthworks will be required to prepare areas for construction of the wet concentrator, accommodation camp, buildings, offices and amenities. These earthworks will include clearing and stockpiling vegetation, topsoil and subsoil close to where it was removed. Any trees that are too large to be picked up using a scraper will be moved to the side of the mining area and stored until they can be placed in the rehabilitation areas as fauna habitat.

All sites will require earthworks for levelling. This will primarily be conducted by cut and fill to minimise earthworks, but some areas may require removal and stockpiling of material.

The majority of pre-production earthworks will be associated with the initial pit development. The first pit to be mined will be located at the southern end of the Amy Zone. Initial clearing of the pit will cover an area of 700 m by 300 m. The proposed layout for initial pit development is shown in Figure 2.3.

The stockpiles will vary in width between 30 m and 70 m depending on the width of the pit and the volume of material to be stockpiled. For the initial pit width of 700 m the stockpile width will be approximately 70 m. As the pit reduces to 200 m wide, the stockpile will reduce to 30 m. The stockpile areas will be cleared but not stripped of topsoil.

Other areas to be cleared of vegetation include areas for overburden stockpiling, process water dams, initial clay fines settling area, initial sand tailings and mineral concentrate stockpiles.

The estimated area required for each facility during the construction phase is provided in Table 2.2.

Table 2.2
Indicative Area of Disturbance for Construction and Pre-production

Operation/Activity	Area (ha)
Access Road	94
Office Area	10
Accommodation Camp	5
Haul Road	3
Mining Area	130
Construction Site	10
Concentrator, offices, workshops, contractors area	5
Overburden stockpile area and initial tailings area	15
Vegetation stockpile (initial)	2
Topsoil stockpiles (initial)	5
Internal Roads (excluding drill tracks)	5
Water pipelines	3
Process water dam	1
Clay fines settling area	4
Power Line (minor services only)	1
Total	**293**

2.2.3 Pit Design

The Amy Zone deposit will be mined as a series of discrete pits. Indicative pit outlines are provided as Figure 2.1 and cover a total of 34 km^2. These outlines may change as a result of detailed mine planning.

The total uncut area of disturbance of the whole project, including access road, internal roads, subsoil stockpiles, concentrator sites, dams and buildings is estimated to be 58km^2. At any particular time the operational area will vary between 30 and 100 ha, depending on the width of the pit being mined.

The total volume of ore to be mined is currently estimated to be 350 Mm^3 and that of the overburden is estimated to be 162 Mm^3.

Pit floor elevations lie between 65 and 75 m above sea level for the first 10 years of operations. As mining proceeds to the north, the pit floor elevations gradually fall to 5-10m above sea level.

At the commencement of mining, the depth of the pit is shallow, at around 5m. However, as the pit floor elevation falls and the surface height increases, the pit depth increases to a maximum of 50m in the centre of the deposit. In the northern portion the pit depth reduces due to a decrease in the height of the dunes. Within this depth the mine path is determined by the ratio of overburden to ore. The depth of overburden has two effects on the mine plan:

- the economic viability of the underlying ore; and
- the practicality of placing overburden without impinging on the orebody.

Access to the pit floor will be via a ramp constructed along the batter of the mine void. The ramp will have a slope of 1:10 or 5.7 degrees. To provide a solid base for the ramp, oversize from the in-pit screener will be used in ramp construction. New access ramps will be constructed approximately every 200 m as the mine advances northward and the old ramps are covered by the tailings.

2.2.4 Plant Construction

Plant construction will include laying concrete foundations, fabricating the plant as a series of modules, securing modules together, fitting interconnecting walkways and pipework and completing electrical connections.

2.2.5 Hours of Work

During the construction period, construction will occur during daylight hours, seven days a week.

2.3 OPERATIONS

2.3.1 Mining

2.3.1.1 Mining Method Options

Gunson has investigated various options for mining the Amy Zone and has selected a conventional "dry" mining method, rather than the "wet" mining method of dredging.

Wet mining is carried out using a floating dredge. The dredge and concentrator float on a pond that is artificially maintained within the mine void and the mined ore is pumped in a slurry form to a concentrator. This method requires a significant volume of water to maintain the pond, which can lead to high water usage and consequential environmental impacts. The method is more suitable when all or part of the ore lies below the water table.

The dry mining method is best suited to the hydrogeological conditions of the Project Area with mining unlikely to intersect the water table, particularly the southern portion of the Amy Zone. In addition, the selected dry mining method will allow mining infrastructure to be largely contained within the mine pit (i.e. on the pit floor). The mobile concentrators will be located near the edge of the pit. This infrastructure will be progressively relocated as mining proceeds from south to north at 1-2 km per annum, minimising the area of disturbance at any one time and enabling progressive rehabilitation of the mined areas.

The mining system has been designed to suit the nature of the overburden and the geometry of the mineral concentrations that make up the orebody. Excavation of the overburden and ore will be conducted using bucket wheel excavators, which are suited to high volume continuous mining of unconsolidated materials. The overburden removal system allows direct deposit of this material into the mine void via a spreader conveyor. This eliminates the use of haul trucks which in turn reduces the use of finite resources such as hydrocarbons and the generation of vehicle emissions and dust from vehicle movements.

The pits will have a narrow mine face that works across the full pit width in 50 metre strips. The small mine void will also minimise the transport distance for overburden, further reducing dust and hydrocarbon emissions.

2.3.1.2 Options for Disposal of Overburden

"Overburden" is defined as the material located below the topsoil and subsoil, and above the orebody, that needs to be removed to allow excavation of the ore. At the Amy Zone, overburden is a combination of red loamy sands and yellow sand with scattered patches of calcrete (Plate 2.1).

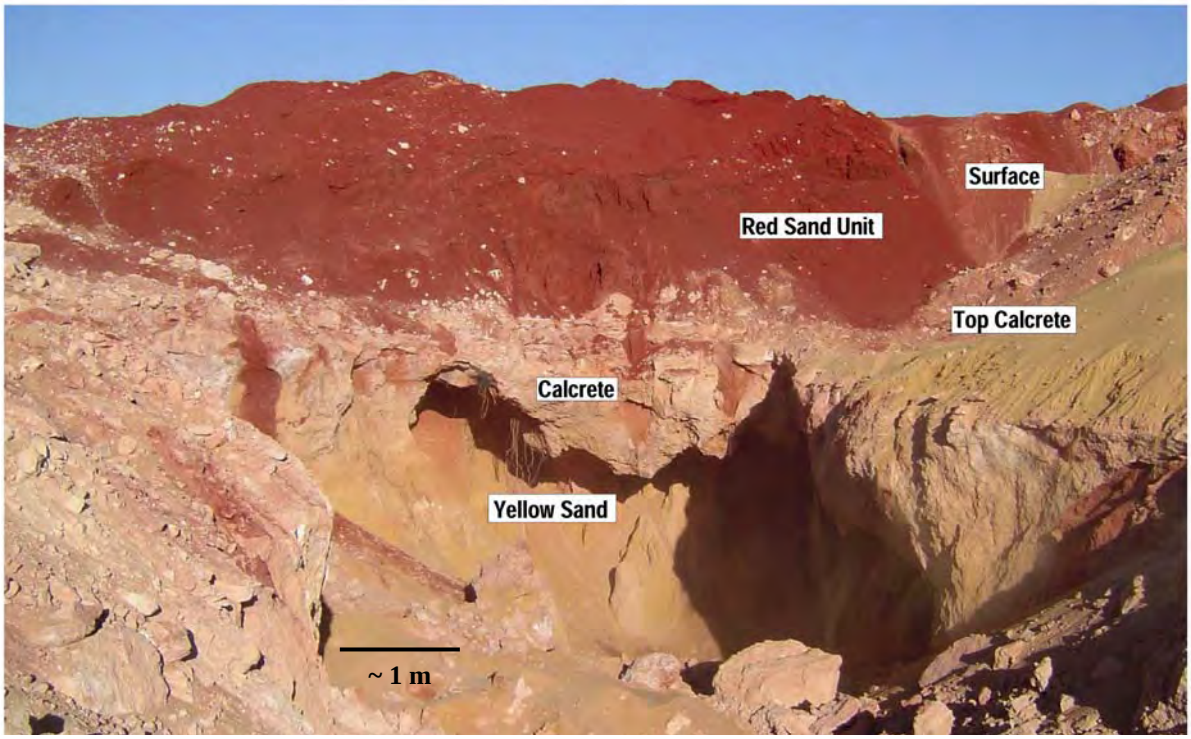

Plate 2.1: Indicative cross-section of overburden at the Amy Zone

The stripping ratio for the southern portion of the Amy Zone averages 0.3 (i.e. 0.3 parts of overburden to 1 part of ore). In the northern section of the orebody, the ratio averages 0.6. The volume of overburden and the cost associated with moving this material means that it must be returned directly to the mine void as backfill (Tennent, Isokangas Pty Ltd 2005).

There are three options for the direct disposal of overburden as backfill:

1. Depositing the overburden on top of wet or dry tailings in the mine void.

2. Depositing the overburden with wet tailings as a mixed backfill.

3. Depositing the overburden directly into the bottom of the mine void and then covering it with wet tailings.

Options 1 and 2 were eliminated due to the distance involved in transporting the overburden around the mine void.

Depositing the overburden at the bottom of the mined-out pit and covering it with wet tailings, is not expected to constrain the rehabilitation process as up to 1m of subsoil and topsoil will be spread over the tailings. This assumption is based on field investigations by D.C. Blandford and Associates (2004), who found that most of the plant root zone occurs in the top 1m of soil (Appendix C).

2.3.1.3 Preferred Mining Method

Mining of the Amy Zone deposit will be carried out using a conventional dry strip mining method, as illustrated in Figure 2.2.

Mining will commence at the southern end of the Operation Area, and progress generally northwards. The sequence of mining the pits is shown on the Mine Layout Plan (Figure 2.1). For each mine pit the following sequence of activities for mining will be undertaken.

After surveying the topography to guide future rehabilitation, a strip of land up to approximately 150 m wide immediately ahead of the mine face will be cleared of vegetation using scrapers and bulldozers.

At the start of each pit, topsoil will be initially removed by scrapers and placed into stockpiles up to 150 m from the mine face. For the remainder of each pit, where possible this will be directly returned to the rehabilitated area. At times when direct placement is not possible topsoil and vegetation will be stockpiled adjacent to the pit for later use in rehabilitation.

The subsoil from each pit will be removed and stockpiled on either side of the mining area, where it will be stored for periods of up to nine months. Once the mine face has passed the stockpiles, the subsoil will be returned to the area from which it was removed to cover the sand tailings.

After clearing and removal of topsoil, bucket-wheel excavations (BWEs) will remove subsoil and the uneconomic mineralised sand (overburden) above the ore for a distance of up to 50 m ahead of the mine face. Overburden removed from the initial part of each pit will be stockpiled and rehabilitated. Overburden from the remaining part of each pit will be returned to the pit void and buried by tailings. Where, because of the distance between pits, the overburden cannot be returned to the mine void it will be stockpiled and contoured to suit the surrounding area.

A second BWE will mine the ore across the width of the orebody (see Figure 2.2). The ore will be conveyed to an in-pit screening module where oversize and roots will be removed and disposed of to mined-out pits. The ore will then be fed to an ore slurry unit, mixed with water and pumped to the concentrator.

Mining of Pits 1-9 is expected to occur over a period of 15-17 years. Although Pit 10 is included in the Project for which Gunson is seeking approval, a decision to develop the pit will not be made until further technical, hydrogeological and ecological studies are completed and it can be demonstrated that the potential impacts associated with Pit 10 can be managed in an environmentally acceptable manner (Commitment 1).

Although studies conducted to date indicate that the potential environmental impacts associated with the development of Pit 10 can be managed effectively, Gunson recognises the environmental sensitivities associated with this area given its proximity to Hamelin Pool and other parts of the SBWHP. Therefore, the company has committed to staging development of the mine such that Pit 10 is conditional upon successful completion of further technical, hydrogeological and ecological studies. Refer to Section 6 for further details.

COMMITMENT 1

Prior to the development of Pit 10, the Proponent will:

- Demonstrate that successful rehabilitation of mined lands in the southern portion of the Project Area (Pits 1-6) is possible. The standards to be achieved to demonstrate "successful rehabilitation" will be defined by the completion criteria provided in the Project's rehabilitation plan.
- Conduct further hydrogeological investigations to verify the expected water balance and groundwater model for Pit 10, so as to prevent adverse impacts to marine life within the Shark Bay World Heritage Property.
- Conduct further investigations into the potential impacts on vegetation and root zones to verify that vegetation within the Shark Bay World Heritage Property will not be adversely impact by the development of Pit 10.
- Conduct further dust investigations to verify that the stromatolites at Hamelin Pool will not be adversely impacted by the development of Pit 10.

2.3.2 Pit Dewatering

The southern part of the Amy Zone has little or no groundwater within the proposed mine pit areas, so there is no requirement for dewatering bores.

Dewatering of the northern Amy Zone pits may be required prior to the commencement of mining in these pits. This is likely to be short term and localised.

In-pit sumps will be used to capture any rainfall or run-off entering the pits. This water will be pumped to the concentrators and used as make-up water in the processing operations.

2.3.3 Processing

2.3.3.1 Options for Concentrator Locations

Early in the development of the proposed Project, it was anticipated that the concentrators would be located within the mine pits to minimise the area of disturbance. However, the selected mining method requires that the concentrators be relocated approximately every two years. Consequently, they will be located outside of the pits except where there is a requirement for the primary concentrator circuit to be located within pits.

2.3.3.2 Preferred Plant Locations

The proposed locations of the concentrator sites are shown on Figure 2.1. The concentrators have been designed as a series of modules that can be moved on transportation units available in Western Australia. The positions of Concentrator 1 as it is relocated from south to north are designated 1 to 13, and those of Concentrator 2 as A to L.

2.3.3.3 Plant Operations

Two concentrators each with a capacity of 2,200 tph will be used to concentrate the HM. In Years 1 and 2, one concentrator will be operational at a rate of 2,200 tph. In Year 3, the second concentrator will increase the processing rate to 4,400 tph. The modular units will be moved forward by one to two kilometres approximately every two years as mining progresses northwards.

The mined ore will be transported by a conveyor system to an in-pit screening module to remove oversize material (for example roots and calcrete). The coarse oversize material will be placed directly back into the mine void.

The screen undersize will be mixed with water to create a slurry. This will be pumped to the wet concentrator plant. The slurry is discharged into a surge bin that is designed to stabilise the feed supplied to the plant. Water will be added to the bin to enable a controlled density to be pumped to the concentrator.

The wet concentrator will consist of banks of spirals, which separate the lower specific gravity silica from the valuable high specific gravity minerals (including zircon, rutile, ilmenite and leucoxene). The process of pumping the ore and water over spirals is repeated until the final concentrate contains more than 90% HM. The tailings from the wet concentrator will be pumped into the mined-out pit.

The primary HMC will be further upgraded in the secondary concentrator. The secondary concentrator includes WHIMS, which exploits the variance in magnetic properties of the minerals to generate an ilmenite-rich magnetic fraction and a zircon/rutile rich non-magnetic fraction.

The non-magnetic fraction will be further classified to upgrade the HM content to +95%HM. Initially the fraction is subjected to a rising current of water which removes particles of fine silica. The coarse, heavy sand (underflow) is subjected to a two-stage spiral circuit and the finer particles (overflow) to a three-stage spiral circuit. The tailings are joined

with the primary circuit tailings and pumped to the mined-out pit.

The two concentrates (i.e. the WHIMS magnetic concentrate and the non-magnetic concentrate) will be dewatered using cyclones and stockpiled separately for transport to Geraldton. The overflow from the dewatering cyclone will be screened and re-used for process water.

The mineral stockpiles will be up to 10,000 t, to allow the HMC to dry before being transported to Geraldton.

2.3.4 Tailings Disposal

2.3.4.1 Options for Tailings Disposal and Water Recovery

Tailings from the mining operations consist of sand, water and fine clay. Gunson investigated three options for tailings disposal to maximise successful rehabilitation.

The first option comprised the separation of the sand tailings and clay fines during processing, with the tailings being returned to the mined-out pits and the clay fines pumped to solar drying dams outside of the pit. Once the clay fines have reached an appropriate moisture level, they are recombined with the top layer of tailings (sand) in the pit. The benefit of this option is that the sand tailings and clay fines, which have different drying rates, can be kept separate until dry. The disadvantage is a significantly lower water recovery.

The second option for tailings disposal is a blended co-disposal system, where the streams of sand tailings and clay fines are re-combined to form a non-segregated mixture that is disposed of to the mine pit. The benefits of this option are that both the clay fines and sand tailings are only handled once after processing and the use of solar drying dams is eliminated.

The third option is to not separate the sand and clay throughout the process, which allows some of the clay to be returned to the pit with the sand tailings. In order to prevent an increase in the clay content of the recycled water, some water will be directed to a settling trench along the edge of the pit. The reclaimed water will be reintroduced to the circuit.

The third option was selected as the preferred method for tailings disposal for the following reasons:

- The Amy Zone contains a very low percentage of fine clay. Only a proportion of the water will need to be a separate stream in order to control the level of clay in the process water.
- Disposing of the clay fines as a separate stream to the sand tailings allows for the different drying rates for these materials.
- The continuous forward progress of the mining excavation will allow a series of smaller trenches to be used, therefore preventing excessive depths of clay to form.
- Locating the slimes trench within the mine pit allows reduces the area of disturbance as it eliminates the need for solar drying dams outside of the pit.
- Locating the slimes trench within the mine pit allows the water seeping from the trenches to be recovered by the water recovery system. This maximises opportunities for recovery of mine water.

A conceptual model for mine water recovery from the tailings disposal areas was developed in conjunction with the mine plan and schedule. Three mine water recovery designs were considered, as follows:

1. The initial concept used open drains corresponding to low areas on the pit floor, with an underdrain to capture seepage from the clay fines (see Figure 2.3 and 2.4).

   Modelling conducted as part of the option selection process demonstrated that this concept would have been adequate for narrow pits, but would not have been practical for wide pits where wide tailings discharge fronts could not be supported by two stacker units.

2. The second concept assumed that the stackers depositing the tailings sand into the pit would work across the pit. The bottom of the swales between the overburden stockpiles would be used as open lateral drains and longitudinal drains would be maintained along the sides of the pit to collect residual seepage from previous tailings deposition across the pit and from the clay settling area. Transfer pumps would operate in the lateral drains in front of the active discharge slope to collect mine water as soon as practical after it has flowed from the base of the pile. This concept assumed that the two stackers would backfill half of the pit each (see Figure 2.5).

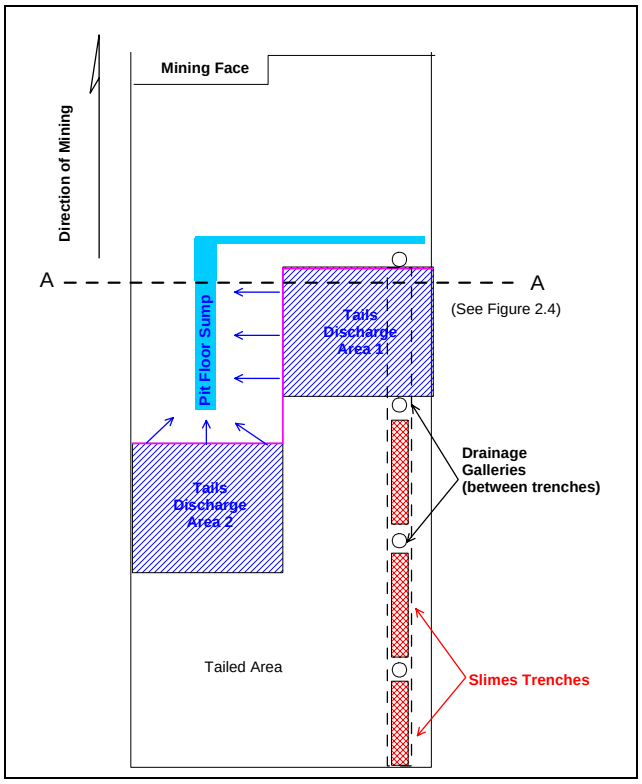

Figure 2.3: Plan View of Initial Conceptual Model for Tails Water Recovery in the Superficial Formation

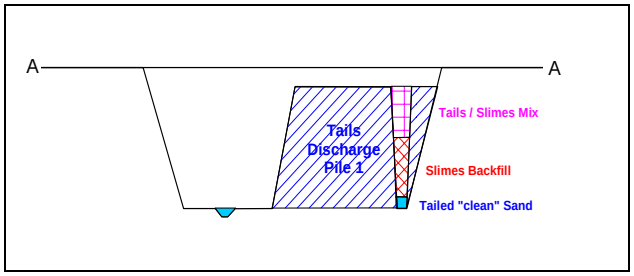

Figure 2.4: Cross-section of Initial Conceptual Model for Tails Water Recovery in the Superficial Formation

Variations of the second concept were also assessed. These considered the use of stackers operating in different configurations, such as from the outside to the inside of the pit and from the centre of the pit to the pit edges. Assessment of these variations focused on the infrastructure required to collect and recirculate the mine water seepage.

3. The third concept utilised most of the design features of the second option, but assumed that the two stackers would work across the entire pit in tandem. Open drains would be installed on both sides of the pit, with one underdrain using a buried pipe collecting seepage from beneath the slimes settling area. Open drains would be maintained where possible behind the active tailings disposal area to collect residual seepage. Mine water would be collected in sumps and pumped to the in-pit pumping module.

Option 3 was selected as the preferred concept for mine water as it is more efficient in recycling water. This is described in Section 2.3.4.2.

2.3.4.2 Preferred Tailings Disposal Method

Tailings from the concentrator(s) will consist primarily of sand and minor quantities of clay and water.

Sand tailings will be produced at a rate of 2,180 tph for each 2,200 tph concentrator. The sand tails are pumped as a slurry at a density of 55% solids by weight from the concentrator to a series of cyclones located in the mined-out pit. The cyclones dewater the sand tails to approximately 65-70% solids to allow water to be recycled. The stacking system is used to generate the contours with final shaping by bulldozers ahead of resurfacing with subsoil and topsoil.

An underdrainage system will be established to collect seepage from beneath the slimes settling area. In addition, open drains will be installed on both sides of the pit to act as seepage interception trenches. The open drains will be maintained where possible behind the active tailings disposal area to collect residual seepage. This could be for a period of several years. Mine water will be collected in sumps and pumped to the in-pit pumping module.

When required, a portion of the recovered water is directed to a settling dam and pumped to the in-pit screening module for re-use. The settling dam will be located in the mine void between the sand tails and the pit batter.

When the slimes content of the recovered water is too high, the water will be diverted to the slimes settling trench where the slimes will be settled and clear water recovered.

The use of the cyclone stacking system and the settling dam for clay fines disposal will minimise any potential increase in the clay content of the process water. The tailings disposal process will be controlled to ensure the stability of the completed landform.

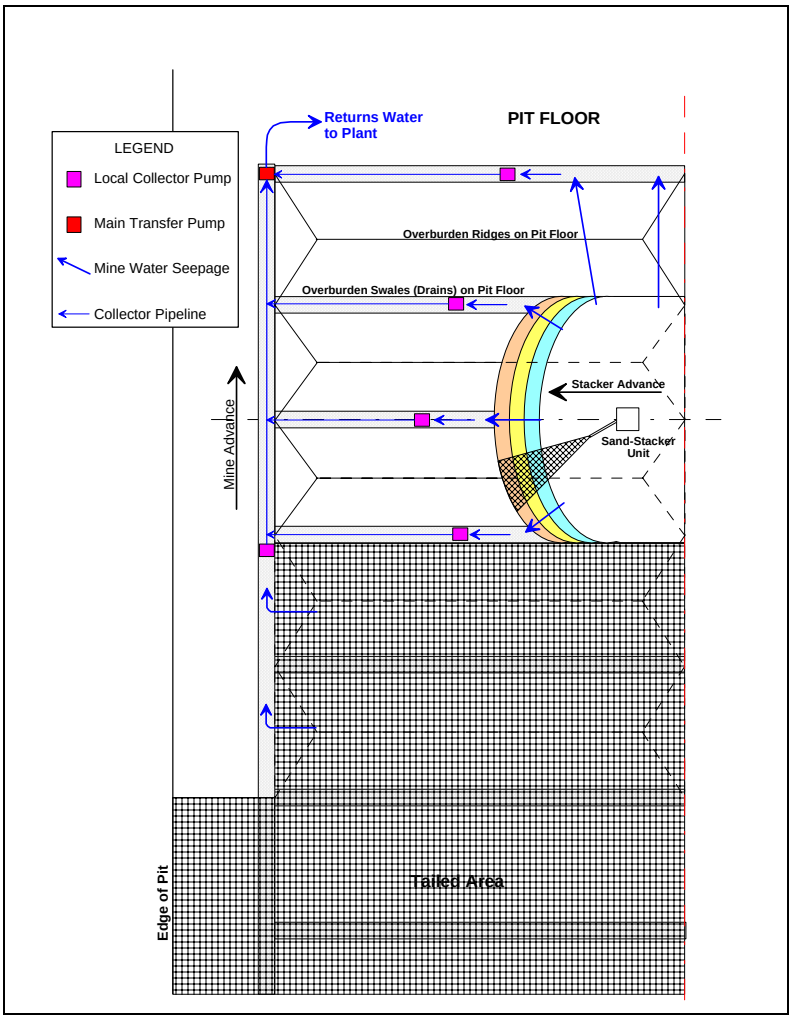

Figure 2.5: Second Conceptual Model of Tails Water Recovery in the Superficial Formation

2.3.5 Transport of Product

The HMC produced at the mine site will be trucked to Geraldton for direct export.

During the first two years of production, it is anticipated that ten road trains per day (five return trips, approximately 80t load) will be required to transport 400 t of HMC to Geraldton. This is approximately 140,000 t of concentrate per annum.

From Year 3, around 20 road trains will be used to transport 800 t per day (ten return trips, approximately 80t load) or approximately 280,000 t of concentrate per annum.

2.3.6 Hours of Operation

The mining and concentrating operations will occur 24 hours per day, seven days a week.

2.4 SITE ACCESS

2.4.1 Alignment Options

During initial planning for the Project, it was proposed to locate the site access road along the boundary of the Coburn and Hamelin pastoral leases. However, locating the access road such that it intersects the centre of the orebody unnecessarily increases the transport distance to Geraldton during the first half of the project life. Consequently, Gunson has identified a route from the southern end of the orebody that traverses the Coburn and Meadow pastoral leases. This road intersects the North West Coastal Highway approximately 3 km north of the Billabong Roadhouse (see Figure 2.6).

2.4.2 Haul Roads

The road connecting the mine site to the North West Coastal Highway will be a private road traversing the Coburn and Meadow pastoral leases

(see Figure 2.7). It will be a two-lane unsealed road constructed of crushed and compacted calcrete. It is expected that up to 300,000 m^3 of calcrete will be required for initial construction, which is likely to be sourced from calcrete pits adjacent to the proposed alignment. The speed limit of the haul road will be 80 km/hr.

An access road will be constructed from the site offices to the initial mine pit. As mining continues to move north, this access road would be extended as required.

Haul roads will also be constructed to connect the mine areas and concentrators to the north-south haul road. These will be installed progressively as the mining operations move northwards and rehabilitated when no longer required.

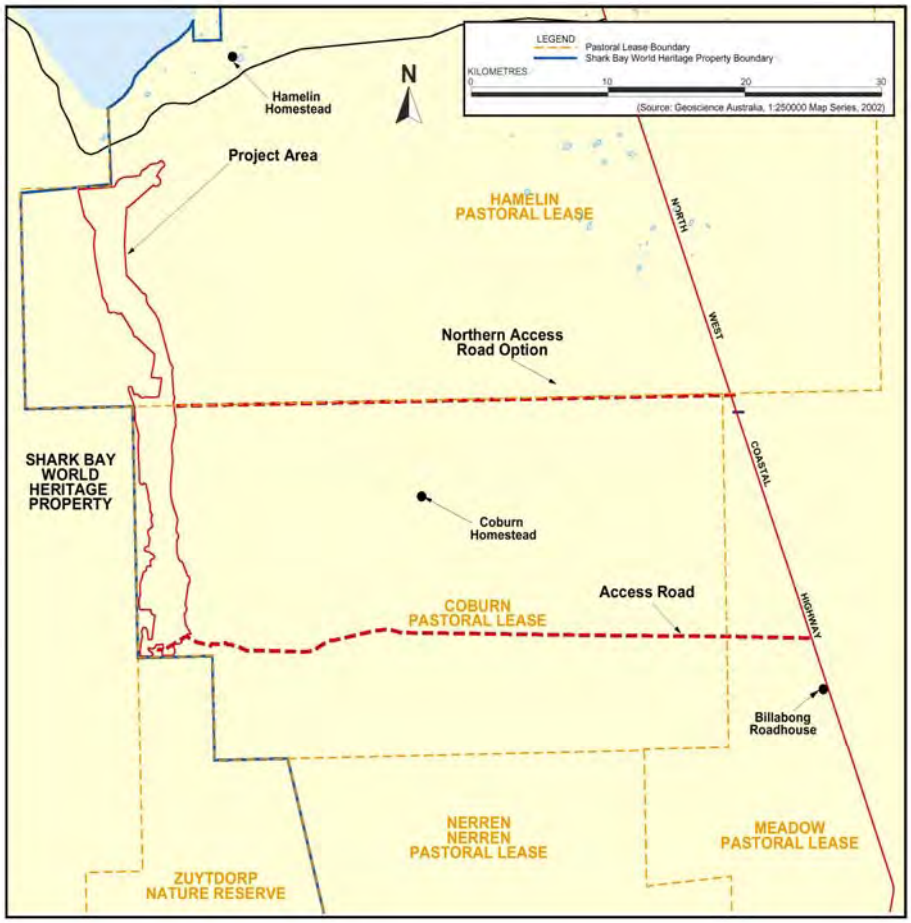

Figure 2.6: Access Road Corridor Options

2.4.3 Access Tracks

The majority of access tracks within the Operation Area will be associated with drilling and sampling of the orebody. Existing tracks cross the orebody from east to west, which vary from 250 m spacing to 1000 m spacing. The drill lines have two interconnecting access tracks for travelling from one drill line to another.

Drill lines will be used wherever possible for general access around the orebody. Additional access tracks will be required for water bores and other services but these will be minor in comparison with the number of drill access tracks.

Internal roads will be constructed to a 4WD standard, with some improvement where required. The speed limit on internal roads will vary between 30 and 50 km/hr.

As mining advances, detailed drilling will be undertaken ahead of the mining operation. Drill lines may be reduced to 100 m or closer spacing to cover at least three years planned mining. This would typically be a distance of approximately 5 km ahead of each pit.

There will be numerous access tracks around the mine pit and these will change position frequently as the mine pit and services move ahead. Such

tracks provide temporary access within the disturbance area of mining activities.
The location of major access tracks is shown on Figure 2.7.

Following mining and rehabilitation, a small number of access tracks will be required for maintenance and monitoring of rehabilitation within the Amy Zone.

2.5 WATER SUPPLY

Water will be required by the Project primarily to transport the ore from the pit, for mineral concentrating, domestic use and dust suppression. As discussed in Appendix D, the volume of water required will depend on a range of factors, including:

- Operational factors such as:
  - the capacity of, and type of liner used for, the water storage dam(s);
  - sand-stacker tailings strategies;
  - slimes management strategies; and
  - in-pit water management.
- The fines content of the sand tailings and superficial formations;
- The hydraulic conductivity of the disposed tailings and the in-situ superficial groundwater formations;
- The hydraulic conductivity of the shallow Toolonga Calcilutite formation, and the structure and form of the Toolonga Calcilutite contact;
- Climatic factors such as evaporation rates; and
- The effectiveness of tailings water recovery, which in turn will depend on the thickness of sand beneath the pit floor and the rate of sand-stacker advance.

Process water will be sourced from groundwater pumped from production bores, pit dewatering bores and in-pit sumps. The volume of process water required is expected to be approximately 5.9 GL/annum of water for the first two years of the Project life under an optimal tailings drainage configuration (see Table 2.3). Three bores, each supplying approximately 100 litres/second, will be required during this period. A fourth bore will be maintained to provide a back-up water supply, if required.

The volume of process water required will increase when full production is reached after Year 2. Up to 10.4 GL/annum of water will be required under an optimal tailings drainage configuration (see Table 2.3), but up to 18 GL/annum will be required if non-optimal conditions occur (see Table 2.4).

Table 2.3
Indicative Life-of-Mine Water Demands under Optimal Drain Configuration

Year	Inputs (GL)	Outputs (GL)	Annual Make-up Requirement (GL)
1	0.01	5.94	5.93
2	0.01	5.94	5.93
3	0.01	9.92	9.91
4	0.01	9.92	9.91
5	0.01	11.27	11.26
5 - 10	0.05	53.18	10.63
10 - 15	0.05	52.28	10.45
15 - 20	0.05	51.38	10.27
Average water requirement for one plant			5.93
Average water requirement for two plants			10.40

Note: Inputs comprise recharge from rainfall and tailings operations. Outputs comprise losses associated with the sand-stacker operations; losses from water retention by and seepage from disposed slimes tailings; evaporative losses from process water sands, slimes settling areas, stacked sand tailings and dust suppression; and water piped to the reverse osmosis plant for use as potable water. See Appendix D for further information.

Table 2.4
Indicative Life-of-Mine Water Demands under Non-optimal Drain Configuration

Year	Inputs (GL)	Outputs (GL)	Annual Make-up Requirement (GL)
1	0.01	7.94	7.93
2	0.01	7.94	7.93
3	0.01	13.91	13.90
4	0.01	13.91	13.90
5	0.01	15.26	15.25
5-10	0.05	73.16	14.62
10-15	0.05	72.26	14.44
15-20	0.05	71.36	14.26
Average water requirement for one plant			7.93
Average water requirement for two plants			14.40

Note: Inputs comprise recharge from rainfall and tailings operations. Outputs comprise losses associated with the sand-stacker operations; losses from water retention by and seepage from disposed slimes tailings; evaporative losses from process water sands, slimes settling areas, stacked sand tailings and dust suppression; and water piped to the reverse osmosis plant for use as potable water. See Appendix D for further information.

The production bores will be spaced to avoid aquifer interference with each other (see Figure 2.1) and will pump continually to a lined dam. The dam will hold sufficient water for plant operation should all three bores fail.

Potable water for the camp and mine office/workshop complex will be refined on site through a reverse osmosis desalinisation system to bring the bore water to a potable standard.

2.6 POWER SUPPLY

Gunson proposes to use natural gas as the primary energy supply to the mine site rather than diesel power. The use of natural gas will significantly reduce greenhouse gas emissions and the volume of hydrocarbons to be stored and used on site.

Modular power units using natural gas will supply power for the mining operation.

The accommodation camp will have an 800 kilowatt (kW) gas powered generator for power supply. An eight megawatt (MW) gas powered generator pack will be located close to the concentrator and will supply electrical power for each 2,200 tph mining and concentrator unit.

Gunson is currently working with Energy Developments Limited, a 'green' energy company, on power supply options for the mine operation that maximise environmental and operational benefits. The preferred option is to truck LNG from Karratha.

2.7 FUEL

Diesel fuel for vehicles and remote pumps will be trucked to site and stored in approved bunded hydrocarbon storage facilities within the workshop compound.

Contractors will have a separate diesel fuel storage facility and diesel fuel delivery vehicle for in-pit refuelling of earthmoving equipment.

Liquid Petroleum Gas (LPG) will be stored in controlled locations within the campsite.

2.8 SITE DRAINAGE AND FLOOD PROTECTION

The Amy Zone is internally draining and does not contain any watercourses. Therefore, there is no requirement for diversion of drainage lines. Site drainage and flood protection will be designed for a 1 in 100 year, 72 hour rainfall event.

2.9 SOLID AND LIQUID WASTES

Potential sources of solid and liquid waste generated from mining operations include:

- overburden;
- oversize (including roots and calcrete);
- tailings (sand tails and clay fines);
- waste water;
- hydrocarbons;
- structural waste;
- domestic waste;
- sewage; and
- waste water from the desalination plant.

The proposed disposal methods are summarised below.

2.9.1 Overburden

At the start of a new pit, overburden will be removed and stockpiled prior to return to the mine void during rehabilitation. Once a steady state of mining has been achieved, the overburden will be placed directly into the pit void behind the mining activity.

Some of the calcrete may be removed from the overburden and crushed for use in hardstand areas, roads and track maintenance. The quantity of overburden expected to be used for road surfaces during normal operations is approximately 20,000 m^3 per annum.

2.9.2 Oversize

The mineral concentrating process is limited by particle size of the mined material. All mined material will be screened to remove calcrete and roots. The oversize material will remain in the mined-out pit void.

2.9.3 Tailings

Tailings comprising sand, water, and clay fines will be disposed of into the mined-out pit void. The method of tailings disposal is discussed in Section 2.3.4.

Radiation monitoring will confirm that background levels are not exceeded in the final rehabilitated tailings.

2.9.4 Waste Water

Waste water is likely to be produced as a result of the concentrating process and any mine dewatering.

The major source of water loss is to tails replacement (approximately one tonne of water to two tonnes of sand). Sand tailings will be pumped from the concentrator at a density of 55% solids by weight. The slurry density will be increased using dewatering cyclones in the tails area where the high density underflow will allow for control of sand placement and minimise water loss to tails.

The total quantity of water used for pumping the sand tails from the concentrator to the stacking cyclones (for each 2,200 tph concentrator) is 1,780 m^3/hr. Approximately 550 m^3/hr of this water will be recovered and recycled from the cyclones and a further 370m^3/hr will be returned from the tailings water recovery system.

Minor losses also occur to the concentrate stockpiles and operational spills.

Disposal of grey water and sewage is discussed in Section 2.9.8.

2.9.5 Hydrocarbons

Hydrocarbon products will be stored in approved bunded facilities located in the workshop compound at the mine site. Should a spill occur, any hydrocarbon-contaminated soils would be bioremediated on site.

Oils and greases will primarily be used by the earthmoving contractor. All waste oils will be collected by the contractor and recycled to an approved facility. Oily rags and filters for disposal will be recycled or disposed of at an appropriate hydrocarbon disposal facility.

2.9.6 Structural Waste

Structural waste may be generated from maintenance activities. This waste will be recycled through a scrap metal merchant, where possible.

2.9.7 Domestic Waste

Domestic waste such as general refuse, green waste, paper and putrescibles will be collected and disposed of to an on-site landfill. Where possible, recyclable wastes will be collected separately and transported off site to a recycling facility.

2.9.8 Sewage and Grey Water

There will be a small amount of waste generated from site personnel from the crib rooms and ablutions on the site. There will typically be a total of 105 personnel on the site over a 24 hour period once full production is attained. It is anticipated that each of these personnel will generate 10 – 50 litres of waste water per day as a result of flushing toilets and washing.

The camp and offices will be established with suitable waste water treatment plants to dispose of domestic liquid waste such as sewage and grey water.

An on-site disposal system will be designed to comply with all relevant standards and regulations.

2.9.9 Desalination Plant Waste Water

Some 200 KL/day of potable water will be required to service the workforce. This will be obtained by desalination of brackish groundwater.

The desalination (reverse osmosis) system has not been selected as yet, but it is anticipated that disposal of approximately 20 KL/day of waste water will be required. At this stage, it is proposed to discharge this waste water to the slimes trenches in the pits.

2.10 OTHER FACILITIES

An office will be located close the accommodation camp. The complex will comprise three demountable buildings, office, ablution block and a crib room.

A transportable office will be located close to the processing plant.

Car parks will be located at the workshops. The area allocated for accommodation will also include a car park.

A small airstrip is located near Coburn homestead and will be upgraded for use by small and emergency aircraft only. Personnel will be accommodated on site.

A landfill for waste disposal will also be established on site.

2.11 WORKFORCE AND ACCOMMODATION

It is expected that the mine site workforce will be supplied primarily from Denham, Geraldton Carnarvon and Perth, but technical positions will be advertised around Australia. During construction, the overall workforce including rostered personnel will total 100. Once mining operations commence the workforce will total 80 personnel including contractors and staff, increasing to 105 once full production is attained.

The accommodation camp will be located near the western end of the access road. The camp will initially be used by construction workers and will cater for 105 persons. The camp will then become the on-site accommodation for mine operations workers. When the second pit commences operation in Year 3, the accommodation camp will need to be expanded to cater for 130 persons.

The final camp design will include 130 accommodation units (including ensuites), two laundry units, kitchen and mess facility with seating for 60 persons, public ablution block, social club including TV/recreation room, reading room, outdoor barbeque area, gymnasium, multi purpose tennis court and a camp office.

2.12 REHABILITATION AND CLOSURE

2.12.1 Rehabilitation Strategy

During review of the Scoping Document prepared for the proposed Project, the EPA expressed concern regarding the feasibility and effectiveness of rehabilitation at the Amy Zone and requested that Gunson demonstrate that successful rehabilitation was in fact possible by providing examples of rehabilitation outcomes under similar conditions. In response to these concerns, Gunson commissioned URS to undertake a Rehabilitation Benchmarking Study and identify those rehabilitation procedures that may enhance or constrain rehabilitation of disturbed land within the Project Area.

The Rehabilitation Benchmarking Study reviewed rehabilitation progress at sites that have disturbances and/or conditions similar to those expected at the Amy Zone, and is provided as Appendix E. Ten sites located in the Gascoyne region were reviewed (see Figure 2.7). These sites comprise:

- The Coburn test pit, which is located in the southern portion of the Amy Zone. The test pit was excavated and backfilled in March 2004 to allow Gunson to assess aspects associated with the mineability of the orebody. The site is being monitored to collect information on natural revegetation within the Nanga land system in the Project Area.
- The Old Hamelin Airstrip, which is located on the Hamelin pastoral lease approximately 5 km east of the Amy Zone. The L-shaped airstrip is located within the Nerren land system and has undergone natural revegetation.
- The proposed Shark Bay Airstrip, which is located approximately 80 km northwest of the Amy Zone. The area proposed for the airstrip was cleared and compacted in 1990, but was not developed further. No rehabilitation has been conducted at this site, which provides useful information on natural revegetation and vegetation succession.
- Rehabilitated tracks on the Peron Peninsula, which are located approximately 100 km northwest of the Project Area and were rehabilitated by CALM in 2003/04. The tracks were selected to provide information on the rehabilitation of areas experiencing similar environmental conditions and which have been compacted by vehicle movements.
- Rehabilitated fire buffers on the Peron Peninsula, which are located approximately 120 km northwest of the Project Area. The fire buffers were rehabilitated by CALM in 1995 and provide information on rehabilitation in an arid area subject to grazing pressure.
- The Denham tip, which is located approximately 80 km northwest of the Project Area. The tip was rehabilitated in 2003 and provides information on rehabilitation in similar environmental conditions to those within the Project Area and in the use of cleared vegetation as a rehabilitation tool.
- Gravel pits at the Useless Loop Salt Mine, which is located approximately 84 km northwest of the Amy Zone. These areas provide information on rehabilitation in an arid environment.
- Sixteen sites on Woodleigh Station, which were disturbed in 1965 as part of a programme by the American National Aeronautics and Space Administration (NASA) to test visibility from space. These sites are located approximately 70 km northeast of the Amy Zone within the Sandplain land system, which also occurs within the Project Area. As little or no rehabilitation was conducted at these sites, they demonstrate the natural revegetation that has occurred.
- An area of natural revegetation on Eurardy Station, approximately 100 km southeast of the Amy Zone. This area was cleared in 1996 and used for a wheat crop in 1997 before being allowed to lie fallow and undergo natural revegetation. The site provides useful information on natural revegetation within the Nanga land system.

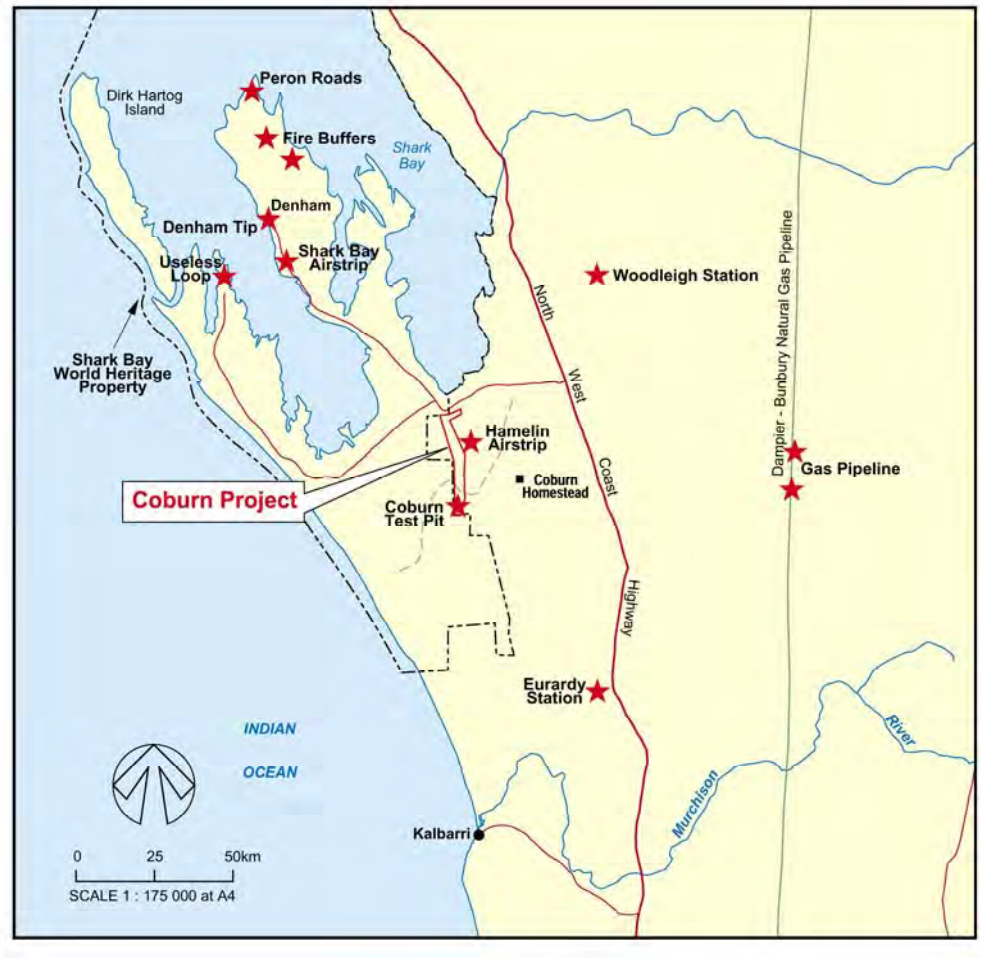

Figure 2.7: Rehabilitation Sites in the Gascoyne Region

- Rehabilitation sites along the Dampier to Bunbury Natural Gas Pipeline (DBNGP). These sites were rehabilitated approximately 25 years ago and provide information on rehabilitiation of disturbances on the Nerren and Sandplain land systems, both of which occur in the Project Area.

In addition, rehabilitation techniques and progress at two existing mineral sands mines were reviewed. These sites are:

- The North Stradbroke Island Mine, which is located off the Queensland coast, near Brisbane.
- The Namakwa Sands Mine, which is located on the northwest coast of South Africa. Both sites have a number of environmental similarities to the Amy Zone and conduct similar operations to those proposed by Gunson.

The location of these sites is provided as Figure 2.9.

The results of the Rehabilitation Benchmarking Study are presented as Appendix E and were utilised in the development of the draft Coburn Mineral Sand Project Rehabilitation Plan.

2.12.2 Rehabilitation Programme

Rehabilitation will be conducted on a progressive basis as mining advances, with clearing occurring ahead of the mining operation and recontouring and revegetation occurring on contoured tailings. The process of clearing, mining, backfilling, contouring and topsoil replacement is presented as Figure 2.2.

A draft Rehabilitation Plan is presented as Appendix F. The plan has undergone an external peer review process, as described in Appendix G.

2.12.3 Decommissioning and Closure

Following the cessation of mining operations, decommissioning activities will be undertaken, which involves the physical removal of equipment or services that have been constructed during mining activities.

The decommissioning and closure activities for the Project are likely to involve:

- The removal and disposal of plant, equipment and infrastructure;
- The removal of any remaining stockpiles;
- The removal of any rubbish from the site;
- The completion of site rehabilitation and revegetation; and
- Monitoring of rehabilitation progress against completion criteria.

Gunson recognises that appropriate planning and adequate provisioning for closure is required to ensure that the decommissioning and closure process occurs in an orderly, cost-effective and timely manner. A Conceptual Closure Plan has been developed for the Coburn Mineral Sand Project based on the ANZMEC & MCA (2000) mine closure guidelines. The plan is presented as Appendix H.

Figure 2.8: Location of the North Stradbroke Island and Namakwa Sands Mines in comparison to the Coburn Project

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3.1 PROJECT NEED

The Coburn Mineral Sand Project represents a significant potential investment in the economic future of Western Australia's Gascoyne Region. Feasibility study estimates show that, at full production, the Project will generate some A$70 million in revenue per annum over a mine life of approximately 20 years.

The Project is expected to become an important contributor to Western Australia's world class mineral sand export industry which in 2002 achieved sales of A$873 million. Overall, mineral sands are one of Australia's most important export products. Rutile, leucoxene and ilmenite are exported to USA, Japan and Europe for processing into white titanium oxide pigment and zircon is exported to Europe and Asia, mainly for use in the ceramics, refractory and chemical industries.

The Amy Zone has an attractive mix of heavy minerals with low levels of uneconomic or trash minerals. The orebody compares favourably with other major coastal dune-hosted deposits in southern Queensland, where profitable mining operations are active on lower grade ore bodies.

The main attraction of the proposed Project is that, according to leading market research group TZ Minerals International Pty Ltd, it is currently the third largest zircon development project in the world, at a time when there is a significant global shortage of zircon.

Zircon is a critical component of sanitary wares, ceramic tiles, the lining of blast furnaces and foundries, television glass, and chemicals, due to its opacity, hardness, heat resistance, chemical inertness and ability to shield radiation.

3.2 PROJECT BENEFITS

3.2.1 Environmental and Social Benefits

Since commencing exploration of the Project Area in May 2000, the Proponent has contributed to the local community through a number of initiatives including:

- Employing Aboriginal consultants on exploration drill rigs to monitor avoidance of culturally significant areas;
- Donating funds to help purchase a community bus for the Shark Bay Shire; and
- Employing local pastoralists to provide logistic support for exploration programmes.

There is a range of environmental and social benefits that would result from the implementation of the Project. These include:

- Contribution of funds and support for scientific research into the ecology of the SBWHP.
- Better understanding of the local and regional environment, including hydrogeology.
- Contribution to the local economy, both directly and indirectly as a result of full-time employment for approximately 105 people on an ongoing basis.
- Provision of funding and opportunities for Aboriginal business/education.
- Contribution of funds for the Shark Bay Interpretive Centre in Denham. This is a $7.7 million conservation and environmental education centre jointly sponsored by the Federal and Western Australian Governments.

3.2.2 Regional and State Benefits

The Project will offer a number of significant benefits for the region, including:

- Contribution to the regional economy of Australia resulting from export earnings, taxes, salaries and purchase of goods and services during construction and operation of the mine; and
- Contribution to the local economy, both directly and indirectly as a result of full-time employment for approximately 105 people on an ongoing basis, while a further contribution will be created by the flow-on effects on service industries and other sectors of the economy.

Table 3.1 presents a summary of economic benefits for the State and the region.

Table 3.1
Summary of Economic Benefits

Factor	Predicted Outcome
Direct employment	105 persons
Indirect employment	400 persons
Regional business opportunities	$15 million pa
Revenue	$70 million pa
Total mine life revenue	$1.3 billion
Royalties and taxes	$152 million

3.3 CONSEQUENCES OF NOT PROCEEDING

The consequences of not proceeding with the Project include loss of benefits to:

- the State, through the loss of royalties and taxes and source of export material;
- the Nanda and Malgana Aboriginal people through the loss of financial and vocational benefits;
- the local community, through the loss of financial support for local business and income for the Shire; and
- the scientific and general community, through the loss of resources to undertake ecological investigations within the SBWHP and to help support the Shark Bay Interpretive Centre.

4.1 REGIONAL ENVIRONMENT

4.1.1 Physical Environment

The Project Area is located in the southwest extremity of the Carnarvon Basin, Western Australia. The Carnarvon Basin is one of the major sedimentary basins of Western Australia and extends from near Cape Range in the Exmouth area, south to the Murchison River and inland to the Kennedy Range (Burbidge, McKenzie & Harvey 2000).

4.1.1.1 Climate

The Shark Bay area is located within a transitional climatic region that experiences an overlap of tropical and temperate zones, resulting in hot dry summers and mild winters. The area is classified as a Hot Grassland (summer drought) by BOM (2003). The area is affected by the winter circulation of the south, and the monsoonal summers of the north (Wyrwoll, Courtney & Sandercock 2000). Table 4.1 provides climate data for the Hamelin Pool weather station, which is located north of, but close to, the Project Area.

The maximum temperature is high for most of the year, and extreme in summer. Summer can bring thunderstorm activity, significant rainfall, tropical cyclones, extreme wind, low levels of cloud cover, extended sunshine duration and high levels of incident solar radiation (Wyrwoll, Courtney & Sandercock 2000). The average rainfall, temperatures and evaporation rates of the Shark Bay area are presented in Figure 4.1 and Table 4.1.

Rainfall in the region is sporadic, with annual precipitation ranging from 200 to 400 mm (DEP 2001). The timing and magnitude of rain is highly influenced by cyclonic and thunderstorm activity. Average annual rainfall is about 212 mm at Hamelin Pool, although rainfall at the Project Area is likely to be significantly higher (Hamelin pastoral lease owner/manager pers. comm.). The majority of rain falls between May and August. Rain in the region is usually caused by one of three factors. Firstly, cloud bands occurring between April and September and are most frequent in May and June. Secondly, cold fronts can bring significant rain when they mix with a tropical moisture source. Finally, rain can also result from tropical depressions, cyclones, summer troughs and lows (Wyrwoll, Courtney & Sandercock 2000).

Evaporation is high, ranging from 3,000 mm per annum in the east to 2,000 mm per annum in the west. This is largely attributed to the lack of cloud cover, low humidity and medium to strong winds (CALM 1998).

The area is influenced by southeast trade winds, which generate southerly winds for the majority of the year. During summer, southerlies consistently blow over 25 km/hr for several days. Cyclones generating wind gusts up to 180 km/hr occur periodically over summer and autumn (CALM 1998).

4.1.1.2 Geology and Geomorphology

The Gascoyne Region is located within the Southern Carnarvon Basin, a geological formation comprising three Palaeozoic Sub-basins: the Gascoyne Platform to the west, and the Merlinleigh and Byro Sub-basins to the east (Mory, Iasky & Ghori 2003). All sub-basins have mainly Palaeozoic fill with a thin cover of Mesozoic (mostly Cretaceous) and Cainozoic strata that extends across the Gascoyne Platform and into the Merlinleigh Sub-basin.

The Carnarvon Basin is one of Western Australia's major sedimentary basins and has undergone various tectonic activity over its history. The basin is bordered to the east by the Yilgarn Block, Gascoyne Province, Hamersley Basin and Ashburton Trough, south by the Northampton Block, and north by the Canning Basin (Wyrwoll et al. 2000). It is also influenced by Victoria Plateau and Carnarvon Coastal Plain geologies (DEP 2001).

The Carnarvon Basin consists of four distinct geomorphological provinces - Edel, Peron, Yaringa and Gascoyne/Wooramel (CALM 1998). The Peron and Edel provinces are the most prominent, covering most of the Shark Bay area (DEP 2001).

The Edel region, which includes the Project Area, is characterized by 40-60 m active and stable, modern, calcareous dunes that formed above the Tamala Limestone over the last 10,000 years (CALM 1998). These Tamala dunes have a north-south alignment, demonstrating that Pleistocene wind directions were similar to those of today. The dunes are covered with calcareous soils of pale to reddish brown sand over loamy sand, and have deep profiles with a pH near 8.5 (Wyrwoll et al. 2000).

Table 4.1
Climatic Data from Hamelin Pool Weather Station

Month	Mean Monthly Rainfall (mm)	Mean Daily Maximum Temperature (deg C)	Mean Daily Minimum Temperature (deg C)	Mean Daily Evaporation (mm)	Mean Monthly Evaporation (mm)	Mean Wind Speed (km/h)	Mean Relative Humidity (%)
Jan	7.6	36.9	20.5	13.4	415.4	18.1	39.5
Feb	13.1	36.7	21.2	13.9	392.7	17.8	42.5
Mar	15.7	34.9	20.1	11.6	359.6	16.5	43.0
Apr	13.7	30.3	17.0	7.1	213.0	14.7	48.0
May	33.1	25.2	13.2	5.2	161.2	13.4	54.0
Jun	47.7	21.5	10.6	3.4	102.0	12.2	63.5
Jul	40.2	20.7	9.2	3.4	105.4	13.3	62.5
Aug	21.5	22.2	9.4	4.7	145.7	14.4	55.0
Sep	8.1	25.4	11.1	6.5	195.0	17.5	46.5
Oct	5.2	28.2	13.0	10.0	310.0	19.2	42.0
Nov	3.7	31.8	15.8	11.0	330.0	19.6	39.0
Dec	2.4	34.8	18.3	12.5	387.5	18.5	39.0
Annual	211.9	-	-	-	3,117.5	-	-
Daily	-	29.1	15.0	8.7	-	16.3	47.5

Source: BOM (2004); BOM station 006025 Hamelin Pool; 20 to 105 years of record.

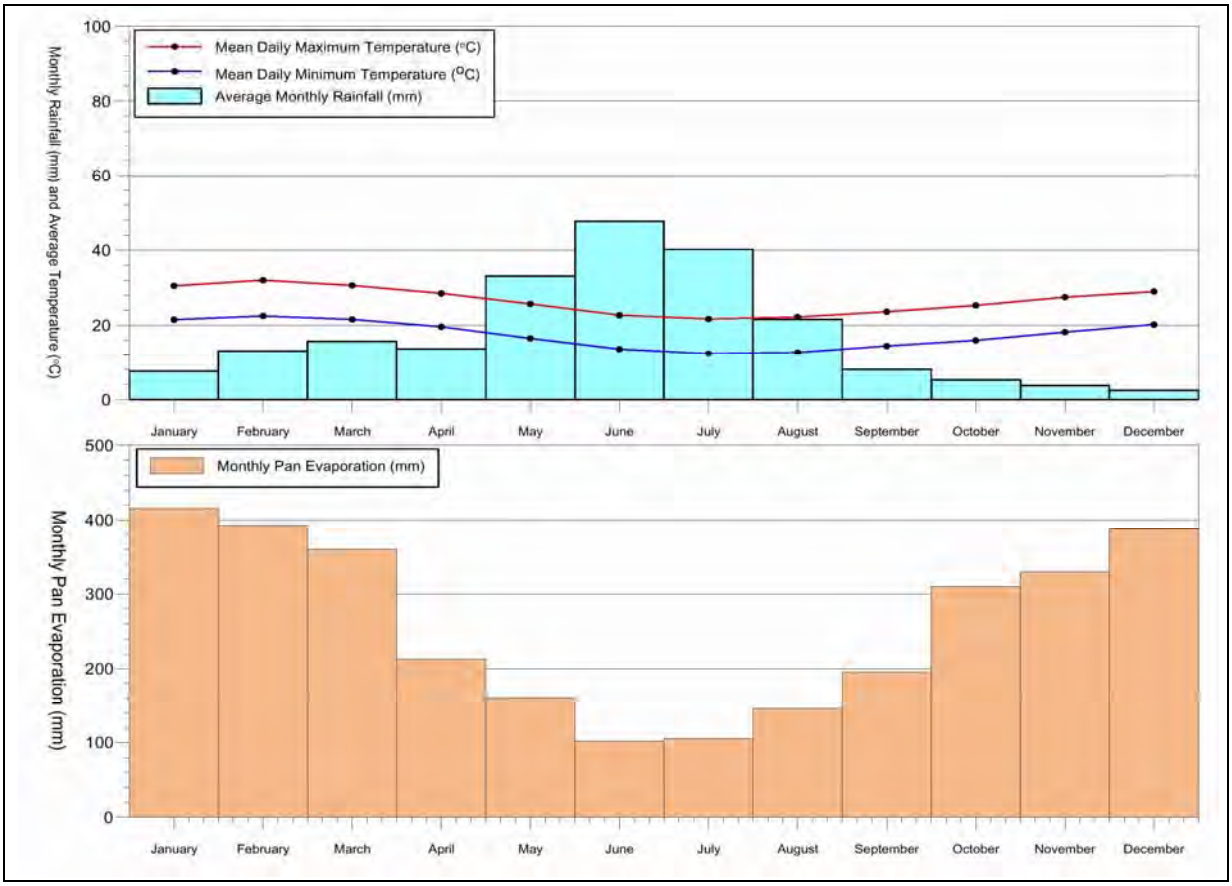

Figure 4.1: Shark Bay Climatic Data (Hamelin Station)

The adjacent Peron area is characterised by the red Nilemah sands, which form broad, undulating sandplains and irregular transverse dunes (Wyrwoll et al. 2000; DEP 2001). They overlay the medium-grained red Peron Sandstone, which is a relic transverse dune complex and the most extensive surface and near-surface rock at Shark Bay (DEP 2001). Tidal flats are prominent while lithified shell bed (coquina) deposits occur as beach ridges and beaches (CALM 1998).

4.1.1.3 Land Systems

A land system is defined as an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation (Burnside et al. 1995). Land systems consist of smaller land units. The land units, and their spatial arrangement relative to each other, form characteristic patterns that can readily be identified on aerial and satellite photographs (Pringle, Van Vreeswyk & Gilligan 1994). Whilst there is some correlation between vegetation types and land units, individual land systems support a range of vegetation communities that are not necessarily restricted to one land system.

The land systems of the Carnarvon Basin have been mapped and described by Payne, Curry and Spencer (1987). A map of the land systems in the Shark Bay area is presented as Figure 4.2.

The land system adjacent to the most of the Amy Zone is classified as the Nanga land system (see Figure 4.2). This system is characterised by undulating sand plains supporting diverse assemblages of South-West Botanical Province vegetation (see Table 4.2). The area to the north and east of the northern portion of the Amy Zone is dominated by the Nerren, Sandplain, Snakewood and Toolonga land systems, with smaller areas of the Yaringa land system (see Figure 4.2). Most of these systems comprise sandy plains vegetated by *Acacia* species (see Table 4.2).

The coastline to the north of the Project Area comprises the Coquina and McLeod land systems (see Table 4.2). Both of these land systems are restricted to coastal areas (see Figure 4.2)

4.1.1.4 Landforms and Soils

Most of the southern Shark Bay area occurs in the Victoria Sand Plain District, which has extensive undulating sandy plains with isolated low coastal dunes. Dune intensity increases to the south and southeast of the mine area (Van De Graaf, Hocking & Butcher 1983). The land surface elevation varies from approximately 20 m AHD in the north of the mine area to approximately 100 m AHD in the south. The dunal system exhibits an apparent interference pattern with cross-patterned dune alignments that has produced many isolated swales. The soils comprise red to dark red sands, clayey sands or loamy sands (DEP 2001).

The Carbla Plateau occurs to the north of the Project Area where the superficial sand cover thins and becomes intermittent between outcrops of duri-crust. Surface drainages become more apparent as the topography becomes increasingly dominated by the duri-crust to the north-east and east. Overall, these trend northwards towards Hamelin Pool.

Table 4.2
Dominant Land Systems in the Vicinity of the Project Area

Land System	Description	Coverage within Carnarvon Basin Survey Area	
		km^2	%
Coquina	Mostly unvegetated ridges of shell grit backed by coastal dunes supporting scattered tall acacia shrublands.	34	0.04
MacLeod	Broad saline plains with sandy banks and low rises above saline slopes and bare mudflats; bare surfaces and low shrublands of samphire and saltbush.	259	0.3
Nanga	Undulating plains of aeolian sand that support diverse assemblages of South-West Botanical Province vegetation. The vegetation primarily comprises shrub heath and tree heath dominated by proteaceous and myrtaceous species	3,485	4.7
Nerren	Sandplains with scattered or clumped mallee and tree-form eucalypts over wanyu-dominated tall shrublands.	1,547	2.1
Sandplain	Extensive red sandplains with tall shrublands of wanyu and understorey shrubs or low woodlands of sandplain gidgee.	9,866	13.2
Snakewood	Plains with red duplex soils supporting tall shrublands of snakewood with an understorey of silver saltbush.	827	1.1
Tarcumba	Flat plains with shallow, calcareous, sandy surfaced soils overlying calcrete; vegetation is dominated by tall acacia shrublands.	183	0.25
Toolonga	Gently undulating calcrete outcrop plains with local and internal drainage. Vegetation comprises tall acacia shrublands.	1,182	1.6
Yaringa	Sandy plains with poorly developed dunes and restricted inter-bank plains, supporting tall shrublands of wanyu and other acacias.	872	1.2

Source: Payne et al. (2000)

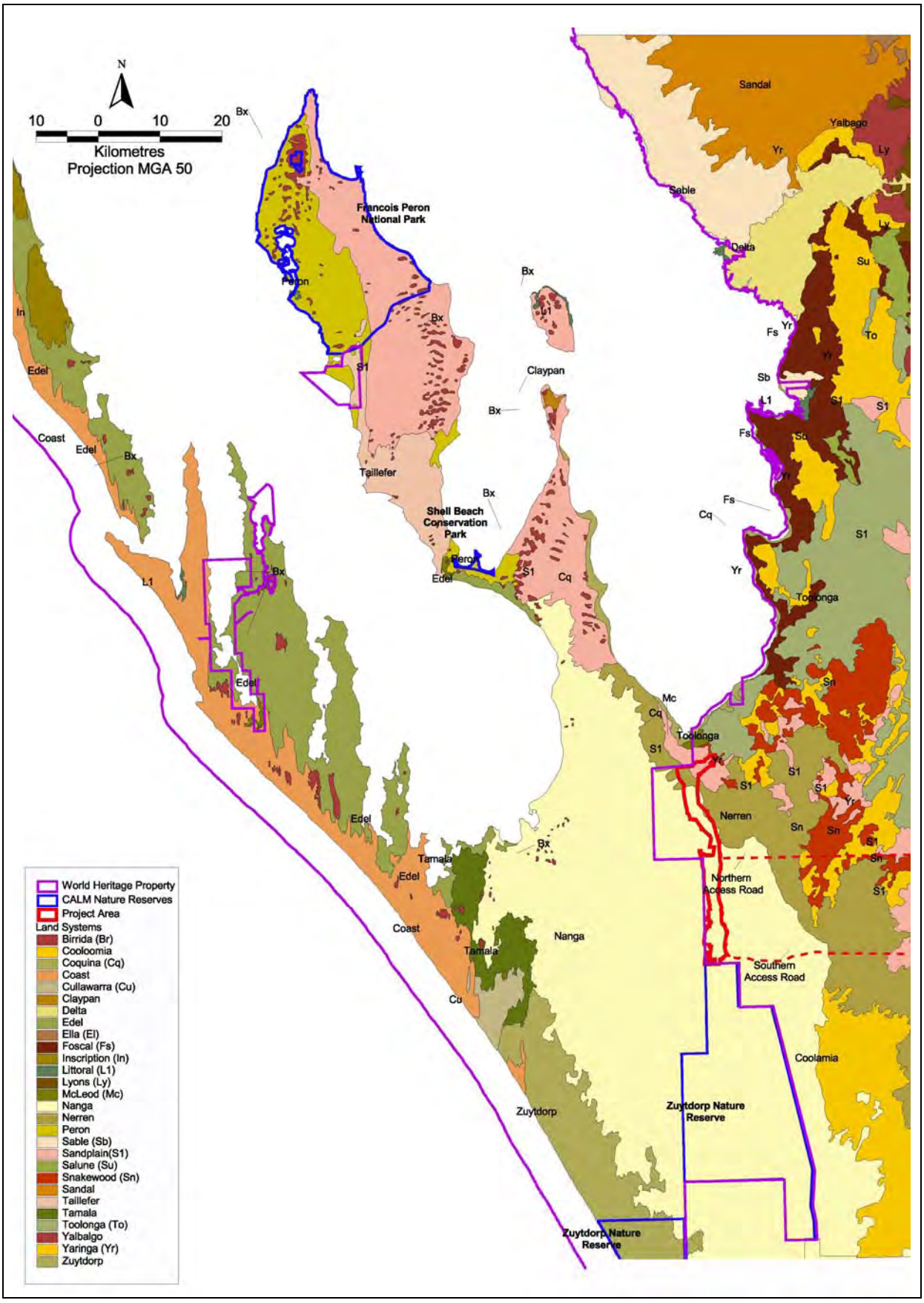

Figure 4.2: Land Systems
Source: Payne et al. (1987)

4.1.1.5 Hydrogeology

The hydrology of the region and the Amy Zone is described in detail in Appendix D. Most of the groundwater aquifers in the region are layers of water trapped below an impermeable upper layer of surface earth (confined). Some superficial (unconfined) aquifers also occur. These are layers of water below the surface of porous earth, therefore allowing rainwater to seep into them unimpeded. A summary of the main confined and unconfined aquifers is presented below.

Confined Aquifers

There are five significant aquifers in the Gascoyne Platform area, all of which are mostly confined except for local areas in the eastern recharge area overlying the Ajana Ridge (refer to Figures 5, 6 and 42 of Appendix D). The principal confined aquifers in the Gascoyne Platform sub-basin of the Carnarvon Basin in order of increasing age are described below:

1. Windalia Radiolarite.
2. Windalia Sand Member of the Muderong Shale.
3. Birdrong Sandstone.
4. Kopke Sandstone.
5. Tumblagooda Sandstone.

The Windalia Radiolarite is not present in the Southern Gascoyne Platform area, which includes the Project Area, and does not appear to occur in the same profile as the Windalia Sand Member of the Muderong Shale. When present, this aquifer yields significant supplies, presumably from secondary permeability (i.e. fracturing) in the siliceous, cherty or flinty layers.

Very strong anisotropy of the hydraulic conductivity has been observed from bores drilled into this formation, usually in old bores that were drilled using cable-tool drilling methods. Upward heads of between 7 and 22 m have been recorded in private bores Yaringa No. 5 and Yaringa No. 15 during drilling, with further head rises after the deeper Birdrong Sandstone was intersected. This suggests that vertical flow between these formations is also restricted. Locally, the private Spinifex Bore exhibited upward heads of about 20 m while drilling through the Windalia Radiolarite between 125 and 128 m depth (Playford & Chase 1955). It is located east of the northern end of the Project Area.

Bores sourcing groundwater from the Windalia Radiolarite that are closest to the Project Area are probably the private bores Spinifex Bore 2 and Nilemah Artesian No. 1A, although brief assessment of the geological logs raises some doubt about whether these bores draw only from this unit

The Windalia Radiolarite is typically about 15 m thick, but probably thins out towards the area where the Windalia Sand Member is present. It is possible that there is a transition zone where these two units overlap that may allow hydraulic interconnection, but this has not been determined formally. There are no aquifer parameters (hydraulic conductivity or storage coefficient) available in either the literature or bore completion reports.

The Windalia Sand Member is restricted to the Southern Gascoyne Platform area on Coburn, Hamelin, Meadow and possibly Nerren-Nerren Stations. This aquifer overlies the Birdrong Sandstone and was previously collectively termed the "Hamelin Beds" in the 1950s (McWhae 1958). This aquifer is utilised by many of the pastoral bores east of the Project Area as it holds adequate supplies with an acceptable water quality for pastoral use. Where the supply is inadequate or the water quality locally exceeds stock limits for salinity, pastoral bores have historically been extended down into the Birdrong Sandstone until the supply or quality becomes acceptable.

The Windalia Sand Member is typically in excess of 20 m thick and thins out towards the west near Spinifex Bore and Nilemah Artesian No. 1A, and to the north near Hamelin No. 5 and Kevin's Bore, which are all private bores (refer to Figure 25 of Appendix D). In Coburn No. 1, this formation was 32 m thick, while in the Project Area, the aquifer thins to about 30 m and is 42 m deeper. Water levels are typically lower than the deeper Birdrong Sandstone and Kopke Sandstone indicating upward hydraulic heads due to the presence of Muderong Shale or non-uniform intrinsic permeability within the sedimentary bedding. These sedimentary bedding characteristics promote lateral groundwater flow and limit vertical flow because of variations between the lateral and vertical permeabilities. The aquifer properties of the Windalia Sand Member are not known, either because they have not been measured or not published. The present study determined values of both hydraulic conductivity and confined storage for this formation.

The Birdrong Sandstone is the most commonly used aquifer in the Carnarvon Basin. This is due to its ability to yield large groundwater supplies and because it is a large resource based on large and uniform extent and extensive recharge zone along the eastern side of the basin.

Typically, the permeability of the Birdrong Sandstone is between about 5 and 10 m/d. There are no published storage coefficients for this aquifer in the literature. Both parameters were measured in the study by URS from test pumping bore DTB1. (see Appendix D). This bore was drilled for URS by Drilling Contractors Australia. Static water level measurements in non-flowing bores reported by McWhae (1958) indicate the Birdrong Sandstone has a hydraulic gradient of about 5×10^{-4}, indicating that groundwater flow is towards the west.

The Kopke Sandstone is probably the second most important groundwater source in the middle and southern parts of the Gascoyne Platform sub-basin. Where the formation is not too deep, it is utilised as a lower salinity water source in preference to the Birdrong Sandstone. In more westerly parts of the Gascoyne Platform, the Kopke Sandstone is generally too deep (greater than 300 to 500 m) to be utilised. Apart from the large volume of groundwater in storage in the Kopke Sandstone, it is possible that this formation is in hydraulic connection with the Tumblagooda Sandstone that overlies the Ajana Ridge and Coolcalalaya Basin beyond. The degree of any interconnection has not yet been determined (Wills & Dogramaci 2000).

This formation has been investigated during oil exploration drilling programmes due to its depth and potential as a hydrocarbon reservoir. Porosities of 23 to 28% have been reported from private bores Yaringa 1, Yaringa 1 East and Coburn 1 (Wills & Dogramaci 2000) with hydraulic conductivities of about 4 m/d. Additional parameters have been determined from test pumping DTB1 in this investigation. Although there is some doubt about the actual flow direction, it was reported that the hydraulic gradient is westwards in the order of 1×10^{-4}. During the development of the numerical model for this study, however, it appears possible that the hydraulic gradient may dip to the north-west or possibly the north north-west. A gradient in this direction may have resulted in the apparently very low through-flow rate determined by Hiller et al. (2002).

The age and flow direction of groundwater in the Kopke Sandstone was examined by Hiller et al. (2002) using analyses of stable isotopes and their ratios. The bores they tested on Carbla and Yaringa Stations suggested the water in the Kopke Sandstone probably entered the formation during wetter climatic conditions. They inferred that this earlier recharge has resulted in lower salinities in this aquifer as a whole.

The Tumblagooda Sandstone is a very large and regionally significant aquifer. Apart from the eastern and very southern margins of the Carnarvon Basin, this formation is generally too deep to be economically exploited. Presently, the only significant abstraction from the Tumblagooda Sandstone is in the Kalbarri region where it outcrops. The formation, has, however, been intersected by some of the deeper petroleum exploration drillholes in the Gascoyne Platform and as such has been investigated as a potential hydrocarbon reservoir, and has yielded some hydraulic parameters.

A summary of the hydraulic parameters derived from the petroleum exploration was presented by Wills and Dogramaci in 2000. In general, the Tumblagooda Sandstone is described as having a porosity of about 22% and a hydraulic conductivity of about 1 m/d. Hydraulic gradients in this formation are unknown, but possibly dip to the north. At shallow depths (<1,000 m), this formation is generally of lower permeability due to pore space clogging by silica overgrowths and kaolinitic clay (Wills & Dogramaci 2000).

Unconfined Aquifers

Unconfined aquifers in and near the Project Area are limited to a shallow palaeo-drainage and down-gradient areas adjoining Hamelin Pool. Apart from a thin, saturated layer occupying the lowermost part of the superficial sand in the axis of an inferred north to north north-west trending palaeo-drainage, the superficial sand deposits in the Project Area are dry, i.e. above the water table.

Outside the Project Area, unconfined (or possibly partially unconfined) groundwater probably exists in the hypersaline estuarine to shallow marine deposits in the Nilemah Embayment. These have been informally described in part by workers investigating the geo-biology of the Hamelin Pool Stromatolites and algal mats (BMR 1990). This study indicated that the groundwater system in the Nilemah Embayment is recharged mainly by rainfall (meteoric) with occasional inundations by highly saline water from Hamelin Pool. It is likely, however, that the Nilemah Embayment receives relatively minor amounts of saline groundwater from the Project Area that are incorporated into the hypersaline system.

Unconfined aquifers in the Shark Bay area also exist in several other places:

- Thin localised fresh-water lenses on top of the saline groundwater have been reported beneath the Hamelin Coquina that fringes the shoreline of some parts of Hamelin Pool. This aquifer is dominated by local direct rainfall recharge and

underlying water levels that are controlled directly by Hamelin Pool.

- Shallow groundwater (up to about 30 m depth), is utilised by Tamala Station for stock water. This groundwater resource is probably restricted to a fresh to brackish water lens overlying saline groundwater within the Tamala Limestone Formation. This aquifer is separated from the Birdrong and Kopke Sandstone aquifers by the Toolonga Calcilutite, Gearle Siltstone/Alinga Formation and Muderong Shale. It is highly unlikely that drawdown will propagate through to this aquifer to a measurable degree.

- Unconfined (or weakly confined) groundwater is probably also present in the easterly groundwater recharge areas where the Birdrong Sandstone and Windalia Sand Member aquifer overly Tumblagooda Sandstone on the Ajana Ridge along the margins of the Gascoyne Platform.

- Small, localised brackish water supplies are apparently present in low-lying areas where the superficial sand deposits cover palaeo-valleys or depressions in the Cretaceous Toolonga Calcilutite. Several soaks, which possibly fall in this category, probably existed in the now derelict Cooloomia Station. These aquifers are probably small, localised features and are physically separated from the Birdrong and Kopke Sandstones by significant aquitards such as the Toolonga Calcilutite and Gearle Siltstone/ Alinga Formation.

None of these external unconfined aquifers are likely to play any part in either the groundwater extraction or mine water recycling system planned for the Coburn Mineral Sand Project. The unconfined aquifers away from the project site are either separated by aquitards of significant thickness or are too remote.

Groundwater Salinity

Many of the logs from Carnarvon Basin drill holes have apparently conflicting salinities with neighbouring bores. The bores are not easily correlated to water level maps that attempt to separate the different formations. In general, the salinities of the confined aquifers decrease with depth as indicated in Table 4.3, except where a bore is screened across (or corroded through to) multiple aquifers.

Table 4.3
Confined Aquifer Salinities in the Gascoyne Platform Area

Formation Name	Typical Salinity Range (mg/L TDS)
Superficial Sand & Recent Marine Deposits	14,000 (on site) >60,000 (Marine Deposits in Nilemah Embayment)
Toolonga Calcilutite	11,200 - 34,400 (on site)
Windalia Sand Member	5,000 – 9,000
Birdrong Sandstone	3,500 – 8,000
Kopke Sandstone	1,500 – 12,000
Tumblagooda Sandstone	<1,000

Existing Water Resources

Management of groundwater resources in the Carnarvon Basin is handled by the DoE, although many of the bores drawing from the deeper (Palaeozoic and Mesozoic) aquifers are unlicensed pastoral bores. Many of the older bores that were flowing uncontrollably under artesian conditions have recently been rehabilitated by either plugging for abandonment or re-lining and re-capping. This programme has involved several bores in the Shark Bay area, but is not yet complete. Near the Project Area, uncontrolled artesian bores still remain on Hamelin Station (Spinifex Bore Nos. 1 and 2), Six Mile Well on Carbla Station and possibly also from the old Nanga Station (Nilemah No. 2). The DoE may plug or rehabilitate these bores in the future if sufficient funding is secured.

Prior to the recent rehabilitation programme, it was estimated that of the approximately 140 artesian bores drilled into the Carnarvon Basin since the early 1900s, only 40 still have substantial flows (>100 kL/d) and the remainder have either stopped or were reduced to a trickle (Astill, Baston & Shepherd 2002). Of these 40 uncontrolled flowing bores, it was estimated that about 15 GL/year was being lost to seepage and evaporation. The main cause for such wastage was inappropriate materials used for constructing the bores and / or lack of bore maintenance, leading to the effective loss of either the controlling headworks or bore casings that separated the shallower formations from the artesian aquifers.

4.1.1.6 Surface Hydrology

The region is characterised by low rainfall, high evaporative conditions, and high infiltration capacity dunal soils. The catchment area upstream of the Project Area is relatively small and is likely to produce little runoff during storm events. Most rainfall typically ponds in depression areas and evaporates or quickly infiltrates.

4.1.2 Biological Environment

4.1.2.1 Flora and Vegetation

The Project Area is located within the transition zone between the South-West Botanical Province and the Eremaean Botanical Province (Beard 1990).

The northern extent of the Irwin Botanical District (a part of the Southwest Botanical Province) is described by Beard (1990) as 'tree heath' comprising herbs and grasses, small and large shrubs, and small trees up to 6 m. The southern portion of the Amy Zone is a part of the Carnarvon Botanical District (a part of the Eremaean Botanical Province) and is characterised by *Acacia* shrublands and low woodlands. This boundary represents the transition from the complex and species rich heathlands and woodlands of south-western Australia to the less diverse *Acacia* shrublands of the Carnarvon Basin and is thought to relate to the increasing quantity and reliability of rainfall to the south-west (Beard 1976).

The region is thought to be a major transition zone for the vascular flora of Western Australia, with 229 taxa ending their northern most range within the World Heritage Property (Trudgen & Keighery 1995).

4.1.2.2 Vertebrate Fauna

Shark Bay is located near the intersection of three phytogeographic regions: the southern inland, northern coastal and southern coastal site groups (Gibson et al. 2000). As a result, many fauna species present in this region are at the northern, southern or western limits of their distribution. Consequently, the Shark Bay area is of significant zoological importance.

Wide-ranging fauna surveys have been conducted previously throughout the Carnarvon Basin (Burbidge, Harvey & McKenzie 2000a). Densities of small non-flying mammals were found to be low during field surveys, assisted by the fact that 23 of the original 48 indigenous species are now extinct in the region (McKenzie, Hall & Muir 2000). A total of one monotreme, three macropod, one honey possum, ten dasyurid, four rodent and nine introduced species were recorded (McKenzie, Hall & Muir 2000).

Previous studies also recorded a total of 13 wide-ranging bat species (McKenzie & Muir 2000) and 279 bird species with relatively stable populations, comparable to the results for the nearby Murchison catchment (Johnstone, Burbidge & Stone 2000). The bird surveys also identified the distribution of the endangered Malleefowl (*Leipoa ocellata*), which were located mainly in mallee and tea-tree scrub on Tamala and Peron Peninsula and in *Acacia* thickets on Woodleigh and Talisker stations (Johnstone, Burbidge & Stone 2000).

Herpetofauna surveys of the Carnarvon Basin recorded 133 species, with patterns in regional composition related to biogeographical, ecological and local evolutionary processes (McKenzie et al. 2000b).

4.1.2.3 Subterranean Fauna

An extensive and diverse stygofauna is known to occur in the northern portion of the Carnarvon Basin, from the karst of Cape Range and the adjacent coastal plains, extending through the Fortescue River catchment into the Pilbara. The stygofauna of the Cape Range peninsula has been well documented (Humphreys 1993), and includes at least seven species of macro-stygofauna that are associated with fresh groundwater of the coastal plains (Knott and Goater, 2005).

Stygofauna has been recorded in areas of saline intrusion associated with Tamala Limestone both to the south and north of the Project Area (W.A. Museum, unpublished data). To the north there is rich and globally significant fauna in the subterranean ecosystems of Cape Range and Barrow Island (Humphreys 1999), and areas to the east contain a rich stygofauna associated with the limestone deposits in palaeovalleys (e.g. Humphreys 1999; Watts & Humphreys 2003; Leys et al. 2003).

No reports of stygofauna in the southern portion of the Carnarvon Basin have been identified. Investigations of saturated sands at Coral Bay south of the Cape range peninsula did not record any stygofauna (Knott and Goater, 2005).

4.1.2.4 Regional Biodiversity

A total of 626 plant and 456 animal species were recorded during the major surveys conducted in the Carnarvon Basin Region (McKenzie et al. 2000a). The biodiversity of this area reflects its location in the transition zone between southern and northern regions.

4.1.3 Social Environment

Western Australia, for the purpose of regional planning and development, is divided up into nine regions. The Shark Bay Shire, within which the proposed Project is located, is situated in the Gascoyne Region. The Town of Carnarvon is the regional centre for the Gascoyne and provides government, commercial and community services for the majority of the region.

The Shire of Shark Bay comprises two peninsulas, 1,500 km of coastline and some 25,000 km^2 of hinterland. The town of Denham is the main settlement within the Shire. Other settlements within the Shire are Monkey Mia, Overlander Roadhouse, Billabong Roadhouse and Useless Loop. Useless Loop is a "closed" mining town.

The Gascoyne Region has a strong community spirit with several sporting, recreational, educational, special interest groups, clubs and committees located within the region. The Living in the Regions (Patterson Market Research 1999) survey found that 85% of respondents agreed the Gascoyne was a "really friendly place to live" (range of 79% to 93%) and overall, perceived community spirit scored 3.5 out of 5 (range of 3.5 to 3.8). In the same survey, respondents were asked to assess their environmental values. Of the nine regions, the Gascoyne region achieved the highest score.

The 1999 Accessibility/Remoteness Index of Australia (ARIA) is a standard approach to measuring remoteness and uses distances to population centres as the basis for quantifying service access and hence remoteness. The ARIA scale is from 0 (highly accessible) to 12 (very remote). According to the ARIA, the least remote town in the Gascoyne Region is Carnarvon (8.16 – remote) and the most remote is Exmouth (12 – very remote).

4.1.3.1 Demographics

The Gascoyne's Estimated Resident Population (ERP) of 10,308 is concentrated in the key settlements of Carnarvon, Exmouth, Denham, Gascoyne Junction and Coral Bay. The Gascoyne Region comprises 0.5% of the State's population, and 2.0% of the population living in regional Western Australia. The population distribution in the Gascoyne Region from 1986 to 2002 is provided as Table 4.4.

The Average Annual Growth Rate (AAGR) for the Gascoyne Region from July 2000 to June 2001 was 1.8%. This compared to an AAGR of 1.5% for the State. Population projections for the Gascoyne Region are provided as Table 4.5.

Selected demographic characteristics are provided in Table 4.6, which shows that the populations of the Gascoyne region and Shark Bay Shire are ageing. Eighteen per cent of the Gascoyne region's population and 24% of the Shire of Shark Bay's population are over 65, compared to 11% for WA as a whole.

Approximately 5% of the population of Shark Bay are of Indigenous origins, compared to 9.3% for the Gascoyne as a whole. The proportion of persons born overseas is lower in the Gascoyne (16.4%) and Shark Bay Shire (15.9%) than for WA (26.8%).

Selected financial details are provided in Table 4.7, which show that little difference exists between the major income and expenses for people living in Shark Bay when compared to the rest of Western Australia.

The population of the Gascoyne region is not particularly transient, with 52.1% of the population holding the same address as five years ago, compared to 51.8% for WA.

Table 4.4
Population by Shire in the Gascoyne Region

Shire	1986	1991	1996	2001	2002p	% of region
Carnarvon	7,286	6,807	6,385	6,723	6,715	65.1
Exmouth	2,292	2,437	2,083	2,306	2,283	22.1
Shark Bay	1,005	767	853	922	942	9.1
Upper Gascoyne	235	278	266	355	368	3.6
Total	**10,818**	**10,289**	**9,587**	**10,306**	**10,308**	**100**

Source: Department of Local Government and Regional Development (2003), taken from 2001 data.
p= projected population

Table 4.5
Population Projections for 2006 to 2031

Year	2006	2011	2016	2021	2026	2031	% diff (2001-31)
Gascoyne	10,500	11,200	12,100	12,900	13,900	15,100	+48.0

Source: URS (2004)

Table 4.6
Selected Demographic Characteristics from 2001

Characteristic	Gascoyne Region (No.)	Gascoyne Region (%)	Shark Bay Shire (No.)	Shark Bay Shire (%)	WA (%)
Aged 15 years and over	13,291	83.0	1,895	88.0	78.7
Aged 65 years and over	2,938	18.3	511	23.7	11.1
Indigenous persons	1,486	9.3	115	5.3	3.2
Born overseas	2,631	16.4	343	15.9	26.8
Same address 1 year ago	10,935	75.5	1,434	76.3	79.5
Same address 5 years ago	7,136	52.1	1,005	55.1	51.8

Note: Population values differ to those in Table 4.3 as ABS population figures are not seasonally adjusted
Source: ABS (2001)

Table 4.7
Selected Medians from 2001

Selected Medians	Gascoyne Region	Shark Bay Shire	WA
Median age	43	51	34
Median monthly housing loan repayments	$600-$799	$600-$799	$800-$999
Median weekly rent	$100-$149	$100-$149	$100-$149
Median weekly individual income	$300-$399	$300-$399	$300-$399
Median weekly family income	$800-$999	$700-$799	$800-$999
Median weekly household income	$700-$799	$500-$599	$700-$799
Mean household size	2.6	2.3	2.6

Source: ABS (2001)

4.1.3.2 Economics

Industry

The Gascoyne has a diverse economy with the major industries being tourism, mining, fishing, horticulture and pastoralism. The contribution of the major industries to the Gascoyne's GRP are illustrated in Figure 4.3. The Gascoyne's Gross Regional Product (GRP) was $574 million in 2001/02, with tourism contributing to just over a quarter of the GRP. Tourism is predominantly based on the attractions of the Cape Range National Park and the Ningaloo Marine Park (see Section 4.1.3.3 for a more detailed analysis of tourism).

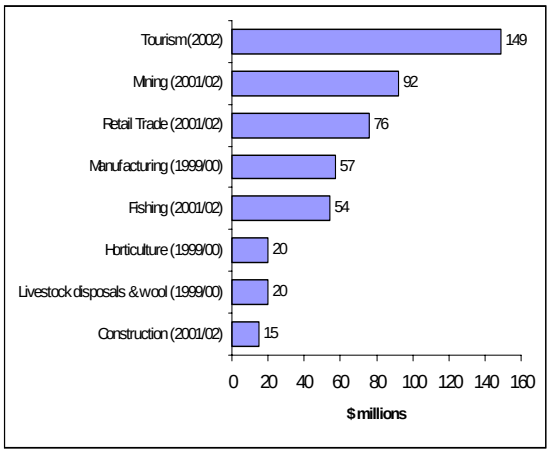

Figure 4.3: Industry Activities
Source: Department of Local Government and Regional Development (2003)

The second largest industry in the Gascoyne is mining, with salt extraction and gypsum mining contributing 75% and 24% of the total value respectively. The trend in Gross Regional Product is shown in Table 4.8. The GRP of the Gascoyne region has increased at a steady rate over the period 1996/97 to 2002/03, following a sharp drop in 1996/97. Over this period the Gascoyne's share of Gross State Product has remained relatively constant at between 4.5 and 4.9%.

Employment

The Gascoyne's labour force has been relatively stable since 1997/98 and was 6,166 in 2001/02. The labour force recovered from a decline in 1996/97 (4,000), which was the result of a reduction in government employment in the region.

Total employment in the Gascoyne Region in the June 2003 quarter was 5,399 people. When the June 2003 quarter is compared with the same quarter of the previous year, employment within the Gascoyne Region grew by 14.8%, compared to 1.5% growth for regional Western Australia and 1.9% growth for the State (Gascoyne Development Commission 2004).

Employment figures by industry for the Gascoyne Region, Shark Bay Shire and WA are outlined in Table 4.9. Agriculture, forestry and fishing is the largest employer (15.7%) in the Gascoyne region, followed by Retail Trade (12.2%). Within the Shark Bay Shire, retail trade is also a large employer of

people (10.3%), but accommodation, cafes and restaurants are the largest employer (13.4%). This is not surprising given the overall importance of tourism to the region and the Shire in particular. The manufacturing, property and business services sectors are small employers compared to WA as a whole, where these sectors employ 10.2% and 10.9% of the total workforce respectively.

Unemployment

Table 4.10 presents the unemployment statistics for the Gascoyne Region, the Shires within it and for the State as a whole.

Over the fifteen month period (June 03 to June 04), the Carnarvon Shire consistently held a higher unemployment rate (6.4-6.8%) than the remainder of the Shires in the Gascoyne region (4.0-5.5%). This is not surprising, given Carnarvon is the major centre and the remainder of the region is relatively isolated. The unemployment rate across individual Shires varied by a maximum of 0.5%.

Table 4.8
Trends in GRP ($ million) for the Gascoyne Region, 1993/1994 to 2002/2003

Region	1993 - 1994	1994 - 1995	1995 - 1996	1996 - 1997	1997 - 1998	1998 - 1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 -0 2003
Gascoyne Region	241	261	89	297	321	326	356	390	424	422
Regional WA	14,929	16,415	18,265	18,437	19,410	19,358	20,638	22,654	24,005	24,406
Western Australia	47,224	50,922	54,919	57,127	61,541	63,597	67,963	73,451	78,089	82,405
% share of Gross State Product	0.51	0.51	0.53	0.52	0.52	0.51	0.52	0.53	0.54	0.51

Source: Department of Local Government and Regional Development (2004)

Table 4.9
Employment by Industry, 2001

Industry	Gascoyne Region (No.)	Gascoyne Region (%)	Shark Bay Shire (No.)	Shark Bay Shire (%)	WA (%)
Agriculture, Forestry and Fishing	963	15.7	74	9.6	4.4
Mining	234	3.8	53	6.9	3.5
Manufacturing	339	5.5	54	7.0	10.2
Electricity, Gas and Water Supply	64	1.0	9	1.2	0.8
Construction	407	6.7	72	9.4	7.5
Wholesale Trade	308	5.0	27	3.5	5.1
Retail Trade	744	12.2	79	10.3	14.8
Accommodation, Cafes and Restaurants	492	8.0	103	13.4	4.6
Transport and Storage	297	4.9	40	5.2	3.9
Communication Services	82	1.3	3	0.4	1.5
Finance and Insurance	85	1.4	18	2.3	2.9
Property and Business Services	376	6.1	47	6.1	10.9
Government Administration and Defence	416	6.8	40	5.2	4.4
Education	336	5.5	38	4.9	7.3
Health and Community Services	415	6.8	43	5.6	9.6
Cultural and Recreational Services	106	1.7	24	3.1	2.2
Personal and Other Services	263	4.3	22	2.9	4.0
Non-classifiable economic units	50	0.8	6	0.8	0.9
Not stated	140	2.3	17	2.2	1.6
Total	**6,117**	**100.0**	**769**	**100.0**	**100.0**

Source: ABS (2001)

Table 4.10
Unemployment June 2003 to June 2004

Shire	Unemployment					Unemployment rate (%)					Labour force
	Jun 03	Sept 03	Dec 03	Mar 04	Jun 04	Jun 03	Sept 03	Dec 03	Mar 04	Jun 04	Jun 04
Exmouth	65	63	66	64	70	4.6	4.4	4.6	4.5	4.9	1,438
Carnarvon	243	239	238	237	250	6.6	6.5	6.4	6.4	6.8	3,682
Upper Gascoyne	11	11	11	10	10	5.4	5.4	5.4	4.9	4.9	204
Shark Bay	24	22	22	23	24	4.4	4.0	4.0	4.2	4.3	553
Gascoyne Region	**343**	**335**	**337**	**334**	**354**	**5.9**	**5.7**	**5.7**	**5.7**	**6.0**	**5,877**
Western Australia	61,200	61,300	61,400	60,700	59,000	6.0	6.0	6.0	5.9	5.7	1,031,700

Source: Department of Employment and Workplace Relations (2004)

4.1.3.3 Adjacent Land Uses

Land resources in the Gascoyne Region predominantly support tourism, agriculture, pastoral, mining and a small amount of urban and industrial development. Eighty three per cent of the land in the Gascoyne Region is used for grazing sheep, cattle and goats on pastoral leases and a very small amount (0.01%) is used for intensive irrigated agriculture at Carnarvon (URS 2004). There are 217 agricultural holdings in the region covering an area of 10.5 million hectares. A small proportion of land used for commercial purposes is held as freehold, less than 5%.

Land use in the Shark Bay Shire includes tourism, salt production, shell grit mining and pastoral. Salt mining in the Shark Bay Shire occurs at Useless Loop and salt production increased from 1.3 Mtpa in 2001 to 1.5 Mtpa in 2003 (Department of Local Government and Regional Development 2003). The Dampier to Bunbury gas pipeline passes through the eastern part of the Shark Bay Shire.

Tourism is a vital industry to the Gascoyne Region and is based on the attractions of the region's unique natural environment. These include the SBWHP, which was inscribed to the World Heritage list in 1991. The property is one of 16 in Australia and attracts many tourists who come to observe dolphins, dugongs, whales, turtles and whale sharks.

It is estimated that over 150,000 tourists visit the region each year (Shire of Shark Bay 2004). One of the most popular tourist attractions in the region is Monkey Mia, where visitors can see wild dolphins come close to shore. Other places and natural features of tourism value include:

- Birridas;
- The Little Lagoon;
- Hamelin Pool Stromatolites;
- Shell Beach;
- Nanga Bay Resort;
- Hamelin Pool Telegraph Station;
- Steep Point;
- Dirk Hartog Island;
- Useless Loop;
- Eagle Bluff;
- WA Ocean Park;
- Pioneer Park (Denham); and
- St Andrew's Church and the old Pearler Restaurant (Denham).

Figure 4.4 shows the location of places of tourism and recreational value. The nearest of these to the Project Area is the stromatolite-viewing platform and boardwalk, approximately 11 km to the northeast of the orebody.

The nearest land users to the Project Area are the managers of the Coburn and Hamelin pastoral leases, which are used for grazing sheep and goats. The Coburn pastoral lease is owned by Gunson Resources Ltd and has an on-site manager residing at the homestead. The Hamelin pastoral lease is owned and operated by the persons currently residing at the Hamelin homestead.

Other land users in the region are the Roadhouse owners, users of the North West Highway and the Nanda and Malgana Aboriginal people.

4.1.3.4 Aboriginal Heritage

Little is known about the pre-European Aboriginal peoples in the Shark Bay area. It is understood that evidence of Aboriginal occupation in the area goes back at least 18,000 years. Tindale (1974) reports that seven tribes lived in the southern Carnarvon Basin, occupying different parts of the area. The area is mainly associated with the Nanda and Malgana people.

According to the WA Aboriginal Affairs Department Register of reported sites, only one archaeological site has been reported in the southern portion of the Shark Bay area. The low number of sites may be ascribed to the lack of archaeological research, but the absence of water

and stone sources probably means that the prehistoric occupation was ephemeral and sparse, leaving very little archaeological residue (Baseline Research 1999).

4.1.3.5 European Heritage

The Shark Bay area is well known for the first known European landing in Australia by Captain Dirk Hartog in 1616 at Cape Inscription, approximately 170 km north west of the Project Area. The earliest records of Australian flora and fauna were compiled in the 17th and 18th centuries by European explorers.

Due to early maritime history, the Shark Bay area is renowned for its shipwrecks, relics and campsites. Early commercial activities in the area have also provided historical and cultural sites and artefacts. These activities have included guano mining, pearling, whaling, fishing and grazing. A solar salt operation and gypsum mine have been in operation since 1968 at Useless Loop. Apart from the salt operation, the fishing industry and pastoralism are the only industries that have persisted over time.

Searches for places of cultural heritage have been conducted on the following databases:

- Australian Heritage Places Inventory;
- Heritage Council of Western Australia Database;
- Shire of Shark Bay Municipal Inventory;
- Register of the National Estate Database; and
- The National Trust Database.

The results of the searches are shown below and, where possible, the locations are presented on Figure 4.4. It is unlikely that any of these places will be affected by the proposed activities.

Australian Heritage Places Inventory

There are two places listed on the Australian Heritage Places Inventory in the Shark Bay area, closest to the Project Area: Hamelin Pool/Faure Sill (10802) and Edel Land (10804) (Figure 4.4).

Hamelin Pool, landlocked in the east, south and west, is a large, shallow marine basin partially separated from Shark Bay by an extensive sand and seagrass bank, the Faure Sill. This shallow sill along the northern boundary of Hamelin Pool greatly restricts tidal flushing. Low precipitation and high evaporation in the area result in increased salinities in the basin and it is one of the few areas in the world where marine waters are hypersaline. The hypersaline conditions support a number of unique geological and biological features. The most significant feature is the diversity and abundance of stromatolites. The stromatolites are living fossils identical to fossils dated at 3.5 billion to 3.9 billion years before present and are of international scientific importance. In addition to stromatolites, there are restricted communities of marine organisms tolerant of hypersalinity, vast deposits of organic shells (coquinas), ooid shells and lithified sediments. The southernmost part of Hamelin Pool is located approximately 5 km north of the Amy Zone orebody.

Edel Land is located within the intermediate zone between the South-west and Eremaean botanical provinces. As the area is located in the transition zone of the two botanical provinces, the area supports a rich and diverse flora especially in its southern section which has not been affected by grazing. The area also supports diverse reptile and bird faunas, with the Zuytdorp Cliffs providing important breeding areas for sea birds. The southern area also contains the historically significant Zuytdorp shipwreck.

Heritage Council of Western Australia

There are nine places listed on the Heritage Council of Western Australia database in that part of the Shark Bay area closest to the Project Area. These places include:

- Denham-Hamelin Pool Telegraph Line (11734);
- Flagpole (11723);
- Hamelin Pool Post & Telegraph Station (fmr) (11720);
- Grave of Thomas Carmody (11722);
- 40 Mile Water Shed (11731);
- Hamelin Station Homestead & Outbuildings (11727);
- Hamelin Pool Postmaster's Quarters (fmr) (11721);
- Shipwrecks (11736); and
- Tamala Homestead, Outbuildings and Cottage Ruins (11730).

Register of the National Estate Database

There are 13 places listed on the Register of the National Estate database for the Shark Bay area. The places are as follows:

- Cape Inscription Lightstation, Dirk Hartog Island (019865);
- Denham Sound, Freycinet Reach, Hopeless Reach and L'haridon Bight, Shark Bay (010806);
- Gudrun Shipwreck, Shark Bay (019188);
- Dirk Hartog Island (010801);
- Shark Bay Area (019791);

- Zuytdorp Shipwreck (010807);
- Small Islands in Shark Bay (010803);
- Shark Bay Road Board Office (fmr), Denham (010809);
- Wolgedda Pioneer Cottage, Nanga Station (010808);
- Edel Land System (010804);
- Hamelin Pool/Faure Sill (010802); and
- Peron – Nanga Area (010805).

Shire of Shark Bay - Municipal Inventory

There are 39 places listed on the Shark Bay Municipal Inventory. Four of these places are Category 1, 15 places are Category 2, 14 places are Category 3 and three places are Category 4. The Category 1 places include the following:

- Former Hamelin Pool Post & Telegraph Station;
- Tamala Homestead, Outbuildings and Cottage Ruins off Overlander and Steep Point Road;
- Cape Inscription Lighthouse and Buildings; and
- Cape Inscription Landing site.

The National Trust

The National Trust's Endangered Places List 2003 does not include any places in the vicinity of the Project Area.

4.1.3.6 Conservation Estate

The Project Area is located adjacent to the southeast boundary of the SBWHP. Although Gunson holds several exploration licence applications within the SBWHP, this proposal does not include development within the property. There is a no mining (exploration) condition on those portions of the four granted exploration licences that overlap the SBWHP.

The SBWHP covers a total area of 2.2 million ha, including the marine reserves and terrestrial areas. The area was placed on the World Heritage list in 1991 as it satisfies all four natural criteria for listing. The four criteria are as follows:

- **Criterion 1:** Outstanding examples representing the major stages of the Earth's evolutionary history.

- **Criterion 2:** Outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment.

- **Criterion 3:** Unique, rare or superlative natural phenomena, formations or features of exceptional natural beauty.

- **Criterion 4:** The most important and significant habitats where threatened species of plants or animals of outstanding universal value from the point of view of science and conservation still survive.

The Zuytdorp Nature Reserve (also known as Cooloomia Nature Reserve) is located to the south of the Project Area, as shown on Figure 4.4. This Class C reserve has an area of 58,850 ha and was gazetted in 1991, but was formed by combining two reserves that had been gazetted in the 1970s. The reserve includes representative sections of the Zuytdorp Cliffs, coastal vegetation and inland heath vegetation of the Victoria Sand Plain district (DEP 2001).

The Hamelin Pool Marine Nature Reserve (Marine Reserve No 6) is located approximately 5 km north of the Amy Zone orebody, as shown on Figure 4.4. This reserve was gazetted in 1990 to protect the environment of Hamelin Pool, particularly the stromatolites, coquina and ooid shoals, and deposits of unconsolidated and lithified beach ridges of *Fragum erugatum* shells.

4.2 PROJECT AREA

4.2.1 Surface Geology

The Amy Zone straddles a fossil J-shaped bay located immediately south of, and broadly parallel to, the present Shark Bay coastline.

The Amy Zone comprises an accumulation of mainly aeolian sands deposited over a Cretaceous basement of clays, clayey sands and limestone. In the southern portion of the Project Area, the basement units are often capped by a hard silcrete layer that is thought to represent a palaeo weathering surface.

Mineralisation is associated with all three of the dune formations present in the Project Area. The lower dunes contain higher grade sheet-like concentrations that are moderately continuous and strike north-northeasterly. Above these lies a second dune formation, which is more sporadically mineralised and generally of a lower grade. The second dune mineralisation may merge with the third dune, which contains a continuous body of mineralisation. Sporadic pockets of mineralisation are also associated with the parabolic dunes of the third dune.

Figure 4.4: Recreational and Heritage Values of the Shark Bay Region

4.2.2 Land Systems

The Project Area occurs primarily in the Nanga land system, but also comprises land units of the Nerren, Snakewood and Sandplain land systems. As indicated in Section 4.1.1.3, these systems comprise sandy plains vegetated by *Acacia* species (see Table 4.2).

The access road also traverses these land systems.

4.2.3 Landform and Soils

A reconnaissance of the soil landscapes and landforms of the Amy Zone was undertaken by D.C. Blandford & Associates in March 2004. The findings of this investigation are presented as Appendix C and summarised below.

The landforms of the Amy Zone comprise a complex dune system with high local relief and lower relief dunes with rolling terrain. The complexity of the longitudinal dune system is a result of a change in wind direction, which may have been associated with a climatic change. The major dune trend lines suggest that the original wind direction was from the south-east to north-west and the subsequent direction is from north-east to south-west. This has created an irregular surface morphology pattern.

Based on the Northcote (1971) system for the classification of Australian soils, there are four principal profile forms within the Amy Zone area. These are presented in Table 4.11.

Table 4.11
Major Soil Types of the Amy Zone

Location	Principal Profile Form	Great Soil Group
Throughout the Project Area	Uc5.21	Earthy Sand
Throughout the Project Area	Uc5.12	Sands
South-east Sections	Uc1.13	Calcareous Sand
Northern Section	Gc1.12	Calcareous Desert Soil

Note: Principal Profile Form after Northcote (1971), Great Soil Groups after Stephens (1961).

It was not possible to map the soil landscape occurring in the Amy Zone at the scale of the investigation. However, it was observed that there was a general lack of variability and a continuity of deep surface sands.

The soils of the Amy Zone are dominated by sands with the majority of soil profiles having some development of fabric to some depth below the surface. This suggests that the soils of the Amy Zone are quite old, having undergone considerable leaching and have a limited capacity to store water.

The soil is sandy throughout the profile and may contain colour changes, weak textural changes, some fabric development and weak horizonation. The sands are typically reddish brown (2.5 YR4/8) to dark red (7.5 R3/6) in colour. The majority of the soil profiles had a surface layer of highly mobile sand. The thickness of this surface layer varied across the Project Area, ranging from 1.0 cm to 15.0 cm. This indicates that the surface layer is quite unstable.

The Particle Size Distribution (PSD) tests indicated that the soils were dominated by the coarse fraction (coarse and medium-grained sands), with over 80% of the sample falling within the sand fraction. All samples contained a small percentage of fines, however this varied with depth and location.

Field observations of the moisture retention capability of the soil profiles within the Amy Zone indicate that the moisture retention increases with increasing depth.

The pH of soils from five representative sites was measured and found to be quite variable, ranging from 7.5 to 9.5. The soil of the Amy Zone is therefore slightly to strongly alkaline.

Field observations indicate that some of the material found at depth is dispersive and is therefore not stable. A more detailed investigation into a range of aggregate stability classes is required to further characterise these materials.

4.2.4 Radiation

Radiation is associated naturally with mineral sands owing to the presence of thorium and monazite. Naturally occurring background radiation levels are typically low and would only present a radiological hazard when in concentrated form.

Radiation Advice & Solutions Pty Ltd undertook a Pre-Operational/Baseline Radiation Monitoring Program in July 2004 using soil samples obtained by Gunson and gamma doserate readings from some 35 sites. (Appendix I) These sites were primarily located in the southern portion of Amy Zone as this is the first part of the Project Area to be developed. Soil samples were analysed by external laboratory Genalysis for uranium and thorium.

The pre-operational environmental gamma survey showed very low levels (less than two nanosieverts per hour) of above-ground radiation, consistent with local sandy soils containing very low levels of

uranium, thorium, and potassium. Even locations which had been identified as containing higher grades of heavy minerals showed gamma radiation doserates that were essentially no more than the cosmic ray component. This was due to the very low monazite content (and hence uranium and thorium content) in the heavy mineral suite.

4.2.5 Hydrogeology

The superficial formations below the Project Area are formed mainly of sands of the reworked Peron Sandstone. To the north of the Project Area, the upper Toolonga Calcilutite has eroded to form a shallow palaeodrainage surface, and the Peron Sandstone has been mostly eroded away. It has no surface expression, dips away and is interbedded with marine deposits

Beneath the Project Area the geological profile contains both confined and unconfined aquifers. There are five major confined aquifers, which have restricted water movement. The groundwater levels are not well defined and the quality varies with depth and location.

The northern part of the Project Area has several shallow unconfined aquifers. The water quality is variable, but is generally saline.

Hydrogeological investigations have been conducted on groundwater systems beneath the Project Area (refer to Section 3 of Appendix D).
The main findings are:

- The main aquifers beneath the Project Area above the Dirk Hartog Group include (from south to north) the Kopke Sandstone, Birdrong Sandstone and Windalia Sand Member with the Muderong Shale between the upper two units. The Windalia Radiolarite may also occur beneath the northern end of the Project Area instead of the Windalia Sand Member.

- The superficial aquifer is mostly dry apart from a thin saturated layer in parts of the northern section of Amy Zone.

- Groundwater qualities vary, particularly that the salinities of the confined aquifers decrease with depth.

4.2.6 Surface Hydrology

The Project Area is internally draining and has few surface water features due to low rainfall, high evaporative conditions, and inferred high infiltration capacity dunal soils. It has no defined watercourses, permanent fresh-water bodies, or birridas (seasonally inundated, saline lakes). There are no known sensitive surface water features within the proposed mining area.

As indicated in Section 4.1.1.6, the catchment area upstream of the Project Area is relatively small and is likely to produce little runoff during storm events. Most rainfall typically ponds in depression areas and evaporates or quickly infiltrates.

4.2.7 Vegetation

Four flora and vegetation surveys have been conducted for the proposed Project by Mattiske Consulting Pty Ltd over a 15 month period. These surveys comprised:

- August 2003 - A spring survey that covered the northern portion of the Amy Zone and the northern access route (which is no longer included in the proposed Project).

- April 2004 - An autumn survey in which 56 permanent vegetation monitoring plots were established and a 5km southern extension of the Amy Zone was mapped.

- September 2004 - A spring survey to collect annual species that covered the entire Amy Zone.
- November 2004 - A survey of the southern access road, the construction camp and two additional extensions of the Project Area.

These survey areas are shown on Figure 4.5.

The objectives, methodology and findings of these flora and vegetation surveys are described in Appendix J, and a summary of the results and conclusions provided in this Section. The vegetation map developed from the surveys is presented as Figure 4.6.

The vegetation system of the survey area is referred to as the Tamala System. The typical vegetation of this system comprises of “tree heath”, or heath with scattered trees.

A total of 18 plant communities, consisting of seven *Eucalyptus* Woodlands, ten Shrublands and one Mosaic community, were defined and mapped. These plant communities are described in Table 4.12.

Communities are described as ‘Threatened Ecological Communities’ (TECs) if they have been defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (English & Blyth 1997, or the EPBC Act). None of the plant communities within the Project Area are considered to be TECs.

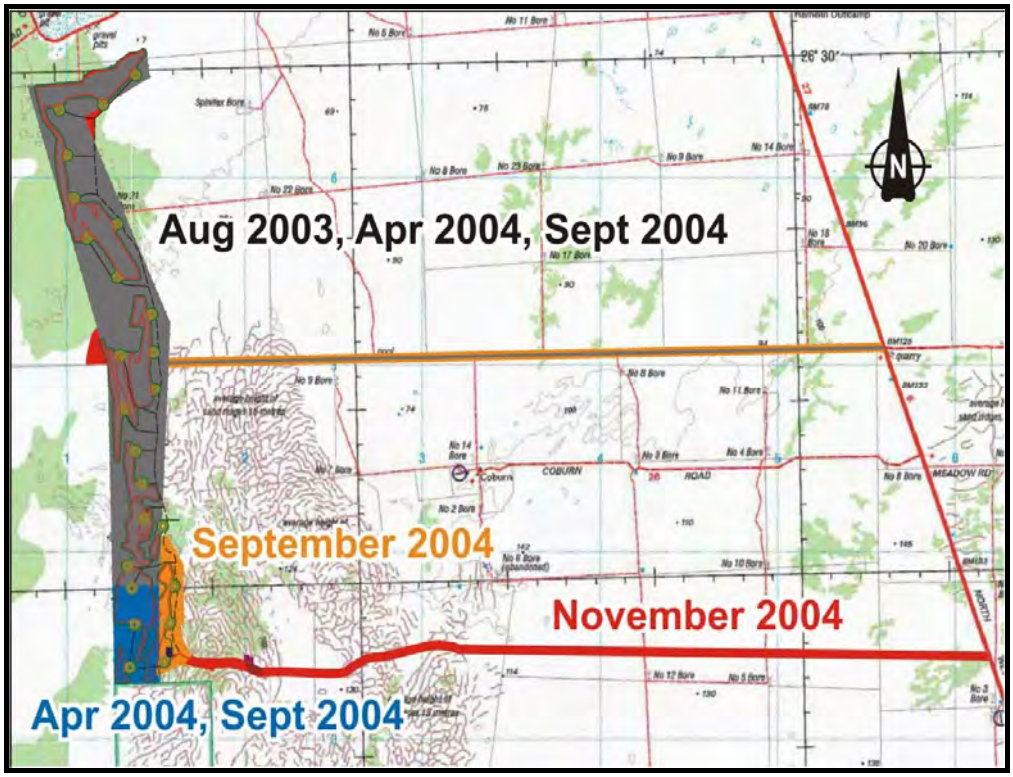

Figure 4.5: Botanical Survey Areas

Of the 18 vegetation communities described and mapped within the Project Area, 14 may be considered as regionally significant. The eucalypt communities E1, E2, E3, E4, E6 and E7 and the mosaic community M1 are regionally significant as they are endemic to the Shark Bay region. These communities occur in the northern one-third of the Project Area.

The shrubland communities S1, S2, S3, S4, S5, S6 and S10 are also endemic to the Shark Bay region and are therefore considered to be regional significant. Community S5 (Plate 4.1) is particularly significant as it is restricted to deep valleys, which are a locally and regionally unusual landform. However, communities S1 and S2 occur over extensive areas, including within the SBWHP.

Twelve vegetation communities (E3, E4, E6, S1, S2, S3, S4, S5, S7, S8, S9 and S10) may be considered locally significant due to the presence of Priority Flora species. Community S10 is especially significant as it is dominated by the Priority 3 species *Physopsis chrysophylla* (P3) and on the basis of current information appears to be restricted within the survey area (Plate 4.2). Vegetation community S5 is also very restricted in the local sense. Vegetation communities E4 and S4 may be considered locally significant as these support *Grevillea acacioides*, the presence of which in the Project Area is an extension of its previously-known range. Three vegetation communities on the eastern section of the survey area and the access road (S7, S8 and S9) may also be considered locally significant due to the presence of calcrete in the soils.

Plate 4.1: Vegetation community S5 (Source: Mattiske Consulting Pty Ltd, 2005). This community is considered to be of significance due to its limited occurrence within the Project Area and the presence of the Priority Flora species *Acacia subrigida* (P2)(Plate provided by Mattiske Consulting).

Plate 4.2: Vegetation community S10. (Source: Mattiske Consulting Pty Ltd, 2005). This community is considered to be of significance due to its limited occurrence within the Project Area and the presence of the Priority Flora species *Physopsis chrysophylla* (P3)(Plate provided by Mattiske Consulting).

4.2.8 Flora

Flora surveys were conducted within sections of the Project Area by Mattiske Consulting Pty Ltd in August 2003 and April, September and November 2004. This Section summarises the results and conclusions of the survey, with the entire report presented as Appendix J. A total of 231 taxa (including subspecies and varieties) from 132 genera and 51 families were recorded. Fourteen introduced (weed) species were recorded. None of these introduced species recorded are listed as Declared Plants, as defined by the Department of Agriculture (2004).

No plant taxa gazetted as DRF under the Wildlife Conservation Act were found within the Project Area. No plant taxa listed as Threatened pursuant to Schedule 1 of the EPBC Act were recorded in the Project Area.

Nine Priority Flora species have been recorded in the vegetation communities in the Project Area (Fig. 4.7), as follows:

- *Acacia subgrida* (P2), in vegetation communities S1, S2, S3 and S5.
- *Eremophila occidens* (ms) (P2), in vegetation communities S1, S2 and S3.
- *Sholtzia* sp. Folly Hill (P2), in vegetation community S2.
- *Acacia drepanophylla* (P3), in vegetation communities E3, S7, S8 and S9.
- *Grevillea rogersoniana* (P3), in vegetation communities S1, S2 and S3.
- *Grevillea stenostachya* (P3), in vegetation communities E6 and S7.
- *Macarthuria intricata* (P3), in vegetation communities S2 and S10.
- *Phyopsis chrysophylla* (P3), in vegetation communities S1, S2, S3 and S10.
- *Jacksonia dendrospinosa* (P4), in vegetation community S2.

The definitions for the Priority categories are provided in Table 4.13.

Eight species were located outside their previously recorded ranges. These are *Acacia galeata*, *Austrostipa macalpinei*, *Daveisia divaricata* subsp. *?lanulosa* (ms), *Dicrastylis soliparma*, *Grevillea acacioides*, *Grevillea stenostachya* (P3), *Trachymene coerulea* subsp. *leucopetala* and the introduced species *Avellinia michelii*, as documented by Western Australian Herbarium records (CALM 2005).

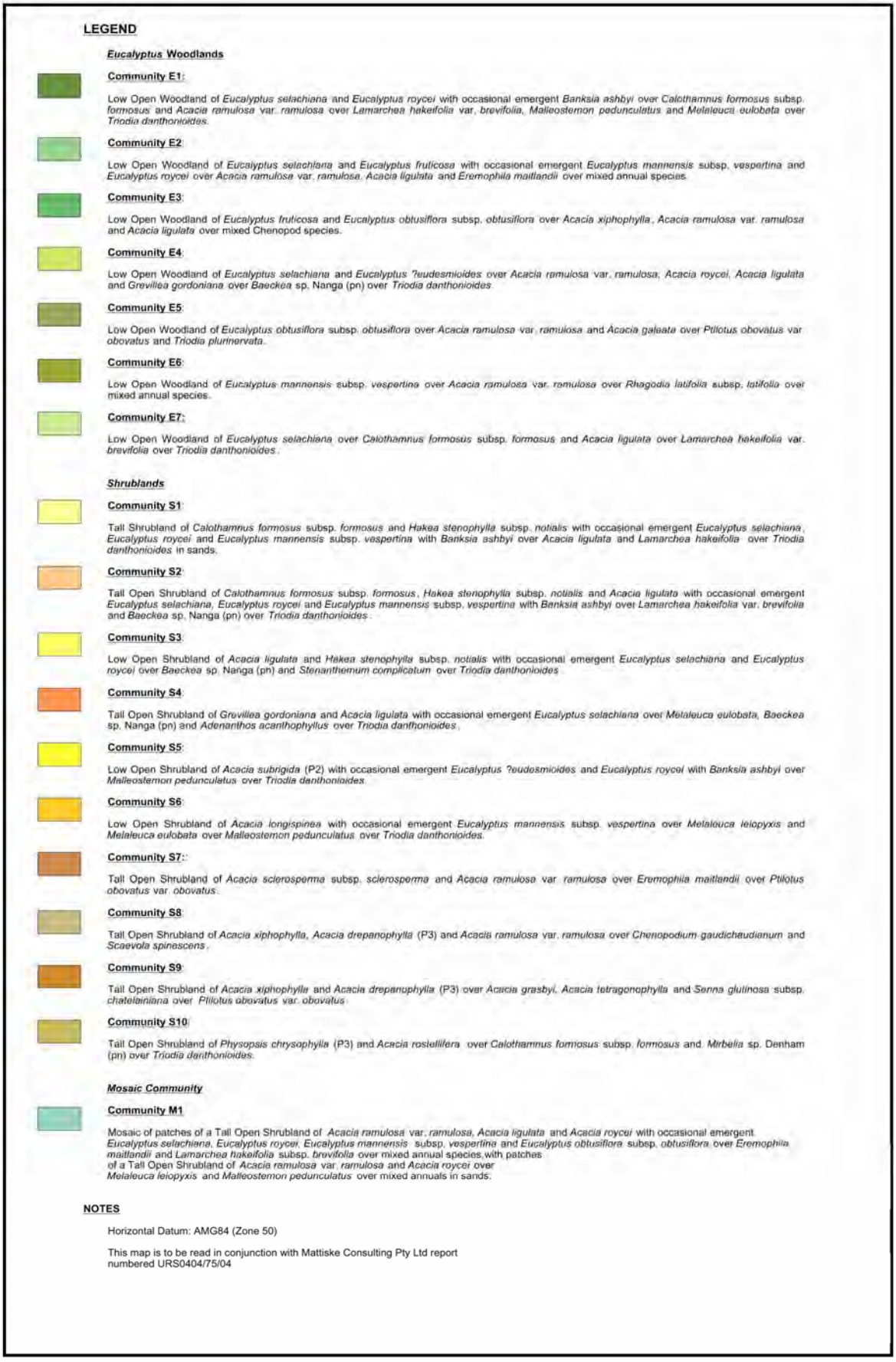

Figure 4.6a: Vegetation Map Legend

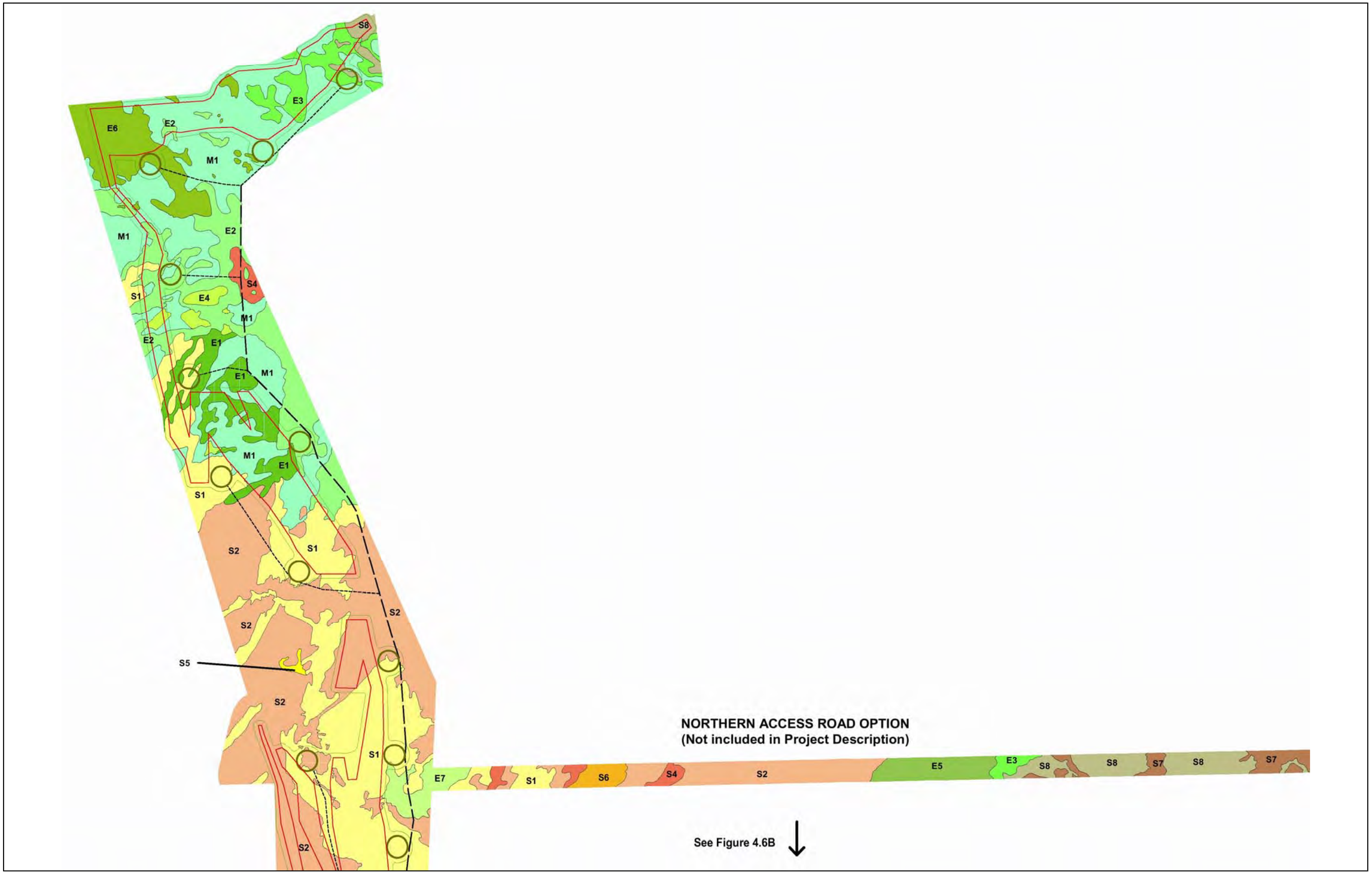

Figure 4.6b: Vegetation Map of the Northern Section of the Project Area

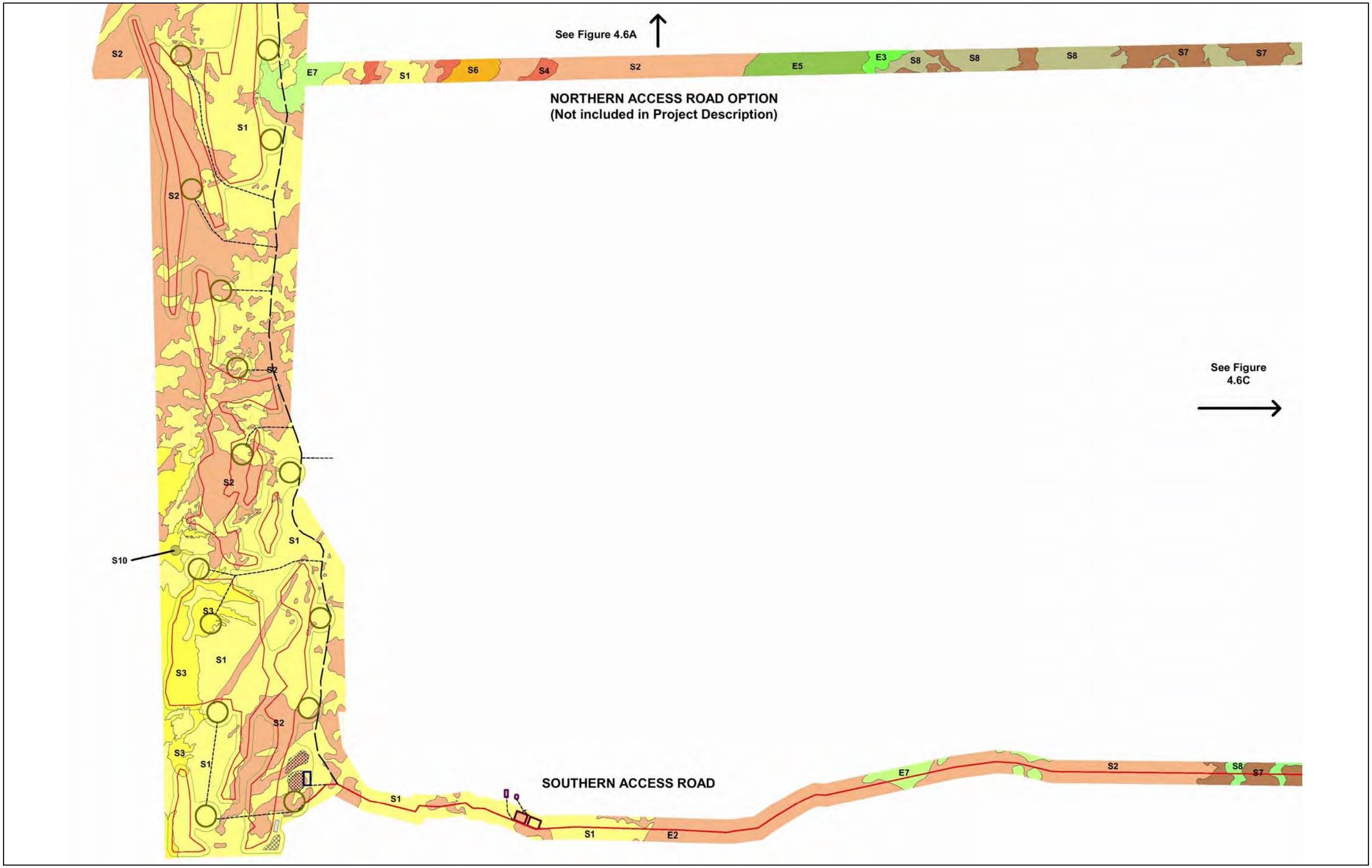

Figure 4.6c: Vegetation Map of the Southern Section of the Project Area

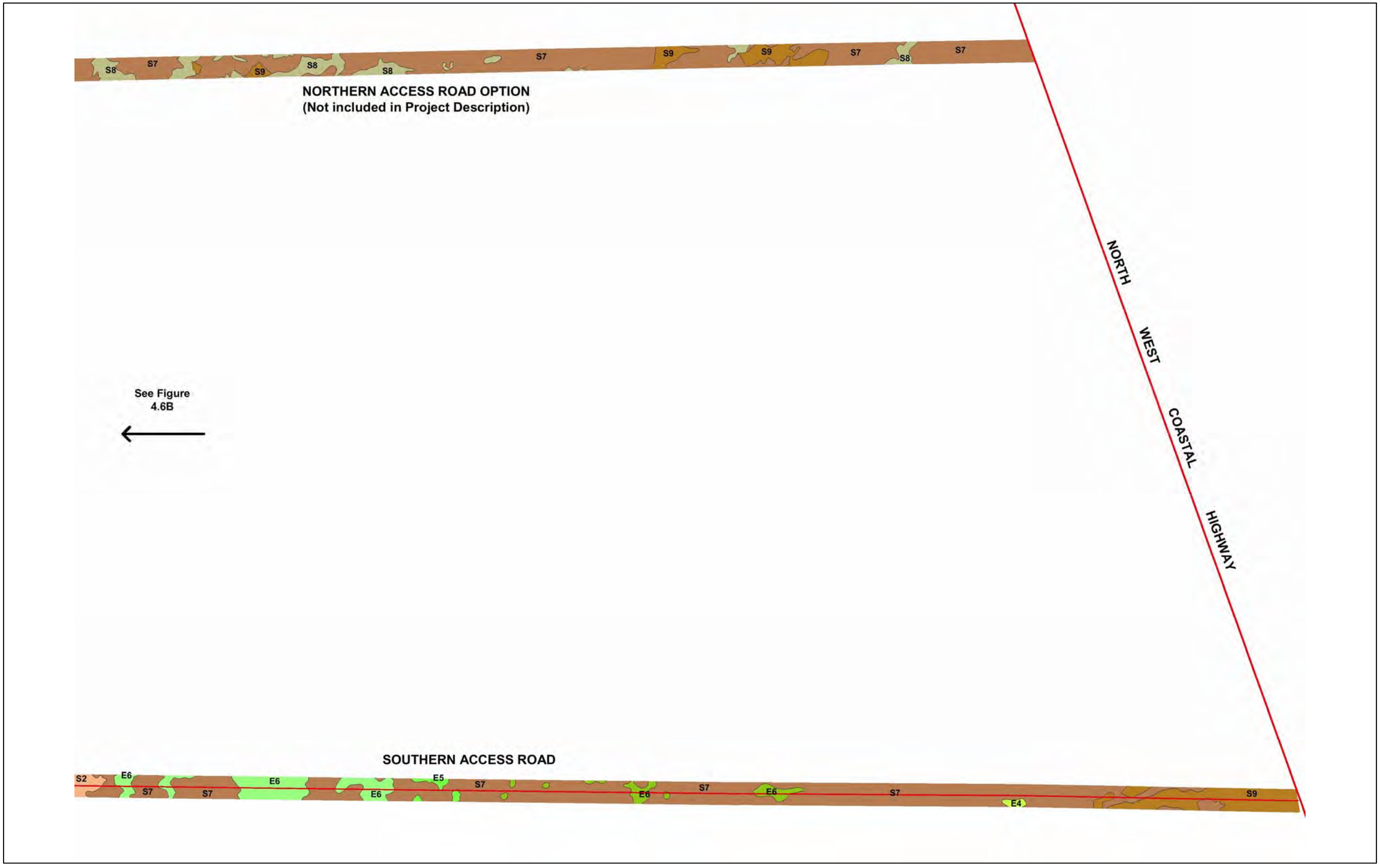

Figure 4.6d: Vegetation Map of the Eastern Section of the Project Area

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Table 4.12
Significance of Plant Communities

Community	Contain Priority Flora	Priority Flora dominant	Restricted to calcareous soils	Range Extension recorded	Locally Significant	Regionally Significant	Comments
E1						X	Regionally significant as endemic to Shark Bay region.
E2						X	Regionally significant as endemic to Shark Bay region..
E3	X				X	X	Locally significant due to the presence of *Acacia drepanophylla* and regionally significant as endemic to Shark Bay region..
E4				X	X	X	Locally significant due to the presence of *Grevillea acacioides* (range extension) and regionally significant as endemic to Shark Bay region..
E5							Not locally or regionally significant.
E6	X				X	X	Locally significant due to the presence of *Grevillea stenostachya* and regionally significant as endemic to Shark Bay region..
E7						X	Regionally significant as endemic to Shark Bay region..
S1	X				X	X	Locally significant due to the presence of *Acacia subrigida*, *Eremophila occidens*, *Grevillea rogersoniana*, and *Physopsis chrysophyll.* Regionally significant as endemic to Shark Bay region..
S2	X				X	X	Locally significant due to the presence of *Acacia subrigida*, *Eremophila occidens*, *Scholtzia* sp. Folly Hill, *Grevillea rogersoniana*, *Macarthuria intricata* and *Physopsis chrysophylla* and regionally significant as endemic to Shark Bay region..
S3	X				X	X	Locally significant due to the presence of *Acacia subrigida*, *Eremophila occidens*, *Grevillea rogersoniana*, and *Physopsis chrysophylla* and regionally significant as endemic to Shark Bay region..
S4				X	X	X	Locally significant due to the presence of *Grevillea acacioides* (range extension) and regionally significant as endemic to Shark Bay region..
S5	X	X			X	X	Locally significant due to the presence of *Acacia subrigida* (P2) and regionally significant as endemic to Shark Bay region..
S6						X	Regionally significant as endemic to Shark Bay region..

Table 4.12 (cont.'d)

Community	Contain Priority Flora	Priority Flora dominant	Restricted to calcareous soils	Range Extension recorded	Locally Significant	Regionally Significant	Comments
S7	X		X		X		Locally significant due to the presence of *Acacia drepanophylla, Grevillea stenostachya* and calcrete soils and regionally significant as endemic to Shark Bay region..
S8	X	X	X		X		Locally significant due to the presence of *Acacia drepanophylla*.
S9	X	X	X		X		Locally significant due to the presence of *Acacia drepanophylla*.
S10	X	X			X	X	Locally significant due to the presence of *Macarthuria intricata and Physopsis chrysophylla* and regionally significant as endemic to Shark Bay region..
M1						X	Regionally significant as endemic to Shark Bay region..
Total	**10**	**4**	**3**	**2**	**12**	**14**	

Table 4.13
Definition of Rare and Priority Flora Species

Conservation Code	Category
R	Declared Rare Flora – Extant Taxa "Taxa which 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 and have been gazetted as such."
P1	Priority One – Poorly Known Taxa "Taxa which are known from one of a few (generally <5) populations which are under threat, either due to a small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P2	Priority Two – Poorly Known Taxa "Taxa which are known from one of a few (generally <5) populations, at least some of which are not believed to be under immediate threat (not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P3	Priority Three – Poorly Known Taxa "Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and wither widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey."
P4	Priority Four – Rare Taxa "Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years."

Source: CALM (2005)

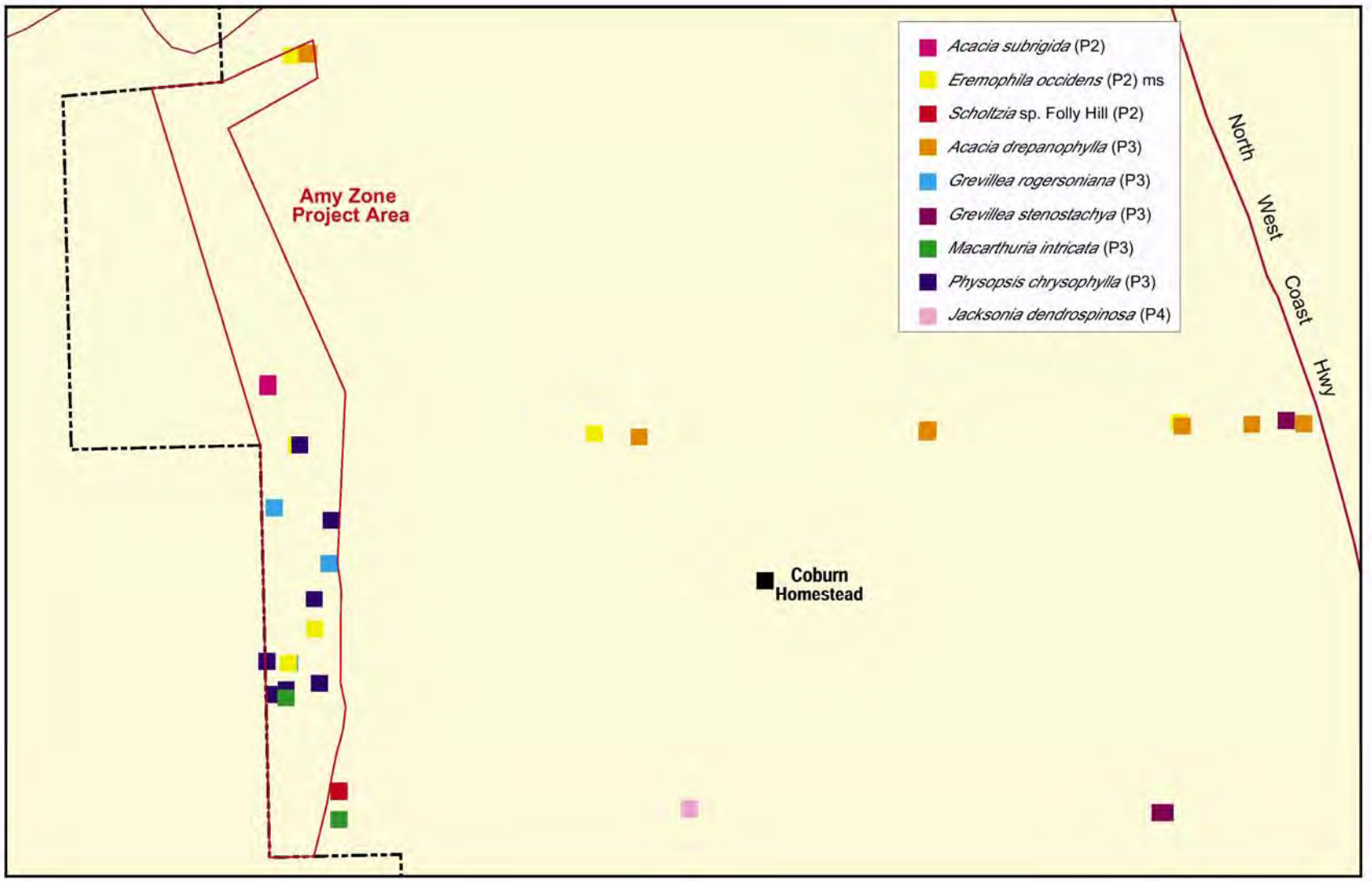

Figure 4.7. Known locations of Priority Flora in proximity to the Project Area.

4.2.9 Vertebrate Fauna

Three comprehensive vertebrate fauna surveys have been conducted for the proposed Project by Ninox Wildlife Consulting (Ninox). These surveys comprise:

- A spring survey in September 2003 that covered the northern portion of the Amy Zone and the proposed (now outdated) northern access route.
- An autumn survey in April 2004 that covered the southern portion of the Amy Zone;
- A spring survey in October 2004 that covered the southern portion of the Amy Zone and a desktop survey that covered the southern access route; and
- A survey for Hamelin Skink habitat, which was conducted in September 2004.

These survey areas are shown on Figure 4.8. The results and conclusions of the Ninox surveys are summarised in this Section, with further details provided in Appendix K.

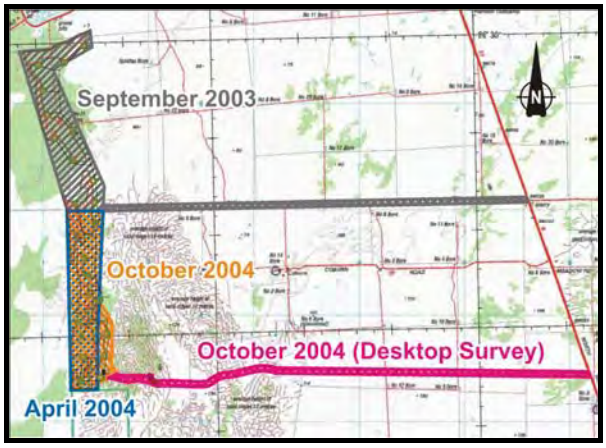

Figure 4.8: Vertebrate Fauna Survey Areas

A total of eight native mammal species, 61 bird species and 45 reptile species were identified in the Project Area.

Most of the vertebrate species recorded during the surveys have a widespread distribution throughout the semi-arid region and are not restricted to individual habitats. However, some vertebrates that are classified as rare, threatened or vulnerable were not found during the Project Area surveys. This is not unusual, as by definition, the presence of these animals would be difficult to confirm because of their scarcity, and is a reality when dealing with short-term studies (Cowan & How 2004).

Three species known to occur in the vicinity of the Project Area are listed under the EPBC Act. The Malleefowl (*Leipoa ocellata*) is currently listed as Vulnerable under the EPBC Act. No birds were actually seen during the surveys, although it was recorded in the area by its distinctive footprints and nesting mounds. No currently used nests were located, and most nests occurred in the southern portion of the Project Area (Fig. 4.9). The Malleefowl were once common and widespread in the semi-arid zone, mainly in the mallee and acacia scrublands, especially in the north and east of the mulga-eucalypt line. The population is believed to be restricted by factors such as clearing of habitat, increased frequency of fire, competition with introduced herbivores including stock and feral animals, and increased predation by exotic animals such as foxes, cats and dogs.

The Thick-billed Grasswren (*Amytornis t. textilis*) is currently listed as Vulnerable under the EPBC Act. It was previously widespread in the southern arid zone, however it is now only located in the Shark Bay area. This bird is commonly found in the northern portion of the Peron Peninsula, is moderately common at Woodleigh Station and north-east of Hamelin Station, but was not recorded during any of the Project Area surveys. Given the extensive surveys for this species in the area and in the Project Area, it is unlikely that the Thick-billed Grasswren inhabits the study area.

The Hamelin Skink (*Ctenotus zasticus*) is listed as 'Vulnerable' under the EPBC Act. It is only known to occur on Hamelin and Coburn Stations where it appears to favour eucalypt woodlands with spinifex (*Triodia*) on red sands - a habitat which occurs at the northern section of the Project Area. It was not recorded during any of the fauna surveys.

The five known locations of this skink are approximately 12 kilometres east of the Project Area. Three of these locations were visited by a fauna specialist and plant ecologist in September 2004. This visit was designed to assess the known skink habitat and compare this with potential habitat within the Project Area. Only the E5 community showed reasonable similarity to the known Hamelin Skink habitats and this community is located outside the Project Area.

Desktop surveys have identified three vertebrates likely to occur in the Project Area that are gazetted under the Wildlife Conservation Act. These are:

- Peregrine Falcon (*Falco peregrinus*): This bird of prey is listed as Other Specially Protected Fauna and was not recorded during surveys. It occurs Australia wide and is believed to be a scarce visitor to the Shark Bay area. It has no particular habitat preference, although it has

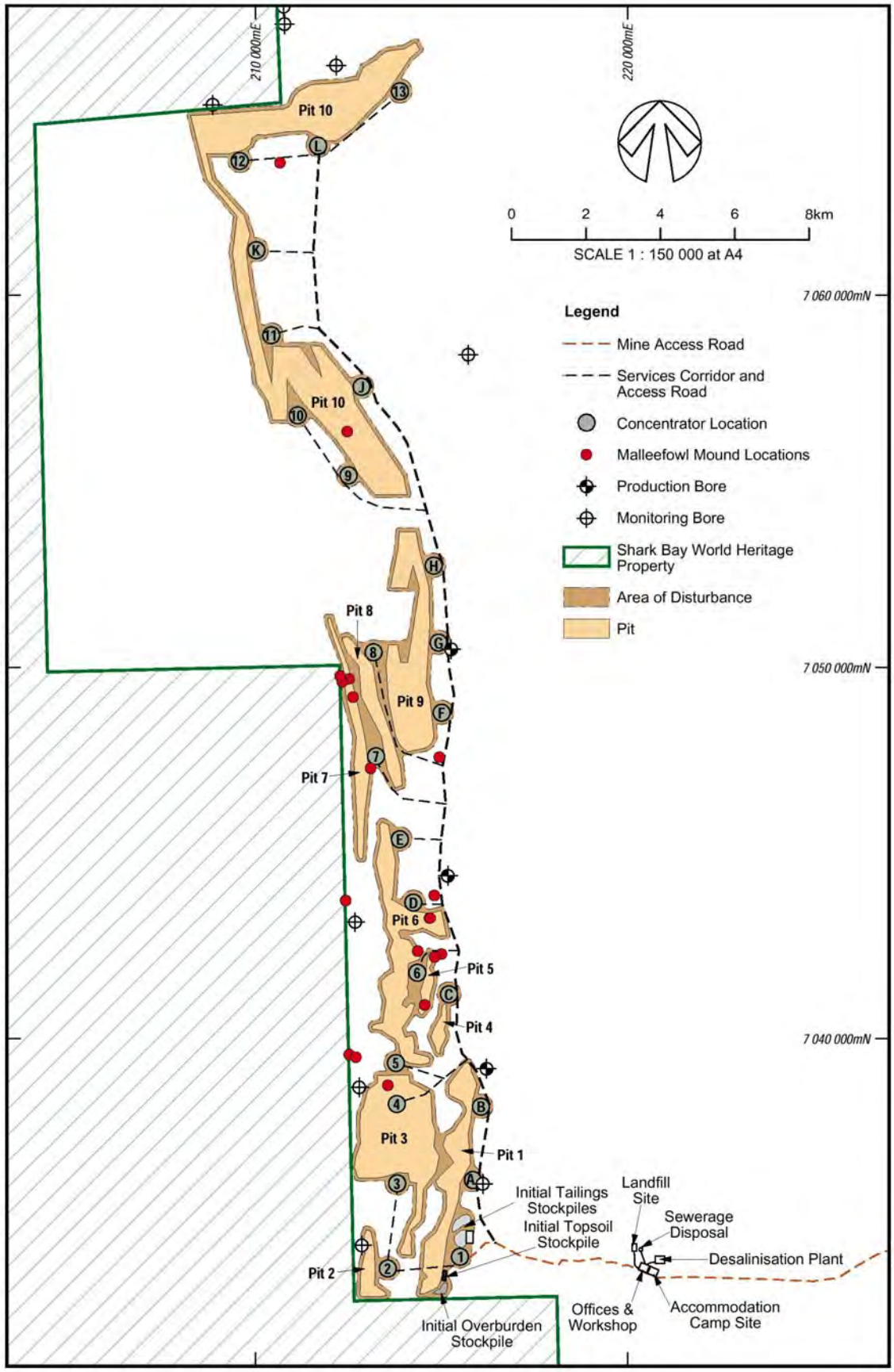

Figure 4.9. Known locations of Malleefowl nests within the Project Area.

been known to nest and roost in artificial 'cliffs' in abandoned mine pits.

- Woma (*Aspidites ramsayi*): Four disjunct populations of this python are known to occur, with one inhabiting the Peron Peninsula. The species is listed as Other Specially Protected Fauna, with the Peninsula population thought to be particularly vulnerable due to its possible isolation. It was not detected during surveying, although it could possibly occur in the Project Area.

- Hamelin Skink (*Ctenotus zasticus*)- discussed previously. Also listed as Vulnerable in the Wildlife Conservation Act.

Desktop surveys have identified a further three vertebrates likely to occur in the Project Area that are gazetted under the CALM Priority Fauna List. These are:

- *Lerista maculosa*: This reptile is known from only two localities south and south-east of Hamelin Pool. It has been listed as Priority 1, however the taxonomic status of this reptile appears to be in doubt and it is likely that it will be synonymised with *Lerista uniduo* (K. Aplin *pers. com.).*

- *Lerista humphriesi*: This skink has been found in semi-arid sandplains between Shark Bay and Murchison, but has not been detected during surveys. It is possible that this species occurs throughout the shrublands and has been listed as Priority 2.

- Australian Bustard (*Otis australis*): This bird is nomadic and thought to be uncommon in the Shark Bay area (Storr 1990), but could occur in the more open habitats within the Project Area. It has been listed as Priority 4.

- Thickbilled Grasswren (*Amytornis t. textilis*): discussed previously. Also listed as Priority 4 in the CALM Priority Fauna list.

The spring surveys recorded the presence of the Rainbow Bee-eater (*Merops ornatus*) which is protected under the Japan/ Australia Migratory Bird Agreement (JAMBA)[1]. It has previously been recorded as a scarce breeding visitor to the Shark Bay area (Storr 1990). Very few individuals were observed during the surveys and no evidence of breeding burrows in the soil was found.

No rare mammals were recorded during the surveys of the Project Area. Whilst many species were known to occur in the area, they now only occur on Bernier and Dorre Islands, or other islands off the mid-west coast of Western Australia. The Brush-tailed Bettong (*Bettongia penicillata*) and Bilby (*Macrotis lagotis*) have been reintroduced onto the Peron Peninsula but are unlikely to occur outside the electric fence that protects the peninsula from exotic predators (C. Sims, *pers comm*.). None of these extant mammals have been recorded naturally on the mainland and are therefore extremely unlikely to be present in the Project Area.

Six introduced mammals were recorded during the surveys. The herbivores were rabbits (*Oryctolagus cuniculus*), goats (*Capra hircus*) and a camel (*Camelus dromedarius*). The three carnivores recorded were feral dogs/dingos (*Canis spp.*), red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*).

A wide-ranging survey has been previously conducted throughout the Carnarvon Basin (McKenzie, Hall & Muir 2000). Results from the nearby survey locations (Nanga, Nerren Nerren and eastern Zuytdorp) of the Carnarvon Basin study and Western Australian Museum records from the local area were compared to results from the Ninox Wildlife Consulting surveys in order to determine whether the species diversity found was representative of the local area.

Mammals

Seven of the nine mammals (78%) known to occur in the area (not including bats; McKenzie, Hall & Muir 2000) were found in the surveys. The two species not found were the Western Grey Kangaroo (*Macropus fuliginosus*) and the Ash-grey Mouse (*Pseudomys albocinereus*). The spring and autumn surveys are therefore expected to have provided results that are representative of the local area.

No bats were captured or observed during the surveying. Six bat species were detected in the Carnarvon Basin study, and all species are expected to occur in the Project Area.

[1] There is some confusion about whether the rainbow Bee-eater is protected under JAMBA as this species is not listed on the Australian Treaty Series 1981 No. 6 – Agreement between the government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment. However, the DEH has advised that this species is included in the Annex to JAMBA and is therefore protected under JAMBA. It was added after the agreement was signed, so is not reflected on the Australian Treaty Series entry which describes the original agreement text and annex (J. Ferris, pers. comm..)

Birds

The area was found to have a moderately rich bird fauna. A total of 77% of the known fauna (79 species; Burbidge et al. 2000) was found in the Project Area surveys. Most of the species that were not seen were at the southernmost limits of their range (Storr 1990). Thus, the bird fauna found is thought to be representative of the local area.

Reptiles

The Carnarvon Basin study (McKenzie et al. 2000b) and records from the Western Australian Museum suggest the presence of 71 reptiles in the area. The Project Area study recorded 45 species. Given additional sampling, it is likely that all species previously recorded in the area would be located within the Project Area. Eight of the species detected in the spring and autumn surveys had not previously been found in the area. The results of the Project Area survey place the reptile fauna into the category of high diversity representative of the Shark Bay area.

Amphibians

No amphibians were recorded in the Project Area in either survey. Four species have previously been recorded (McKenzie et al. 2000b). None of these species are classified as rare, threatened or vulnerable.

Habitats of Significance

No particularly significant individual habitat was located within the Project Area. Two habitat stands may be construed as being of local significance. The results show the eucalypt woodlands in the northern section of the Project Area are likely to contain a greater range of species of reptiles and birds than the shrublands due to the greater abundance of nesting and roosting hollows. The S3 shrubland community in the southern sector support a larger diversity and abundance of reptiles.

4.2.10 Stygofauna

A field survey for subterranean fauna was conducted by UWA Zoology personnel in October 2004. The findings of this survey are presented in Appendix L (Knott and Goater, 2005).

No groundwater fauna was recorded during the field survey. The water samples collected contained many fragments of surface arthropods that had fallen into the bore. All arthropods collected were terrestrial species typically dwelling at the surface or in soil. One bore contained Collembola and Acarina invertebrates, but no individuals showed characteristics common in stygofauna such as a lack of pigment, eyeless, extenuation of limbs and sensory structures.

The lack of stygofauna in the Project Area could be due to the high concentration of minerals in the groundwater. Similar particles are not evident in sediments where stygofauna has been recorded.

4.2.11 Land Uses

The Project Area is located on the Coburn and Hamelin pastoral leases, which are used for the grazing of sheep and goats The Coburn pastoral lease is owned by Gunson Resources Ltd and has an on-site manager residing at the homestead. The Hamelin pastoral lease is owned and operated by the persons currently residing at the Hamelin homestead.

The only inhabitants in the vicinity of the Project Area are the managers of the Coburn and Hamelin leases. The Coburn homestead is located approximately 20 km east of the Amy Zone orebody and the Hamelin homestead is located approximately 9 km northeast of the northern end of the Amy Zone, as shown in Figure 4.4.

The Project Area is also utilised by native fauna including larger mobile species such as emus and kangaroos. Appendix K outlines the other fauna inhabiting the Project Area.

Another land use in the Project Area is mineral exploration. Gunson holds exploration licences and mining leases that cover the Amy Zone and surrounding area, as shown in Figure 1.3. Arrangements to access the land have been made with the pastoral leaseholders and Aboriginal people in relation to exploration activities.

4.2.12 Aboriginal Heritage

In 1999, Gunson's predecessor Stuart Metals NL engaged Baseline Research to conduct a preliminary anthropological and archaeological survey of areas on Coburn, Hamelin and Tamala pastoral leases. Survey Area A (covering the Hamelin and Coburn pastoral leases) was cleared for a proposed drilling programme as there were no ethnographical sites located during this survey.

An anthropological and archaeological mining work program survey was conducted over mining lease applications 09/111 and 09/112 in the southern end of the Amy Zone and the proposed access road in early December 2004 with representatives nominated by the Nanda working group. No registered Aboriginal sites were located within the survey area, and no new archaeological

or ethnographical sites were located. One archaeological site was located near the proposed access road, but this road has been diverted so as to avoid any disturbance.

Final anthropological and archaeological mining work program surveys are proposed for mid 2005.

All surveys will include representatives nominated by the Nanda working group (and Malgana working group where necessary) along with other Aboriginal people with an interest in the Gunson Project Area.

4.2.13 European Heritage

Searches for places of cultural heritage have been conducted on the following databases:

- Australian Heritage Places Inventory;
- Heritage Council of Western Australia Database;
- Shire of Shark Bay Municipal Inventory;
- Register of the National Estate Database; and
- The National Trust Database.

No places of cultural heritage have been found to occur within the Project Area and it is unlikely that any of these places will be affected by the proposed activities.

5.1 INTRODUCTION

The environmental approvals process in WA is a public process and the Proponent is expected to consult with the public and government agencies to ensure that updated information about local issues and concerns is used in the environmental and social impact assessment.

The objective of the consultation programme conducted during the preparation of this PER was to enable individuals, groups and agencies potentially affected by the proposed Project to have their interests and concerns considered during the environmental impact assessment process.

The purpose of this section is to summarise the considerable level of consultation and stakeholder involvement that has occurred since the environmental assessment process commenced in 2003.

5.2 CONSULTATION DURING THE REFERRAL PROCESS

Gunson initiated a stakeholder consultation programme in early 2003 to coincide with the commencement of the environmental assessment process. The aims of the consultation undertaken during this phase of the environmental approvals process were to:

- Identify key stakeholders;
- Provide stakeholders with information on the proposed Project; and
- Identify the key issues and potential impacts that need to be assessed in the impact assessment.

During this initial phase of consultation, Gunson identified and consulted with the following stakeholders:

- DEH;
- DoE (Perth and Mid-West regions);
- EPA;
- DoIR;
- CALM;
- DIA;
- Department of Agriculture;
- Shark Bay World Heritage Property Scientific Advisory Committee (SAC);
- Shark Bay World Heritage Property Community Consultative Committee (CCC);
- Gascoyne Development Commission (GDC);
- Mid-West Development Commission;
- Shire of Shark Bay;
- The Wildflower Society of Western Australia;
- City of Geraldton;
- Pastoral Lease Holders;
- Yamatji Land and Sea Council;
- Nanda Aboriginal Working Group;
- Malgana Aboriginal Working Group; and
- Other Aboriginal people with an interest in the area.

Consultation was primarily undertaken through a series of presentations and information sessions. A site visit was undertaken by the DEH, DoE and CALM in June 2003 and the Nanda Aboriginal people, together with other Aboriginal people with and interest in the area visited the site in December 2004.

5.3 CONSULTATION DURING PER PREPARATION

During the preparation of the PER, consultation sessions were conducted with a range of Government agencies, community groups and individuals interested in, or affected by the proposed Project.

The aims of the consultation programme during the PER production phase were to:

- Identify additional stakeholders;
- Disseminate information and identify stakeholder issues;
- Obtain feedback from stakeholders;
- Respond to stakeholder issues; and
- Communicate Proponent's response.

5.3.1 Identification of Stakeholders

Stakeholders comprise:

- People affected directly by, or concerned about, the environmental assessment and management of the Project;
- Government agencies that would be regulating the proposed operations;
- People with a direct commercial interest in the Project; and
- Aboriginal people with an Aboriginal heritage or native title interest in the area.

The Government agencies consulted during the preparation of the PER are listed below:

- DEH;
- EPA;
- DoE;
- DoIR;
- CALM;
- DIA; and
- Shire of Shark Bay.

Other stakeholders and Non-Government Organisations (NGOs) that were consulted during the preparation of the PER are listed below:

- Pastoral Lease Holders;
- Wildflower Society;
- Shark Bay World Heritage Property SAC;
- Shark Bay World Heritage Property CCC;
- Conservation Council of WA;
- Yamatji Land and Sea Council;
- Nanda Aboriginal Working Group; and
- Malgana Aboriginal Working Group.

5.3.2 Dissemination of Information and Identification of Issues

Site visits for relevant regulatory authorities were hosted by Gunson in August and September 2004. Project presentations were also provided to local pastoralists following the September site visit. The aim of the site visit was to provide the stakeholders with an appreciation and understanding of the Project in the context of the environmental setting. Information was also distributed by Gunson and URS via pamphlets and update letters to relevant stakeholders.

A series of meetings, together with site visits, were conducted with the Nanda Aboriginal Working Group, Malgana Aboriginal Working Group and other Aboriginal people with an interest in the area.

A series of meetings on soils, landform and rehabilitation issues were also undertaken during 2004 with officers from the CALM, DoE, EPASU and the DoIR.

5.3.3 Feedback on Stakeholder Issues

The issues identified during the consultation programme are listed in Table 5.1, with the main issues being:

- The potential difficulty in successfully rehabilitating the land after mining;
- Potential impacts to the SBWHP;
- Potential groundwater drawdown effects on conservation values and groundwater users;
- Potential impacts to conservation values due to tailings seepage;
- Potential disturbance to Aboriginal heritage sites;
- Impacts on Malleefowl, which is listed as Vulnerable under the EPBC Act, due to the removal of breeding mounds within the Project Area;
- Potential presence of the Hamelin Skink within the Project Area;
- Impacts to Priority Flora, as nine Priority Flora species have been recorded in the Project Area; and
- Potential dust deposition on the vegetation within the SBWHP.

5.3.4 Proponent's Response to Issues

Gunson has a sound understanding of the government and community issues relevant to the Project due to the comprehensive and ongoing stakeholder consultation process that has been implemented throughout the environmental approval process. The consultation has provided the opportunity for the issues to be addressed in the design and management of the Project. The main actions that were undertaken as a result of the consultation are listed below:

- A benchmarking field study was undertaken to determine what factors contributed to successful rehabilitation. The benchmarking exercise also provided evidence that sites in similar environments nearby and overseas are being rehabilitated successfully.

- In response to an issue about the potential impacts to the Hamelin Skink raised by the EPASU, a targeted survey was undertaken by Ninox Wildlife Consulting in September 2004.

- The need to undertake a frog survey was considered based on a concern raised by the EPASU. There were four frog species that were known to occur in the general area. Given the unpredictable climate of the area and the relative abundance of potential frog species within their known distribution, it was decided that specific field work to detect the presence of frogs was not warranted. Further, no amphibians were captured, seen or heard during the fauna surveys undertaken in September 2003 and April 2004, even though extensive trapping was conducted in a variety of habitats.

- In response to a concern raised about potential impacts on Malleefowl, a detailed Malleefowl Management Plan was developed. This includes baiting of foxes and monitoring Malleefowl populations to mitigate the loss of nine breeding mounds in the Project Area. Gunson will avoid disturbing mounds, where practicable.

- In response to the concerns about groundwater drawdown, raised by government agencies and the pastoral lease holders, a detailed groundwater study was undertaken. The findings of the study indicate that there will be drawdown impacts on about 60 private bores. Apart from the Spinifex Bore (on Hamelin

Station), none of the existing artesian bores are likely to stop flowing. The study also confirmed that there would not be any impacts to conservation values associated with the Hamelin Pool as a result of groundwater drawdown.

- In response to the concerns about disturbance to Aboriginal heritage sites, Aboriginal heritage surveys have, and continue to be, conducted. Once a site is identified, it is managed in accordance with the Aboriginal Heritage Act.

A summary of the issues raised and the response developed by the Proponent in relation to these issues are provided in Table 5.1. The table also indicates where in this PER the reader can find additional information on the issues.

Gunson's response to the issues raised by the stakeholders is being communicated through the distribution of the PER and follow-up briefings with key stakeholder groups (see Section 5.4).

Table 5.1

Summary of Environmental Issues Raised by Stakeholders

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Sustainability	Difficult to see how environmental sustainability could possibly be achieved.	Gunson has adopted the guiding principles of the ICMM for sustainable development. Gunson has also developed a Sustainability Policy (Appendix M) which it will implement for the Project. This Policy considers environmental and biodiversity aspects. The key to achieving sustainability is to ensure that the Project does not result in the loss of any biodiversity or values of the SBWHP. To mitigate the effects of clearing and rehabilitation of the mine area, the Proponent has bought the Coburn pastoral lease and will de-stock it for several years to allow vegetation to recover and then re-stock it at a rate well below carrying capacity. In addition, the Proponent will undertake introduced predator culling on the property to control populations of dingoes, cats and foxes. These actions will more than adequately mitigate the loss of habitat in the mining area and should result in a long-term increase in regional biodiversity values. In addition, Gunson is developing an EMS, which incorporates sustainability principles.	Section 7.1 Appendix M
Conservation Estate and Values	What guarantees are there that the mining operation will not impact on the SBWHP?	A preliminary environmental risk assessment was conducted to identify the key issues which are related to the abstraction of groundwater (Appendix D), tailings seepage, vegetation clearing and rehabilitation (Appendix F). With respect to rehabilitation and movement of exposed soil from the proposed mine into the SBWHP, a survey was undertaken by D.C. Blandford & Associates in December 2004. (Appendix C). This survey was undertaken to address a concern about the differences in system stability between the mining lease area and the 'undisturbed' SBWHP. The survey was designed to observe pre-existing conditions of both sites, relative to each other and to set a benchmark of environmental condition, for future comparison. With respect to groundwater abstraction, dewatering and tailings seepage, the Proponent commissioned URS to undertake groundwater investigations and modelling of potential impacts to determine location of areas at risk from groundwater drawdown and mounding of brackish tailings water (Appendix D).	Appendix D Appendix F Appendix C

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Conservation Estate and Values	It is noted that the surface sands in this area demonstrate a degree of instability due to wind erosion. This may have implications for revegetation and off-site dust impacts on the SBWHP.	A survey was undertaken by D.C. Blandford & Associates in December 2004 to observe pre-existing soil conditions of the SBWHP and the Project Area (Appendix C) (see above). A rehabilitation benchmarking study was also conducted to investigate rehabilitation works in semi-arid environments (Appendix E). It was determined that it is likely that the Project Area could be rehabilitated to a level of ecological function similar to but not as high as the level prior to disturbance. It is expected that the recovery period will be lengthy. An air quality assessment has been undertaken to assess the dust emissions from the Project (Appendix N). There is potential for dust to be generated locally from large open areas associated with the mining activities. However, the wind direction is predominantly from the south and windborne dust will be directed in a northerly to north-easterly direction, away from the SBWHP. Therefore, there will be minimal risk to vegetation within the SBWHP from airborne particulates. Dust will be managed through the implementation of the Dust Management Plan (Appendix O).	Section 7.3 Appendix C Appendix E Appendix N Appendix O
	The Cretaceous deposits of the Winning Group within the Project Area dip towards the west and north. These deposits are adjacent to and dip towards very significant parts of the SBWHP.	The Late Cretaceous Toolonga Calcilutite occurs at the base of the superficial formations and the thickness of this unit increases to the northwest from the Project Area. In areas where the superficial formations are dry, the water table occurs within the Toolonga Calcilutite. In these areas, groundwater flow in the superficial formations is controlled in part by the dip direction of the Toolonga Calcilutite beds. Where the superficial formations form the water table aquifer, groundwater flow is controlled by topography, the Toolonga Calcilutite contact and other factors. This concern has been noted by the Proponent and addressed in the groundwater resources impact assessment (Appendix D).	Appendix D
	Consider fencing the boundary between the Project Area and the SBWHP.	Prior to the commencement of construction activities, discussions will be held with CALM in relation to the need for fencing between the Project Area and the SBWHP.	-
	Investigate hydrogeological links of the Project Area to SBWHP and Hamelin Pool.	The nearest groundwater dependent ecosystem is likely to be the salina and estuarine ecology associated with the Nilemah Embayment and Hamelin Pool. Both are groundwater discharge areas. The stromatolites along the shoreline of Hamelin Pool, near the old Hamelin Telegraph Station, are located in groundwater discharge zones about 12 km from the northern project area. The groundwater discharge is from a different catchment than the project area and Nilemah Embayment. There are no predicted impacts on the Hamelin Pool ecosystem due to occurrence of residual tailings waters in the superficial formations and water table environment.	Appendix D

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Conservation Estate and Values	Consider impacts to Hamelin Pool.	The groundwater study (Appendix D) has shown that there is no hydraulic connection between the aquifers of the Project Area and Hamelin Pool. Therefore, there is a very low likelihood that any groundwater drawdown will affect the algal mats or stromatolites at Hamelin Pool. The modelling undertaken as part of the air quality assessment (Appendix N) indicated that up to 1.2 g/m^2/month will be deposited at the southern end of Hamelin Pool. The Proponent will implement measures to minimise fugitive dust sources and will undertake ongoing monitoring of deposited dust levels at the boundary of the Project Area and at Hamelin Pool.	Section 7.5 Section 8.1 Appendix D Appendix N
	Consider quantifying nature conservation values and pastoral values.	The Project Area is largely located in the Nanga land system. This system is known to have low pastoral value (Payne et al. 1987). The other land systems in the northern section of the Project Area are Nerren, Sandplain, Snakewood and Toolonga. These land systems have low to moderate pastoral value. The conservation values of the flora and vegetation within the Project Area were considered by Mattiske Consulting Pty Ltd (Appendix J). Of the 18 plant communities recorded in the surveys, 14 were considered to be significant as their distribution is unknown within the broader geographic region and some communities contain a number of Priority Flora.	Appendix J
	Consider the opportunity to enhance conservation areas to offset any loss of values from the Project.	Gunson has considered opportunities to enhance conservation areas, if any losses occur and can be attributed to the Project. To this end, Gunson has purchased the Coburn pastoral lease and intend to de-stock it for several years to allow recovery of vegetation before re-stocking it at a level below carrying capacity. This action will more than adequately mitigate the loss of values from the Project Area and should result in an increase in regional biodiversity and conservation values.	Section 7.6.2
Flora and Vegetation	What will happen to the vegetation type identified by Mattiske Consulting as S5?	Gunson recognises that plant community S5 is locally significant and has made the commitment that it will not disturb that area. In addition, it will leave an undisturbed buffer of at least 50 m width around the vegetation community to protect it from edge effects.	Section 7.6.2 Section 11 Appendix J
	There is concern about the proposed clearing of a large area of regionally significant vegetation. How could it be possible to manage the impacts of clearing 2,000 ha of vegetation?	Clearing will be limited to that necessary for the Project. In addition, the actual pit face will be narrow and will advance from south to north in pockets of the Amy Zone at about 1-2 km per annum. Progressive rehabilitation will be undertaken immediately and this will ensure that the operation has a small, manageable, moving footprint. As stated earlier, Gunson proposes to mitigate the disturbance of the vegetation in the Project Area by de-stocking the Coburn pastoral lease and managing it to enhance regional conservation values.	Section 2.2.3 Section 7.6.2
	Consider clearing issues associated with access roads.	Approximately 94 ha will be cleared for the mine access road. Clearing will be limited to that necessary for the access roads. This has also been considered in the Vegetation and Flora Management Plan (Appendix O).	Appendix O

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Flora and Vegetation	Undertake botanical surveys to identify any Declared Rare, Threatened or Priority Flora in the Project Area.	Comprehensive flora and vegetation surveys of the Project Area were undertaken by Mattiske Consulting Pty Ltd in August 2003, and April, September and November 2004. No DRF was recorded during either of the surveys. Nine Priority Flora species were recorded, which comprised three Priority 2 species, five Priority 3 species and one Priority 4 species.	Section 4.2.7 Section 4.2.8 Appendix J
	Undertake comparison of flora and vegetation in Project Areas with SBWHP.	A comparison has been undertaken by Mattiske Consulting Pty Ltd. In a regional context, a study by Gibson et al. (2000), as cited in Mattiske Consulting Pty Ltd (2005), recorded a similar composition of species, except for three priority species recorded in the Project Area.	Appendix J
	Consider impact of introduced species (weeds).	The flora and vegetation surveys that were conducted by Mattiske Consulting Pty Ltd found 14 introduced (weed) species. These are currently restricted to small, disturbed sites. Gunson has developed a draft Weed Management Plan (Appendix O) which aims to manage site operations in a way that prevents the introduction and proliferation of weed species.	Section 4.2.8 Appendix O
Flora and Vegetation/ Fauna	There is a potential to impact on species that may be unknown in the area if comprehensive survey work is not undertaken. This applies to both flora and fauna.	Comprehensive flora and vegetation surveys were undertaken by Mattiske Consulting Pty Ltd in August 2003, and April, September and November 2004. Fauna surveys were conducted by Ninox Wildlife Consulting Pty Ltd in September 2003, and April and October 2004. The surveys have been undertaken over two consecutive years. It is believed that sufficient information on species presence has been collected. Full species lists are available within the appended survey documents.	Section 4.2.7 Appendix J Appendix K
	Mining will impact a large area over a long period of time. Surely there is significant potential to impact native flora and fauna?	Whilst the mining operations will occur for 20 years, the actual pits will generally be narrow and will advance from south to north at about 1-1.5 km per annum. This relatively slow time-frame allows pre-stripping and topsoil removal to advance just in front of the mining face, direct return of cleared topsoil and vegetation, and progressive rehabilitation. This is a continual process and the operation has a small and slow moving footprint. It is predicted that most birds, larger mammals and reptiles will be able to avoid the impact of clearing. Small mammals, small reptiles and burrowing frogs, if present in the mining area, may be killed by large machinery. However, the clearing will have very little impact on the species populations. No loss of species is likely as a result of the project.	Section 2.1 Section 2.2 Section 2.3 Section 7.8 Appendix K
Vertebrate Fauna	What habitat type is the Hamelin Skink known to occur in and will that habitat type be affected by the mining operations?	The Hamelin Skink is only known to occur on Hamelin and Coburn pastoral leases where it appears to favour eucalypt woodlands with spinifex ground cover on red sands. The specimens lodged with the WA Museum were from a location some 12 km east of the Project Area. These locations were visited and habitats inspected. As a result, only one community in the Project Area (E5) is considered to be similar, and it will not be significantly affected by mining operations. No skinks were found in this habitat when surveyed.	Section 4.2.9 Section 7.8.2 Appendix K

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Vertebrate Fauna	What are the impacts to Shark Bay Sandhill Frog *Arenophryne rotunda*	The diversity of the frog fauna in the Project Area is considered to be low due to the unreliable nature of the rainfall and lack of surface water. The Sandhill Frog is locally abundant within its restricted range from Kalbarri to Shark Bay, including Dirk Hartog Island (Roberts 1990). Ninox Wildlife Consulting has advised that the Sandhill Frog could occur on suitable habitat in the extreme south-western section of the proposed mining area. (Appendix K). If this species is present, the likely impact will be the removal of its habitat.	Section 7.8.2 Appendix K
	Consider impacts to Shark Bay Burrowing Frog, if present.	As the scientific name for this species has not been provided it is assumed that the 'Shark Bay Burrowing Frog' is the same as the Shark Bay Sandhill Frog. As stated above, the diversity of the frog fauna in the Project Area is considered to be low. Also, no amphibians were captured, seen or heard during the fauna surveys undertaken in September 2003 and April 2004, even though extensive trapping was conducted in a variety of habitats (Appendix K).	Section 7.8.2 Appendix K
	Consider impact to Malleefowl.	The main impacts to Malleefowl relate to the removal of habitat and the loss of existing breeding mounds. A Vertebrate Fauna Management Plan (Appendix O) has been developed to address these impacts, and includes baiting of foxes and monitoring Malleefowl populations to mitigate the loss of breeding mounds in the Project Area.	Appendix O
	Undertake fauna studies to identify endemic species and community representation.	Three fauna surveys have been undertaken by Ninox Wildlife Consulting. These surveys were undertaken in September 2003 and April and October 2004. A targeted survey to search for the Hamelin skink was undertaken in September 2004. Of the species recorded in the Project Area during the fauna surveys, none were endemic to the Shark Bay area.	Appendix K
	Fauna translocation is undesirable. The rate of clearing should be comparable to habitat revegetation to allow fauna to recolonise.	Gunson will aim to maximise fauna habitat reconstruction to allow fauna to recolonise. This is one of the key aims of the Rehabilitation Plan (Appendix F). Gunson propose to de-stock the Coburn pastoral lease and control introduced predators in mitigation for translocation of fauna.	Appendix F
	Undertake comparison of fauna in Project Area with SBWHP.	As the SBWHP is adjacent to the Project Area, most of the species found within the Project Area should also occur in similar habitats within the adjacent SBWHP (Ninox Wildlife Consulting, pers. comm.).	Appendix K

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Vertebrate Fauna	Consider regional context of habitats.	Ninox Wildlife Consulting (2005) indicates that there are no individual habitats of regional significance within the Project Area. However, it was found that the eucalypt woodlands (communities E1 – E7) in the northern section of the Project Area contained nesting hollows for fauna. As tree hollows are scarce in the sandplains and *Acacia* shrublands of the region, there is strong competition for hollows. Therefore, disturbance of the eucalypt woodlands in the northern section of the Project Area would reduce the number of hollows available for fauna use within the region. Other habitats of significance were shrubland community S3, located in the southern sector of the Project Area. It was observed that this habitat supported a higher diversity and abundance of reptiles and birds.	Appendix K
	Undertake studies on critical habitat for fauna.	It was identified by Ninox Wildlife Consulting (2005) that plant community S3 supported a higher diversity and abundance of reptiles and birds. Information about this community was collected in an extensive vegetation and flora study undertaken by Mattiske Consulting Pty Ltd. The shrubland community S3 is considered to be locally significant due to the presence of Priority Flora species and because it has a mature, open structure. The eucalypt woodlands in the northern section of the Project Area, which contain some nesting hollows, have also been mapped and described by Mattiske Consulting Pty Ltd (2005). The habitat and potential presence of the Hamelin Skink was identified by Ninox Wildlife Consulting during a survey undertaken in September 2004. The results of this survey indicated that the habitat of this skink does not occur within the Amy Zone. However, a plant community (E5) along the access road is likely to provide suitable habitat for the Hamelin skink.	Appendix J Appendix K
	Consider impacts of introduced species (pests).	Six species of introduced mammals were recorded during the fauna surveys (Appendix K). These were rabbits, camels and goats, which were not very common, and dogs/dingos, foxes and cats. Evidence of the presence of dogs/dingos, foxes and cats were noted more regularly. The introduced herbivores can pose a threat to the rehabilitation and this issue has been addressed in the Rehabilitation Plan (Appendix F). The impact of introduced predators (fox, dog/dingo and cat) threatens Malleefowl numbers. Therefore, the Vertebrate Fauna Management Plan (Appendix O) includes measures to eradicate the introduced predators.	Appendix F Appendix K Appendix O
Subterranean Fauna	The potential impacts on stygofauna within and outside the SBWHP are unknown. Consider potential for stygofauna in Project Area.	A stygofauna survey was conducted in October 2004 by the University of Western Australia (Appendix L). The study did not record any stygofauna within the Amy Zone. The potential for stygofauna to be disturbed by the Project is very low given that most of the ore body is above the groundwater level.	Section 4.2.10 Section 7.9 Appendix L

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Soil and Landforms	Consider potential for acid sulphate soils.	It is unlikely that acid sulphate soils are present within the Project Area. Based on the results of the soil survey conducted by D.C. Blandford & Associates, the soils within the Project Area are typically calcareous and sandy. These soil types do not tend to contain sulphate. Also, the pH of the soils at a depth of 0.1-1.2 m ranged between 7.5-9.5, which is slightly to strongly alkaline.	Appendix C
	Undertake soil studies (soil profile composition) for rehabilitation.	A survey was undertaken by D.C. Blandford & Associates in December 2004 (Appendix C). This survey was designed to define the baseline landscape and soil conditions. This provides a benchmark of landscape condition for future comparison. Four soil profile forms were identified during the survey, with the majority of the profiles being described as sandy throughout their depth (Appendix C).	Appendix C
Rehabilitation	There is concern about the complexity of restoring soil profiles and uncertainty of re-establishing vegetation in this area.	A Rehabilitation Benchmarking Study has been undertaken (Appendix E) to determine the feasibility of revegetation of this area. This study confirmed that examples of successful revegetation do exist in the region and provide confidence that rehabilitation is possible. A Rehabilitation Plan (Appendix F) has been developed and contains rehabilitation specifications to ensure that a stable landform is returned following mining to allow the site to be revegetated.	Appendix E Appendix F
	Consider landform design and re-shape to ensure congruity with the surrounding environment.	A field inspection of the SBWHP was undertaken by D.C Blandford & Associates in December 2004 to determine the stability of the landforms within the SBWHP and the Project Area (Appendix C). This information provides a basis for the rehabilitation specification for landform design, which has been included in the Rehabilitation Plan (Appendix F). It is anticipated that rehabilitated landforms will integrate with the surrounding environment.	Appendix C Appendix F
	Consider how rehabilitation will be affected by wind erosion.	The report prepared by D.C. Blandford & Associates (Appendix C) highlights the need to consider a surface treatment during early stages of vegetation establishment. It was suggested that these treatments might include cover crops, surface mulching, windrowing vegetation and artificial meshes. These options have been included in the Rehabilitation Plan (Appendix F).	Appendix C Appendix F
	Consider fencing the site after rehabilitation to prevent grazing.	A Rehabilitation Plan has been developed and contains rehabilitation specifications, including details about fencing requirements for rehabilitated areas.	Appendix F
Surface Water	Consider water diversion requirements.	As there are no surface water features within the Project Area, there will not be any requirements for water diversion.	Section 7.4
Groundwater	What quantity of groundwater will be required for the project?	Process water will be sourced from groundwater. It is anticipated that initially around 5.9 gigalitres per year of water will be required for mining operations. At full production, the lower-bound and upper-bound process water demands range from about 10 to 18 gigalitres per year Potable water for the camp and mine office will be processed through a reverse osmosis system. These supply needs are comparatively insignificant.	Section 2.5

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Groundwater	Water requirements for the Project are a critical issue and there are concerns that there are insufficient water resources available to support the project.	A detailed assessment of groundwater resources and tailings water management has been undertaken by URS (Appendix D). This assessment identifies the Birdrong Sandstone and Kopke Sandstone as regional confined aquifer systems that are able to meet the water supply needs of the Project. The impacts of abstractions of 10 to 18 gigalitres per annum have been assessed using representative regional groundwater flow models of the Gascoyne Platform and associated aquifer systems. The detailed assessment confirms that there will be sufficient groundwater resources to meet the process water demands of the Project. These assessments also include monitoring and management strategies to protect the rights of other local groundwater users. Based on work by Wills and Dogramaci (2000) and Hiller et al., (2002), recharge to the Windalia Radiolarite and Birdrong Sandstone aquifer systems in areas between Shark Bay and Carnarvon is in the order of 0.5% of annual average rainfall and 4.5 gigalitres per annum. These estimates are semi-quantitative. Notwithstanding, the forecasts of annual process water demands exceed the estimates of annual recharge. As such, the proposed process water supply abstractions would involve the removal of groundwater from storage and partial dewatering of the regional aquifer systems. The developed groundwater flow models indicate that if 18 gigalitres per annum is removed from storage for a period of 21 years, this would represent only 0.02% of the available groundwater in storage in the models. The models do not represent the entire extent of the aquifer systems. It should also be recognised that the long-term sustained abstraction from uncontrolled bores in these aquifer systems supports the assessments of groundwater availability. It is understood that abstraction from the uncontrolled bores was estimated at 9 gigalitres per annum, also substantially above the rates of estimated recharge. Therefore, substantial water resources are available to support the Project.	Appendix D
	There is concern about the requirement for large quantities of groundwater, and potential drawdown effects. What will the impact be on the water supply of the surrounding pastoralists?	The detailed groundwater resources assessments of the regional confined aquifer systems include comprehensive desktop and field investigations, including a census of private bores and predictive simulations of drawdown impacts. The census enables the current condition and use of the existing bores to be quantified, essentially providing a benchmark. A representative regional groundwater flow model of the confined aquifer systems has been applied to predict the drawdown impacts on the private bores. The findings of both of these aspects have been combined to develop appropriate management plans that mitigate the occurrence of adverse impacts. There will be drawdown impacts. Apart from Spinifex Bore on Hamelin Station, none of the existing artesian bores are likely to stop flowing. However, the pressures of artesian bores within 65 km of the Project are likely to be reduced during the period of mining.	Section 7.5 Appendix D

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Groundwater	Investigate water usage and aquifer regeneration.	A detailed assessment of groundwater resources and tailings water management has been undertaken by URS (Appendix D). These assessments frame the current understanding of the local aquifer systems in context with mining plans, tailings processes and process water supply abstractions. Groundwater flow models have been developed that enable the sand tailings processes to be explored to investigate opportunities whereby process water can be recovered and re-used. It is understood that typical mineral sands operations use process water at rates of 1 kL per 2 tonnes of ore. The completed simulations indicate that the sand tailings operations might be engineered such that consumptive process water demands are at rates potentially as low as 0.6 kL per 2 tonnes of ore. The detailed groundwater resources assessments of the superficial formations include the impacts of pit dewatering and mounding of the water table due to disposal of sand tailings. The superficial formations would be artificially recharged by the proposed mining developments. The detailed groundwater resources assessments of the regional confined aquifer systems include predictive simulations of the rates of aquifer recovery after 21 years of abstraction to meet process water supply demands. The simulations indicate the Windalia Radiolarite, Windalia Sand Member, Birdrong Sandstone and Kopke Sandstone would recover within six years to groundwater levels comparable with the present day.	Appendix D
	Consider likelihood of intersection with water table.	The Amy Zone is mostly a dry deposit (i.e. above the water table), but is partly saturated below a thin superficial water table aquifer in localised areas in the northern sections. It is not anticipated that active dewatering will be required due to the expected low yield when mined.	Appendix D
	Consider disposal options of pit water.	As mentioned above, it is unlikely that there will be a requirement for active pit dewatering as the Amy Zone only intersects a thin superficial aquifer in the northern end. Dewatering abstractions are estimated to be less than 500 kL/day, sustained for a period of about 1 year. All pit water will be used in the processing plant.	Appendix D

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Dust/ Particulates	Consider impacts from dust on vegetation and marine values.	It is anticipated that dust will be generated during clearing activities and from vehicular movement. However, the vast majority of the material to be mined is medium to coarse sand with a very low content of clay and silt fines. Modelling indicates that whilst there is potential for dust to be generated, most will occur locally and not over extensive areas. Nonetheless, dust management will be required. During clearing activities, dust levels will be visually monitored to ensure that the dust does not leave the Project Area. Should the dust levels become excessive during construction, dust suppression measures (e.g. water spraying) will be implemented or mining activities will stop until wind conditions improve. Clearing of new mining areas will be restricted to the wetter periods of the year where possible, and will not be undertaken when strong winds are blowing in the direction of the SBWHP. Brackish water will be used for dust suppression during operations. If necessary, a hydrocarbon emulsion will be sprayed on cleared surfaces to stabilise loose sands. Dust management measures are available and will need to be applied to ensure that there will not be any decline in vegetation health due to dust deposition. The modelling undertaken as part of the air quality assessment (Appendix N) indicated that up to 1.2 g/m^2/month will be deposited at the southern end of Hamelin Pool. The Proponent will implement measures to minimise fugitive dust sources and will undertake ongoing monitoring of deposited dust levels at the boundary of the Project Area and at Hamelin Pool.	Section 8.1 Appendix N
	Consider impacts on vegetation, soils and rehabilitation from use of brackish water for dust suppression.	The source of water for dust suppression is likely to be from the Kopke and Birdrong aquifers. The TDS of the water is approximately 8,900 mg/L. Vegetation may be affected by the use of brackish water for dust suppression if overspray or runoff occurs. To manage the storm water runoff, all storm water from the plant site will be intercepted by a drainage system, channelled into a sediment retention basin and allowed to evaporate.	Section 7.5 Appendix D
Liquid and Solid Waste	Consider waste disposal requirements.	Overburden, oversize and tailings material will be disposed into the mine void. All waste oils will be collected by the earthmoving contractor and recycled to an approved facility. The camp and offices will be established with suitable processing systems to dispose of domestic liquid waste such as sewage and grey water. Domestic waste such as general refuse, paper and putrescibles will be collected and disposed into an on-site landfill. Where possible, recyclable wastes such as glass, cans and plastics will be collected separately and transported off-site to a recycling facility.	Section 2.9 Section 8.5

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Radiation	Consider potential for radiation hazard in tailings.	Radiation Advice & Solutions Pty Ltd undertook a Baseline Radiation Monitoring Programme in July 2004 (Appendix I) using soil samples obtained by Gunson and gamma doserate readings from some 35 sites, primarily concentrating in the southern part of Amy Zone. The results found very low levels (less than two nanosieverts per hour) of above-ground radiation. Even locations which had been identified as containing higher grades of heavy minerals showed gamma radiation doserates that were essentially very low due to the very low monazite content (and hence uranium and thorium content) in the heavy mineral suite. There is therefore very low potential for radiation hazards in tailings.	Section 9.1 Appendix I
Road Transportation	Consider transportation from mine site to Geraldton.	The increase in vehicle traffic generated by transporting the concentrate from the mine site to Geraldton is considered minimal in relation to the volume of traffic already utilising the North West Coastal Highway. The net increase of trucks for the project travelling towards Geraldton is one additional truck approximately every one and a half hours.	Section 9.2
Aboriginal Culture and Heritage	Consider Native Title.	A Mining Agreement exists between Gunson and the Nanda Native Title Claimants and is being negotiated with the Malgana working group.	Section 9.4
	Consider Aboriginal Heritage.	Full consultation has occurred with all Aboriginal people with an interest in the area. Further Aboriginal heritage surveys are scheduled for mid-2005.	Section 9.4
Stakeholder Consultation	Undertake up-front, transparent and broad stakeholder communication.	Gunson initiated a stakeholder consultation programme in early 2003 to coincide with the commencement of the environmental approval process. Consultation has been conducted with Commonwealth, State and local government agencies, NGOs and the pastoral leaseholders. Consultation has included a series of presentations and information sessions, pamphlets, update letters and site visits for relevant stakeholders. In addition, a series of meetings on soils, landforms and rehabilitation issues was undertaken during 2004 with stakeholders from CALM, DoE, EPASU and the DoIR.	Section 5
Other	Where will the mining operation source its power supplies? Will a power station be constructed in the area?	Power generation will be sourced from containerised generators that are adjacent to and moving with the concentrator(s). The generators will be run using natural gas which has significant environmental and operational benefits in comparison to diesel fuel.	Section 2.6
	Consider source of workforce to maximise use of local workforce.	During construction there will be up to 100 personnel. Once operations commence, the workforce will total about 80 personnel, increasing to some 105 personnel once full production is attained. It is expected that the mine site workforce will be sourced primarily from Denham, Geraldton and Carnarvon.	Section 2.11

Table 5.1 (cont.'d)

Element of Environment	Issue Raised	Proponent's Response	Reference in PER
Other	Consider environmental offsets.	Gunson considered environmental offsets in light of the release of the Preliminary Environmental Offsets Position Statement No. 9 (EPA 2004a). Environmental offsets are aimed to ensure that significant and unavoidable adverse impacts are compensated by a positive environmental gain. Following the completion of the impact assessment and the development of mitigation measures, it was considered that the mitigation measures would counterbalance the impacts and offsets would not be required. The primary mitigation measures are: • The development and implementation of a Rehabilitation Plan (Appendix F) ensure that the reconstructed landforms are stable. • Progressive rehabilitation, including the implementation of rehabilitation trials to mitigate the clearing of approximately 5,745 ha. • The development and implementation of a Vertebrate Fauna Management Plan (Appendix O), including the baiting of foxes, cats and dingos and monitoring Malleefowl populations inside and outside of the Project Area, to mitigate the loss of breeding mounds in the Project Area. • The purchase and de-stocking of the Coburn pastoral lease for several years to allow vegetation recovery and subsequently re-stocking of the lease to levels below estimated carrying capacity of the land.	Section 7.6 Section 11 Appendix F Appendix O

5.4 CONSULTATION DURING PUBLIC REVIEW PERIOD

This PER is subject to an eight-week public review period. During this time, the Proposal will undergo further scrutiny by regulators and the community.

Gunson will maintain its existing comprehensive stakeholder consultation by continuing its consultation programme during the public review period. The programme will include the following actions:

- Information sessions and follow-up consultation with those who were consulted during the preparation of the PER.
- Placing the PER on the Gunson website (www.gunson.com.au).
- Media releases to provide information on the PER and its availability for review.
- Provision of information to the Shire of Shark Bay for discussion during its Council meeting(s).
- Undertake a follow-up briefing for the SBWHP SAC and CCC.

5.5 CONSULTATION FOLLOWING PROPOSAL IMPLEMENTATION

In the event that the Project receives environmental approval and is implemented, Gunson intends to continue the consultation process throughout the construction, operation and decommissioning phases in accordance with their Sustainability Policy (Figure 1.3).

The environmental issues that may arise from the Project, and the studies required to adequately address these issues, were identified through the following process:

- A preliminary environmental risk assessment was undertaken in 2003 during the early stages of the Bankable Feasibility Study. The aim of the assessment was to identify any potential environmental "fatal flaws" or significant environmental risks that would require attention during the course of the Project. This initial phase of work was also utilised to gauge the sensitivity of the proposed Project due to its proximity to the SBWHP.
- A review of available information was undertaken in 2004 to identify the key environmental issues associated with the development of the Project. An updated environmental risk assessment was undertaken in 2005.
- Consultation was conducted with the Commonwealth, State and local government agencies (including DEH, EPA, EPASU, DoE, CALM, DoIR, DIA, Department of Agriculture and Shire of Shark Bay). The pastoral leaseholders and NGOs were also consulted during the period of June 2003 to December 2004 (refer to Section 5).
- Preparation of the Environmental Scoping Document. This document was submitted to EPA in October 2004 to confirm the scope of works for the preparation of this PER. The guidelines were subsequently finalised by the EPA in December 2004.

Subsequent to the identification of environmental issues, information on the potential environmental effects of the Project was updated through:

- A review of the project design in light of the outcomes of consultation and the risk assessments.
- Additional desktop and field investigations, particularly in relation to rehabilitation, flora, fauna and groundwater.

The way in which Gunson has addressed the Scope of Works is summarised in Table 6.1, which is structured as follows:

- Column 1 identifies the element of the environment.
- Column 2 lists the environmental factors identified in the Environmental Scoping Document and the Scope of Works.
- Column 3 identifies the work that Gunson and the EPA consider would be required for the environmental assessment.
- Column 4 outlines the investigations and other studies conducted by Gunson to address the EPA's objectives and work requirements, the key outcomes of this work, and the predicted environmental impacts that would occur as a result of proposal implementation.
- Column 5 provides an overview of the measures proposed to mitigate or manage the predicted environmental impacts.
- Column 6 describes the outcome that is predicted to occur if the mitigation and management measures are successfully implemented.

In essence, Table 6.1 provides a summary of the impact assessment study and management action requirements to mitigate identified impacts. Further detail is provided in Sections 7 to 12.

Table 6.1
Identification of Environmental Factors

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
INTEGRATION					
Sustainability	Natural and Social Environment	Ensure, as far as practicable, that the proposal meets or is consistent with the sustainability principles in the *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee 1992). Scope of Work • Investigate opportunities to incorporate key sustainability principles into the Project.	Gunson recognises that sustainability is becoming an increasingly important issue, with regards to resources and resource management. Therefore, implementation strategies for sustainable development have been included in the Project design.	Gunson has adopted the International Council on Mining and Metals (ICMM) Guiding Principles to guide it in developing and maintaining sustainability within the Gunson Project. Gunson will implement strategies for sustainable development for the Project. These include: • Undertaking research programmes associated with the mining operations on an as needs basis to address information gaps as they arise during the life of the Project. • Providing scientific and technical advice (where required) to assist in the future development of standards and controls. • Developing and implementing an EMS consistent with ISO14001. • Progressively rehabilitating disturbed areas. • Improving site rehabilitation techniques as more advanced information becomes available. • The use of natural gas as the energy source for major machinery on site.	In implementing this Project, Gunson will contribute to sustainable development by funding scientific research and providing scientific advice on rehabilitation of mineral sand mines in environments where re-mobilisation of sands is a natural process. This will contribute to the knowledge of refining rehabilitation techniques for similar environments. The use of natural gas as the primary source of fuel is also more sustainable than the use of more conventional fuel sources, such as diesel. Sustainable practices will be implemented in many facets of the Project and funding of work on the SBWHP will be provided. Biodiversity on the Coburn pastoral lease will be improved through destocking for several years and reduction of predators through predator control programmes.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Conservation Estate and Values	Project Area and surrounds, including the SBWHP and Zuytdorp Nature Reserve.	The primary objective is to protect the environmental values of areas identified within the Project Area and surrounds, including the SBWHP and Zuytdorp Nature Reserve, as having significant environmental attributes of conservation significance. If this cannot be achieved within the Project Area, ensure that these conservation values of the Project Area in areas that will be cleared or disturbed are adequately represented in SBWHP, Zuytdorp Nature Reserve or elsewhere. <u>Scope of Work</u> • Undertake baseline flora, fauna and stygofauna surveys to define environmental values and their conservation significance within the Project Area and compare the conservation significance of the SBWHP and/or other protected areas based on available information. • Assess potential impacts (direct and indirect, including from weeds and changes to hydrology) on conservation values as a result of the proposed activities.	The Project is located adjacent to the SBWHP, which includes the Zuytdorp Nature Reserve. Although Gunson holds several exploration licence applications within the SBWHP, this proposal does not include development within the SBWHP. Atmospheric modelling has indicated that there is a low potential for dust to affect the vegetation in the SBWHP, as the winds are predominantly from the south and windborne dust is predicted to be away from the SBWHP. The modelling has also shown that there is the potential for dust deposition at Hamelin Pool when mining commences on the northern end of the Project Area. Deposited dust levels were predicted to be below NSW EPA impact assessment criterion at the closest extremities of Hamelin Pool. Indirect impacts to the SBWHP may occur due to wildfire, weed infestation and modification of local hydrology. Groundwater mounding may occur where the thickness of the superficial formations is less than 10 m. These areas are west and north of the proposed pits in the SBWHP and further east. If unmanaged, the groundwater mounding poses potential risks to overlying vegetation if the artificial water table reaches the root zone.	Dust management will be an integral component of site environmental performance, and will undertake a range of preventative measures to minimise fugitive dust sources as part of its daily operations. In addition, Gunson will undertake ongoing monitoring of deposited dust levels at the boundary of the Project Area and at Hamelin Pool. Other management measures to protect the conservation estate are: • Additional groundwater and ecological investigations to refine the understanding of the local groundwater and vegetation systems in the northern end of the Project Area and surrounds, prior to development of Pit 10. • Reviewing the mine plan for the northern pit to reduce the volume of tailings water in residual mounds. • Groundwater monitoring and recovery of water in mounds beneath the SBWHP to the west of the Project. • Preparation of a detailed emergency response plan, including the procedures to be followed in the event of a fire. • Installation of a plant and equipment washdown area at the entrance to the mine site. • Rapid identification and eradication of weeds.	It is considered that the Project will present minimal risk to the values of the SBWHP because groundwater mounding beneath the property to the west of the mine can be monitored and managed via recovery bores, and the northernmost pit (Pit 10) will not be mined unless Gunson demonstrates that the potential impacts on the SBWHP can be managed in a manner acceptable to the Minister for the Environment. It is predicted that groundwater mounding will occur in superficial formations due to the deposition of tailings. This water may reach the root zones of vegetation stands in the SBWHP. Monitoring water table depths and subsequent abstraction of groundwater via recovery bores will mitigate the potential risks to vegetation in the SBWHP. It is considered that the risk of wildfire as a result of this Project is low because high housekeeping standards will be maintained for storage areas. The Project will not result in an increased spread of weeds within the SBWHP, due to the implementation of the weed management plan.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Biodiversity	Biota of Project Area and surrounds	Avoid adverse impacts on biological diversity, comprising the different plants and animals and the ecosystems they form, at the levels of species diversity and ecosystem diversity. <u>Scope of Work</u> • Undertake baseline flora and fauna surveys to assess potential impacts (direct and indirect) of mining operations on biodiversity. • Assess potential impacts (direct and indirect, including from weeds and changes to hydrology) on biodiversity as a result of the proposed activities.	Comprehensive flora and vegetation surveys were undertaken by Mattiske Consulting Pty Ltd in August 2003, and April, September and November 2004. No DRF were recorded in the Project Area, but there were nine Priority Flora species. Fourteen introduced (weed) species were recorded in the Project Area. Approximately 5,745 ha of vegetation will be cleared in stages, which is less than 25% of the vegetation within the Project Area. The clearing will include disturbance of locally significant plant communities, which contain Priority Flora species. Of the plant communities that are considered to be locally significant due to the presence of Priority Flora, five communities will either be left undisturbed or have less than 10% disturbance to the community within the Project Area. Predicted impacts to fauna are expected caused by loss of habitat due to the clearing activities identified above. However, due to the mobile nature of the fauna and their expected high regional distribution, the regional impacts on fauna diversity are expected to be minimal. The greatest impact is expected to be the clearing of 10 Malleefowl nesting sites and the forced relocation of individual animals due to the mining operations.	The management measures proposed for minimising the impact on biodiversity are: • De-stocking the Coburn pastoral lease for several years to allow vegetation to recover and then re-stocking it at a rate well below carrying capacity. • Undertaking introduced predator culling to control populations of dingoes, cats and foxes. • The protection of plant community S5, as this community has a high density of Priority Flora. • Prior to clearing, collecting seed from significant flora for use in rehabilitation. • Clearing will be limited to that which is necessary for operations. • Topsoil will be directly returned to sites ready for rehabilitation, to maximise seed viability. • Implement a monitoring and eradication programme for weeds within the Project Area and adjacent areas. • Implement tailings water recovery strategies to minimise groundwater mounding. • Implement programmes to monitor water table depths.	It is anticipated that there will be reduced local biodiversity values as a result of the project due to the clearing of 5,745 ha of vegetation. However, it is expected that there will be no loss of regional biodiversity values or species because most, if not all, vegetation communities and flora species will be retained within the plant communities that will not be completely disturbed or occur outside of the Project Area. In addition, regional protocols such as the proposed de-stocking will more that adequately mitigate the effects of the proposed mining operations. It is also considered that the management measures proposed to control the spread of weeds and minimise groundwater mounding will be adequate to ensure that regional biodiversity values are not adversely affected. The proposed mitigation and management measures are expected to mitigate the local loss of fauna by improving reproduction and survival of species outside the Project Area.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
BIOPHYSICAL ENVIRONMENT					
Flora and Vegetation	Plant Communities (including any Threatened Ecological Communities)	Maintain the abundance, species diversity, geographic distribution and productivity of plant communities through the avoidance or effective management of adverse impacts and improvement of knowledge. Achieve a short-term revegetation objective of soil stability and a long-term objective of a self-supporting vegetation community suitable to the land capability of the Project Area. <u>Scope of Work</u> Conduct baseline studies to: • Define and map vegetation associations within the survey area. • Review conservation significance of flora and vegetation in the area in a local and regional context. • Assess potential impacts (direct and indirect) on flora and vegetation from clearing and mining operations. Consultation with CALM on impacts to, and management of flora and vegetation. Propose measures to reduce impacts. Develop a Rehabilitation Plan.	Comprehensive flora and vegetation surveys were undertaken by Mattiske Consulting Pty Ltd in August 2003, and April, September and November 2004. Approximately 5,745 ha of vegetation will be cleared in stages. The clearing will include disturbance of locally significant plant communities, namely S5, S8, S9 and S10. Two of these communities will not be disturbed (S5 and S10) and only 9% and 5% of S8 and S9 respectively, will be cleared. Plant communities may be impacted by dust generated from mining. This is likely to occur along haul roads where there may be a short-term localised loss of vegetation condition. Groundwater mounding from tailings seepage could also affect vegetation to the north, west and east of the Project Area. A rehabilitation benchmarking study conducted to investigate rehabilitation works in semi-arid environments has concluded that it is likely that the Project Area can be rehabilitated to a level of ecological function similar to the level prior to disturbance, but this will take some time to occur. A Rehabilitation Plan has been developed to outline the scope of works that will be undertaken to design a successful rehabilitation programme for the mine site.	The management measures proposed for minimising the impact on flora and vegetation are: • The protection of plant community S5 by a 50 m buffer, as this community has a high density of Priority Flora. In addition, no disturbance is planned for plant communities E5, S6 and S10. • Prior to clearing, as much seed as possible from significant flora will be collected for use in rehabilitation activities. • Clearing will be limited to that which is necessary for operations. • Topsoil removed from cleared areas will be directly returned to sites ready for rehabilitation, to maximise seed viability. • Groundwater mounding will be monitored and abstracted where necessary by recovery bores to ensure no adverse impact occurs.	There will be no impact on plant community S5 or S10 as these will not be disturbed by the Project. Priority flora will also be retained in plant community S10, as this community will not be disturbed. Other communities which have been identified as having a high density of Priority Flora are S8 and S9. However, less than 9% and 5% of these communities, respectively, will be disturbed. It is expected that there will be no loss of species diversity as a result of the Project, because most of the flora species are widely distributed outside of the Project Area, with the exception of *Eremophila occidens* (ms). It is predicted that revegetation will be successful through the implementation of the Rehabilitation Plan and the use of improved rehabilitation techniques throughout the life of the Project. The rehabilitated areas will contain similar species to those present prior to clearing, as the topsoil will provide the seed source for the revegetation. Based on the results of the benchmarking exercise, ecological function will return to a similar level to that prior to disturbance after a lengthy recovery period.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Flora and Vegetation (continued)	Declared Rare Flora (DRF) and Priority Flora: Flora of conservation significance: Threatened species	Maintain abundance, species diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect Declared Rare and Priority Flora that occur in the Project Area, consistent with the provisions of the *Wildlife Conservation Act* 1950. Protect any flora listed in the Schedules of the *Environmental Protection and Biodiversity Conservation Act* 1999 that occur in the Project Area. Protect flora of other conservation significance (e.g. undescribed taxa, range extensions, outliers). <u>Scope of Work</u> Baseline studies to identify DRF, Priority Flora or other species of conservation significance. Provide an assessment of the local and regional significance of flora present in the Project Area. Assess potential impacts (direct or indirect) of the Project on DRF, Priority Flora or flora of conservation significance. Consult with CALM on impacts to, and management of, DRF, Priority Flora, and other flora of particular conservation significance. Propose measures to ensure the protection of DRF, Priority Flora and other flora species of conservation significance.	Comprehensive flora and vegetation surveys were undertaken by Mattiske Consulting Pty Ltd in August 2003 and April 2004. No DRF were recorded in the Project Area, but there were nine Priority Flora species. Fourteen introduced (weed) species were recorded in the Project Area. Approximately 5,745 ha of vegetation will be cleared in stages. The clearing of vegetation will include clearing of plant communities containing Priority Flora species, such as *Jacksonia drendrospinosa* (P4), *Acacia drepanophylla* (P3), *Grevillea rogersoniana* (P3), *Grevillea stenostachya* (P3), *Macarthuria intricata* (P3), *Physopsis chrysophylla* (P3), *Acacia subrigida* (P2), *Eremophila occidens* (P2) and *Scholtzia* sp. Folly Hill (P2). There is the potential for indirect impacts to flora due to the spread of weeds. The disturbance associated with the operations will pose a risk of increased weed invasion. This issue is addressed in a Weed Management Plan (Appendix O).	The management measures proposed for minimising the impact on flora and vegetation are: • The protection of plant community S5, as this community has a high density of Priority Flora (see Appendix M Sustainability Implementation Plan, Element 7.2). • Prior to clearing, as much seed as possible from significant flora will be collected for rehabilitation. • Clearing will be limited to that which is necessary for operations. • Topsoil removed from cleared areas will be directly returned to sites ready for rehabilitation, to maximise seed viability. • Additional searches for *Eucalyptus beardiana*, which is a declared rare species should be carried out on the southern haul road prior to the finalisation of the access route and the location of the accommodation facility. • Installation of a plant and equipment washdown area at the entrance to the mine site.	There will be no impact on plant community S5 as it will not be disturbed by the Project. There will be clearing of Priority Flora species within the Project Area. However, it is expected that there will be no loss of species because most of the flora species are widely distributed outside of the Project Area, except for *Eremophila occidens* (ms). It is predicted that there will not be any disturbance to *Eucalyptus beardiana*, because it has not been recorded in the Project Area and if it is identified during in future searches, the Project will be re-designed to avoid disturbance to this species.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Vertebrate Fauna	Specially Protected (Threatened) Fauna and Priority Fauna and their habitats.	Maintain the abundance, species diversity, geographical distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act* 1950. Protect fauna listed on the Schedules of the *Environmental Protection and Biodiversity Conservation Act* 1999. <u>Scope of Work</u> Review vertebrate fauna recorded, or which may potentially occur in the Project Area. Conduct baseline studies to identify existing native fauna and fauna habitats throughout Project Area. Assess the relationship between vertebrate fauna and the plant communities of the Project Area to identify significant habitats. Assess potential impacts on native fauna, and fauna habitat, as a result of mining. Consult with CALM on any impacts to, and the management of, threatened fauna species and priority fauna species. Propose measures to manage and/or mitigate impacts primarily through the maximisation of fauna habitat reconstruction during rehabilitation and secondly through the identification of proposed fauna translocation areas, if required.	Comprehensive fauna surveys were conducted by Ninox Wildlife Consulting Pty Ltd in September 2003, and April and October 2004. Further, a targeted survey to search for the Hamelin Skink, which is listed as vulnerable under the Threatened Fauna section of the *Wildlife Conservation Act* 1950 and the *Environmental Protection and Biodiversity Conservation Act* 1999, was undertaken in September 2004. The surveys have been undertaken over two consecutive years. It is believed that sufficient information on species presence has been gathered. The largest impact on fauna will be due to the clearing of 5,745 ha of fauna habitat, including the loss of fauna habitat, including Malleefowl breeding mounds. There will be a localised loss of vertebrate species that are too small or immobile, as they will be unable to relocate to unaffected areas. Many of the birds, larger mammals and reptiles will be able to relocate and avoid the impact of construction and mining. However, there may be some territorial conflicts associated with competition for food resources, shelter and breeding sites. It is expected that these conflicts would be resolved over time and naturally stabilise.	The mitigation measures proposed to minimise the impact on vertebrate fauna are: • De-stocking the Coburn pastoral lease for several years upon approval from the Pastoral Board to allow vegetation to recover and then re-stocking it at a rate well below carrying capacity. • Monitor Malleefowl populations within and outside of the Project Area. • Baiting of foxes to minimise predation of Malleefowl. • Fencing around the water dams to stop encroachment by large/medium sized mammals. • Placing mesh at the edge of the water dam to allow small vertebrate fauna in the water dam to exit. • Rehabilitation will be structured to encourage the return of fauna by providing micro-relief and dense vegetation cover.	There will be a localised loss of fauna habitat as a result of the Project, including the loss of Malleefowl breeding mounds. It is predicted that larger mammals, larger reptiles and birds will be able to avoid the impact of clearing. Small mammals, small reptiles and burrowing frogs (if present) are likely to be killed by large machinery. However, while the local impact on individual animals will be high, the clearing will have very little impact on the species overall and no particular species is at risk. Furthermore, de-stocking the Coburn pastoral lease and undertaking predator control will have a beneficial impact on native fauna on the lease.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Subterranean Fauna		Maintain the abundance, species diversity, geographical distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act* 1950. Protect fauna listed on the Schedules of the *Environmental Protection and Biodiversity Conservation Act* 1999. <u>Scope of Work</u> Sample existing bores and additional bores installed during groundwater investigation. Identify stygofauna present, if any. Assess potential impacts on subterranean fauna as result of mining and associated activities. Propose measures to manage impacts.	A stygofauna survey was conducted in October 2004 by the University of Western Australia. The study did not record any stygofauna within the Project Area.	As a research contribution on the distribution of stygofauna in Western Australia, Gunson commits to undertake further sampling of bores within the Project Area.	No stygofauna have been recorded in the area, so no impact is predicted. Some additional sampling could be useful to confirm the baseline study results. However, the extent and length of sampling should be reviewed in light of the absence of stygofauna in the Project Area.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Land	Soil and Landform	Maintain the integrity, ecological functions and environmental values of soils and landform in the Project Area. Minimise the footprint of disturbance during the life of the Project. <u>Scope of Work</u> Topographic surveys and surveys to determine undisturbed characteristics of soils and landforms. Propose measures to rehabilitate the impacted areas to an acceptable standard.	A survey was undertaken by D.C. Blandford & Associates in December 2004. This survey was designed to define the baseline landscape and soil conditions. This provides a benchmark of landscape condition for future comparison. Four soil profile forms were identified during the survey, with the majority of the profiles being described as sandy throughout their depth. Mining operations will modify landforms within the Project Area and disturb the soil profile. The earthy fabric of the subsoil will be destroyed, forming material with a single-grained fabric. This predisposes it to accelerated wind erosion.	Soil issues will be managed by implementing the following: • Minimising the area of land susceptible to erosion. • Progressively rehabilitating disturbed areas. • Replacing the top 1 m of soil over mine tailings to protect the soil profile and seed bank. • Using surface treatments (e.g. bitumous emulsions, cover crops, surface mulching, windrowing vegetation and artificial meshes) if required. • Defining rehabilitation specifications to create a stable landform and suitable soil profile. • Classify soils and place dispersive soils at depth if they are found to occur.	The salinity of the soil (including tailings) that will be replaced in the voids will initially be slightly higher than the pre-mining soil, as the water used in the process is saline. It is expected that the salinity of the soil will decrease, as the salt will be leached by rainfall. The final landforms are anticipated to be undulating, having lower dunal heights than the pre-mining landforms. There will not be any voids left at the cessation of rehabilitation works. The landforms will be stable and suitable for revegetation.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Land (continued)	Rehabilitation	Ensure proposal area and other area affected by the proposal is returned to a standard consistent with its post-mining land capability. Ensure that the post-mining landform is stable, and is, as far as practicable, integrated into the surrounding environment. <u>Scope of Work</u> Investigations into the characteristics of reconstructed soil profiles. Investigations as to the suitability of species for revegetating the land according to land capability. Investigate options for maximising habitat reconstruction. Establish trials to assess the ability of reconstructed landforms to achieve the rehabilitation objectives. Conduct investigations into surface stability of reconstructed landforms. Undertake a rehabilitation benchmarking exercise to investigate rehabilitation in similar environments in the region, including Woodleigh Station. Develop a Rehabilitation Plan.	A rehabilitation benchmarking study conducted to investigate rehabilitation works in semi-arid environments concluded that it is likely that the Project site can be rehabilitated to a level of ecological function similar to the level prior to disturbance. It is expected that the recovery period will be lengthy. A Rehabilitation Plan has been developed to outline the scope of works that will be undertaken to design a successful rehabilitation programme for the mine site. A survey was undertaken by D.C. Blandford & Associates in December 2004. This survey was designed to define the baseline landscape and soil conditions. This provides a benchmark of landscape condition for future comparison. The mechanical disturbance of the soils during mining activities will result in the destruction of fabric. The consequence of this is that the soil will be less favourable for plant growth and more prone to erosion.	The rehabilitation techniques to be implemented for the Project are detailed in the Rehabilitation Plan. Some of the key rehabilitation procedures are: • Place overburden directly into the mine pit. This decreases the need for stockpiling. • Approximately 4% of the original ore will be returned as fine clay tailings (slimes). • Approximately 95% of the ore mass will be returned as clean sand tailings. • Sub-soil will be spread on top of the tailings, followed by the topsoil layer. The sub-soil will form a transition zone between the topsoil and the saline tailings. • Contour the surface to reflect the landforms similar to the pre-mining landforms. • Removed vegetation will then be spread to decrease wind erosion, provide another source of seed, and provide protection and nutrients to seedlings. • The surface may then be further stabilised through the use of polymer sprays, windbreaks, biodegradable matting or appropriate alternatives if required.	The final landforms are anticipated to be undulating, having lower dunal heights than the pre-mining landforms. There will not be any voids left at the cessation of rehabilitation works. The landforms will be stable and suitable for the re-establishment of vegetation. It is predicted that revegetation will be successful through the implementation of the Rehabilitation Plan and the use of improved rehabilitation techniques throughout the life of the Project. The rehabilitated areas will contain similar species to those present prior to clearing, as the topsoil will provide the seed source for the revegetation. Based on the results of the benchmarking exercise, ecological function will return to a similar level to that prior to disturbance after a lengthy recovery period.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Water	Drainage, site hydrogeology and surface water	Maintain the integrity, functions and environmental values of natural surface water drainage. Maintain the integrity, functions and environmental values of hydrogeology. Ensure that beneficial uses of groundwater can be maintained. <u>Scope of Work</u> Provide details and justification of water requirements for the Project. Characterise existing hydrogeological systems of Project Area. Assess implications of Project on groundwater systems, existing and potential future users of groundwater, and any groundwater dependant ecological systems, including those within the SBWHP and Zuytdorp Nature Reserve. Consultation with DoE on impacts to, and management of surface water and groundwater. Propose measures to manage and/or mitigate impacts.	Surface water drainage will be affected by the modification of the landscape. However, as there are no known sensitive surface water features within the Project Area, the impacts on drainage are localised and readily manageable. No groundwater-dependent flora or fauna are known to occur in the Project Area. The nearest groundwater-dependent ecosystem is likely to be the estuarine ecology associated with Hamelin Pool and the Nilemah Embayment. There are no predicted impacts on these ecosystems, as the Project Area has different groundwater discharge zones. The findings of the study indicate that there will be drawdown impacts on about 60 private bores. Apart from the Spinifex Bore (on Hamelin Station), none of the existing artesian bores are likely to stop flowing. The impacts of groundwater drawdown will be identified quickly and managed, as Gunson will maintain regular contact with the private bore owners in the region to find out whether they have observed drawdown in their bores. Modelling has also been undertaken to assess the potential impact of tailings seepage causing groundwater mounding. A number of areas in the SBWHP that could be affected by mounding have been identified.	The reconstruction of the final landform will be designed to minimise erosion and to re-establish natural surface water regimes. A set of management measures have been developed to ensure that groundwater mounding from tailings seepage is minimised. A groundwater monitoring programme has been developed to enable assessment and management of the drawdown in the deep aquifers due to process water supply abstraction and in the shallow aquifers due to mine dewatering and residual mine water mounding. Groundwater mounding in the SBWHP will be managed by abstraction via recovery bores to ensure that no adverse impacts occur to undisturbed vegetation.	Development of the Project will result in local and regional impacts on the groundwater resources of the superficial and deep aquifers, including: • Groundwater drawdown will occur in 60 private bores during mine life. Apart from Spinifex Bore (on Hamelin Station), none of the existing artesian bores are likely to stop flowing. • Mine water is expected to mound beneath the active stacker areas due to seepage into the adjoining undisturbed superficial sand.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
POLLUTION MANAGEMENT					
Air Emissions	General	Ensure that gaseous emissions from this proposal, in isolation and in combination from neighbouring sources and background concentrations, do not cause an environmental or human health/amenity problem by meeting statutory requirements and appropriate criteria. Scope of Work Define existing meteorological and ambient air quality environment. Define potential sources of air emissions (in particular NOx, CO and SO_2) and assess significance with regard to human health impacts and comparison with appropriate ambient standards. Propose measures to manage air emissions.	An air quality assessment was undertaken by URS for the Project. Air pollution is not a single entity, but comprises a number of pollutants, which may have separate sources and effects. In the case of this Project, the main emission with potential for off-site effects is particulate, primarily dust from large open sources associated with mining activities. Carbon dioxide, carbon monoxide, oxides of nitrogen and sulphur dioxide emissions will be very small. Products of combustion will be produced from on-site power generation, on-road and off-road vehicles and equipment, and the modular power generation units for the concentrators which burn natural gas.	The Project has been designed and will be operated to minimise gaseous emissions. The main method, as outlined in Section 2.6 and Appendix N, is through the use of natural gas as the main energy production source for the site.	The combustion of natural gas, on-road and off-road vehicles and equipment, will result in carbon dioxide, carbon monoxide, oxides of nitrogen and small quantities of sulphur dioxide. Modelling of these emissions predicts offside emissions to be well below relevant ambient criteria.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Air Emissions (continued)	Dust/Particulates	Ensure that dust emissions, both individually and cumulatively, do not cause an environmental or human health problem or significantly impact on amenity, by meeting statutory requirements and appropriate criteria. Use all reasonable and practicable measures to minimise airborne dust. <u>Scope of Work</u> Define existing meteorological and ambient air quality environment. Define potential sources of dust and assess significance of emissions with regard to human health and environmental impacts. Propose measures to manage dust/particulate emissions.	An air quality assessment was undertaken by URS for the Project. The main emission with potential for off-site effects is dust, primarily from large open sources associated with mining activities. The main mining activities that have the potential cause dust emissions include topsoil removal; excavation, dumping, stockpiling and transfer of ore and overburden; machinery and vehicle movements; and dust pick-up from exposed areas. The modelling undertaken as part of the air quality assessment indicated that up to 1g/m^2/month could be deposited at the southern end of Hamelin Pool.	The management measures proposed for the control of dust: • Use of water sprays across work zones and unsealed areas to suppress dust. • Ensure exposed surfaces and stockpiles are watered or sprayed where required. • Progressive rehabilitation of cleared areas throughout the life of the mining operation. • Schedule works that have the potential to generate large volumes of dust for favourable meteorological conditions. • The proponent will commit to integrating best practice dust management procedures in consultation with the DoE and regular monitoring and reporting of offsite impacts including vegetation and stromatolites located within the SBWHP.	It is predicted that dust concentrations will be well below respective guidelines at Hamelin Pool, Hamelin Homestead and the SBWHP. Maximum off-site dust concentrations are predicted to occur to be to the east of the Project Area, indicating minimal risk to vegetation within the SBWHP. Through the implementation of the dust management measures, dust will not adversely affect the surrounding environment or cause human health problems.
	Greenhouse Gases	Minimise emissions to as low as reasonably practicable on an on-going basis and consider offsets to further reduce cumulative emissions. <u>Scope of Work</u> Define existing meteorological and ambient air quality environment. Assess Project's implications for Australia's Greenhouse Gas Inventory. Propose measures to reduce greenhouse gas emissions.	The air quality assessment also included an assessment of greenhouse gas emissions. The largest contributor to the net greenhouse emissions from the Project is for power generation. To minimise the amount of greenhouse gas emissions, Gunson intends to utilise natural gas as the energy source for the Project. It is predicted that this will deliver significant greenhouse benefits in comparison to alternative fossil fuel sources.	To minimise the amount of greenhouse gas emissions from the Project, Gunson intends to utilise high efficiency (38-40%) variable load generator units using natural gas as the energy source for the Project. It is predicted that this will deliver significant greenhouse benefits in comparison to alternative fossil fuel sources. In addition, the Proponent has bought the Coburn pastoral lease and will de-stock it for several years to allow vegetation to recover and then re-stock it at a rate well below carrying capacity. This vegetation has the potential to offset greenhouse gas emissions.	It is predicted that greenhouse emissions will range from approximately 35,000 t CO_2 in the first two years to 70,000 t CO_2 /annum in Year 3 of the Project life. Net emissions anticipated to result from the Project are predicted to represent a minor contribution (0.1%) of the State's greenhouse emissions inventory (estimated 65.9 Million tpa in 2002, Western Australian Greenhouse Taskforce 2004).

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Noise	Noise	Ensure that noise emissions, both individually and cumulatively, do not adversely impact on the amenity of nearby residents by meeting statutory requirements and appropriate criteria. Scope of Work Describe existing noise environment. Define potential sources of noise and assess significance of emissions with regard to sensitive receptors. Propose measures to manage noise emissions.	A noise impact assessment was conducted by Herring Storer Acoustics using a modelling programme known as SoundPlan 6.1. The model was used to predict the noise propagation to noise sensitive premises. In addition, using the Environmental Protection (Noise) Regulations 1997, the noise received at the neighbouring residences was assessed by way of noise contours and single point calculations. The results of the noise assessment predicted that the L_{A10} noise levels received at the Coburn and Hamelin homesteads would be 10 dB(A) and 11 dB(A), respectively. These levels are below the assigned L_{A10} noise level of 35 dB(A) for the night-time period under the Environmental Protection (Noise) Regulations 1997.	The proposed noise management measures are: • All unnecessary noise emissions will be kept to a minimum. This is not only to prevent affecting the amenity of nearby residents, but to reduce the effect of habitat disturbance for local fauna by the effects of noise. • Document and respond to any noise complaints. • Should a particular noise be excessive during operations, there may be a requirement to alter the noise source, so that it makes less noise.	All operations (including transport of the HMC to Geraldton) comply with both Environmental Protection (Noise) Regulations 1997 and EPA's Draft Statement No. 14.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Water	Groundwater and Surface Water Quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential users, including ecosystem maintenance are protected. Ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land users, by meeting statutory requirements and appropriate criteria. Scope of Work Identify potential sources of impacts to surface and ground water quality. Assess the potential impacts from any change in surface water and groundwater quality on the surrounding environment. Assess potential impacts on regional groundwater quality and other users of the groundwater resource. Consultation with DoE on impacts to, and management of surface water and groundwater. Propose measures to manage and/or mitigate impacts.	The use of brackish water for dust suppression during operations was considered in the groundwater assessment. The use of the brackish water may cause some vegetation deaths on the shoulders of access roads. Surface water quality may be affected by storm water runoff from the mine site, as it will contain salt from the use of brackish water for dust suppression. To manage this issue, all storm water from the plant site will be intercepted by a drainage system, channelled into a sediment retention basin and allowed to evaporate.	Storm water runoff from the site will be collected in the site's stormwater drainage system and allowed to evaporate from sediment retention basins. This will minimise the amount of sediment and salt that will be transported offsite.	The groundwater and surface water quality of areas outside of the Project Area will not be diminished as a result of the Project.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Waste	Liquid and solid waste disposal	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on-site or disposed of off-site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on-site to prevent groundwater and surface water contamination or risk to public health. <u>Scope of Work</u> Identify potential sources of contamination. Propose measures to manage solid and liquid waste storage, handling and discharge.	The liquid and solid wastes produced from the Project have been identified. There is a range of potential impacts if the wastes are not managed properly, including the contamination of land, surface water and groundwater, ecological habitats and an increase in pests and weeds.	Liquid and solid wastes will be managed as follows: • Waste water is likely to be produced as a result of the concentrating process. Approximately 45% of this water will be recovered and recycled. • All waste oils will be collected by the earthmoving contractor and recycled to an approved facility. • Oily rags and used filters will be recycled or disposed of at an appropriate hydrocarbon disposal facility. • Structural waste will be recycled through a scrap metal merchant, where possible. • Domestic waste, (e.g. general refuse, green waste, paper and putrescibles) will be collected and disposed of to an on-site landfill. Recyclable wastes will be collected separately and transported off site to a recycling facility. • Storm water from the plant site will be intercepted by a drainage system, collected in a sediment retention basin and allowed to evaporate. • The camp/offices will be designed with suitable sewerage processing systems to dispose of domestic liquid waste such as sewerage and grey water.	Wastes will be minimised where possible. In the case of water usage for the concentrating process, the waste water will be recovered and reused. Other wastes will be recycled where possible.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Waste (continued)	Tailings Management	Ensure that the post-mining landform is safe, stable, non-erodible, and is, as far as practicable, integrated into the surrounding environment. Minimise environmental impacts due to tailings disposal operations. Scope of Work Define tailings disposal, management and monitoring methods. Define post-mining land use. Define physical characteristics and chemical composition of tailings. Propose measures for management of tailings.	Fauna may be attracted to and become trapped in wet areas of tailings. Tailings management in respect to re-establishment of the soil profile may have implications for rehabilitation as the tailings will have a higher salinity than the pre-mining soils.	To manage seepage from the tailings, as much water as possible will be recovered to minimise groundwater mounding. Monitoring of the water table levels will be undertaken. The proposed rehabilitation techniques are detailed in the Rehabilitation Plan. These include tailings management strategies such as the specifications for the return of tailings to the pit. Sub-soil will be spread on top of the tailings, followed by the topsoil layer. The sub-soil will form a transition zone between the topsoil and the saline tailings. The surface will be re-contoured to reflect the landforms similar to the pre-mining landforms. The surface may be further stabilised through the use of polymer sprays, windbreaks, biodegradable matting or appropriate alternatives if required.	Fauna deaths as a result of becoming trapped in the tailings dam will be minimal. The post-mining landform will be stable.
Light	Light	Avoid or manage potential impacts from light overspill and comply with acceptable standards. Scope of Work No specific survey/investigation required.	The use of lights for the 24 hour operation will produce light overspill.	The light overspill from the Project will be managed by positioning the level of lights as low as possible.	It is considered that there will be minimal impact of night-glow from the Project.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
SOCIAL SURROUNDINGS					
Public Health and Safety	Risk and Hazards	Ensure that risk to the public is As Low As Reasonably Practicable (ALARP). Ensure that risk is managed to meet DoIR requirements and EPA criteria in respect of public health and safety. <u>Scope of Work</u> Identify potential off-site risks. Propose measures to manage potential off-site risks.	There are no major off-site risks that are associated with the mine site, with the exception of transport. A desktop transport study was undertaken using traffic data from Main Roads Western Australia.	The risks to public safety on the North West Coastal Highway will be mitigated by having appropriate signage displayed on either side of the access road / North West Highway intersection. The road will also be widened to safely accommodate B-Double turning movements into the high speed environment.	The additional B-Double vehicle traffic generated by transporting the concentrate from the mine site to Geraldton is considered minimal in relation to the volume of traffic already utilising the highway. It is estimated that the net increase of trucks travelling towards Geraldton as a result of the project is one additional truck approximately every one and a half hours.
	Radiation	Ensure that risk to the public is ALARP. Ensure that risk is managed to meet DoIR requirements and EPA criteria in respect of public health and safety. <u>Scope of Work</u> Baseline survey to determine existing background radiation levels. Assess risk to public health and safety. Propose measures to manage potential radiation.	Radiation Advice & Solutions Pty Ltd undertook a Baseline Radiation Monitoring Programme in July 2004 using soil samples obtained by Gunson and gamma doserate readings from some 35 sites, primarily concentrating in the southern part of Amy Zone. The results found very low levels of above-ground radiation. Even locations which had been identified as containing higher grades of heavy minerals showed gamma radiation doserates that were essentially very low due to the very low monazite content (and hence uranium and thorium content) in the heavy mineral suite. Due to the presence of thorium and monazite in the mineral sands there is the potential for the formation of radiation 'hot spots' when returning tailings to the mine void. If the material is deposited in a confined area of rehabilitation and not distributed over a larger area, then a radiation hazard could exist for fauna and humans.	Gamma surveys in addition to random radiation surveys will be undertaken during operations. The random radiation surveys will also cover the stockpiled ore and waste and mineral transport activities. Other management measures proposed to minimise risks to public health and safety are: • Radiation training for employees on the issues involved with handling and storage of the material. • Record keeping and annual reporting of HMC movement and radiation levels.	The post-mining radiation values will be at or below the baseline values, minimising the risk to public health and safety.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Public Health and Safety (continued)	Road Transportation	Ensure that roads are maintained or improved and road traffic managed to meet an adequate level of service, adequate safety standards and Department for Planning and Infrastructure requirements. Ensure that traffic activities resulting from the Project do not adversely impact on the social surroundings. <u>Scope of Work</u> Characterise traffic levels and traffic composition of the transport route. Assess potential impacts to existing heavy haulage traffic levels and overall traffic levels, and estimated wear to infrastructure along the transport route. Identify all credible accident events that have the potential to cause fatalities and put in place controls appropriate to the risk.	A desktop transport study was undertaken using traffic data from Main Roads Western Australia. The concentrate will be transported to Geraldton utilising B-Double (capacity of 80 tonnes). The expected tonnage is 400 tonnes per day for years 2006 and 2007, which equates to five return trips per day. After 2008, the tonnage will increase to 800 tonnes per day and ten return trips a day. North West Coastal Highway is a two lane major rural highway that originates at Geraldton and has the highest daily number of heavy vehicles of all major roads in the region. It was estimated that there would only be a slight increase in traffic on the North West Coastal Highway as a result of the Project.	The management measures for the intersection of the mine access road with North West Coastal Highway are: • The mine access road and the associated intersection with North West Coastal Highway will have appropriate signage displayed either side of the access road / North West Highway intersection. • Management of the road modifications and signage requirements will be the responsibility of both Gunson and MRWA. The management of the mine access road will include: • Monthly inspections of road conditions and random reports from the transport personnel and other road users. • Grading of the road annually or on an as-needs basis to ensure that the road condition is safe for use.	The additional B-Double vehicle traffic generated by transporting the concentrate from the mine site to Geraldton is considered minimal in relation to the volume of traffic already utilising the highway. It is estimated that the net increase of trucks travelling towards Geraldton as a result of the project is one additional truck approximately every one and a half hours. This will not adversely impact on the social surroundings.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Surrounding Land Use	Aesthetics and Recreation	Ensure that aesthetic values are considered and measures adopted to reduce visual impacts on the landscape, during mining and at closure, as low as reasonably practicable. Scope of Work Establish a social profile of the Shark Bay region. Identify potential impacts of the proposed Project. Outline community attitudes toward the Project. Propose management and/or mitigation to issues raised.	A desktop assessment of potential visual impacts was undertaken. Given the isolation of the Project, distance to transport routes and intervening topography and vegetation, it is anticipated that the Project Area will not greatly reduce public amenity. The northern section of the Project Area may be visible from topographic high points and as the Project will be a 24-hour operation, there will be night-glow from the site. The generation of dust during construction and mining operations may reduce the aesthetic values of the area. However, dust suppression measures will be implemented to address this issue.	To minimise the visibility of the mine site from the neighbouring properties the following mitigation measures are proposed: • The topsoil stockpiles will be rehabilitated as soon as practically possible • Vegetation will be retained around the Project Area as a screening mechanism. • Disturbed areas will be rehabilitated, as soon as possible. • Lights will be positioned at a level as low as possible. The management measures proposed for the control of dust are: • Use of water sprays across work zones and unsealed areas to suppress dust. • Ensure exposed surfaces and stockpiles are watered or sprayed where required. • Progressive rehabilitation of cleared areas throughout the life of the mining operation.	Through the implementation of the dust management measures and the visual amenity mitigation measures, it is predicted that the visual impact of the Project will be kept to as low as reasonably practicable.

Table 6.1 (cont.'d)

Element of Environment	Environmental Factor	Objectives and Scope of Work	Predicted Environmental Impacts	Proposed Mitigation and Management Measures	Predicted Outcome
Culture and Heritage	Aboriginal Culture and Heritage	Ensure that proposal complies with the requirements of the *Aboriginal Heritage Act* 1972. Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect historical and cultural associations with the area. Scope of Work Consultation with Yamatji Land and Sea Council and Department of Indigenous Affairs to determine whether further survey work is required. Any Aboriginal heritage survey would be conducted in compliance with the provisions of the *Aboriginal Heritage Act* 1972.	Numerous Aboriginal Heritage studies have been undertaken both within the Project Area and on adjacent properties. One archaeological site was located near the proposed mine access road, but this road has been diverted so as to avoid any disturbance to the site.	The management measures proposed to ensure that the Project does not adversely affect Aboriginal heritage sites are: • Conducted a number of Aboriginal heritage surveys since 1999 covering the area proposed to be disturbed. • Survey the land proposed for mining up to the end of Year 10 of the mine life, by mid-2005. • Gunson will advise the Yamatji Land and Sea Council of mining activities. • A cultural heritage survey will be conducted before any ground disturbing activity proceeds.	The Project will not impact any Aboriginal archaeological or ethnographic sites.
Culture and Heritage (continued)	European Heritage	Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect historical and cultural associations with the area and comply with relevant heritage legislation. Scope of Work Conduct desktop identification and evaluation of the European cultural and heritage values of the Project Area. Identify potential impacts on any identified values of the area.	Searches for places of European cultural heritage have been conducted on the following databases: • Australian Heritage Places Inventory. • Heritage Council of Western Australia Database. • Shire of Shark Bay Municipal Inventory. • Register of the National Estate Database. • The National Trust Database. There are no European heritage sites known to occur near or within the southern portion of the Amy Zone with the exception of the SBWHP.	To ensure that the Project does not impact on sites of European heritage, such as the Hamelin Pool, the following management is proposed: • Undertake groundwater monitoring at the northern end of the Project. • Ensure that adequate dust suppression measures are undertaken to ensure that dust does not cross the site boundary.	It is predicted that the Project will not adversely affect European heritage sites.

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7.1 SUSTAINABILITY

7.1.1 Objectives and Standards

The most widely accepted definition of sustainable development is the one developed by the Brundtland Commission, which defined it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987).

More recently, the Mining Minerals and Sustainable Development (MMSD) report suggested that, in the context of the minerals industry, the goal of sustainable development should be to "maximise the contribution to the well-being of the current generation in a way that ensures an equitable distribution of its costs and benefits, without reducing the potential for future generations to meet their own needs" (International Institute for Environment and Development [IIED] 2002).

The International Council on Mining & Metals (ICMM), which was established following completion of the MMSD project, has also adopted the Brundtland Commission's definition of sustainable development.

On a National level, the National Strategy for Ecologically Sustainable Development (NSESD), adopted by all levels of Australian Government in 1992, provides broad strategic directions and framework for governments to direct policy and decision-making for ecologically sustainable development (ESD). The NSESD is aware that there is no universally accepted definition of ESD, but it recognises the Commonwealth Government definition for ESD in Australia:

'…using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'.

In 2003, the Western Australian Government released 'Hope for the Future: The Western Australian State Sustainability Strategy'. The Strategy encompasses goals and priority issues for government action towards achieving the visions for sustainability within Western Australia. In addition, the strategy outlines actions for the State's mining industry. These actions comprise:

- Working towards assessment of complex or strategic mining and petroleum projects using sustainability criteria.
- With key stakeholders, developing a set of agreed sustainability operating principles for the mining and petroleum sectors through a working group or groups managed through the DoIR and the Sustainability Roundtable.
- Fostering local community involvement (particularly Aboriginal communities, pastoralists and local shires) as part of the sustainability assessment process.
- Establishing transparent processes to enable community awareness of the day-to-day regulatory system for exploration, mining and minerals processing including through the web site of the DoIR.
- Working with industry on the development of voluntary accreditation for mining and petroleum industry sustainability.
- Implementing strategies that support the use of local employment in mining ventures, particularly using regional centres as employment hubs, and encourage mining companies to maximise their purchasing of goods and services within regions.

(Government of Western Australia 2003).

Gunson recognises that sustainability, locally, nationally and globally, is becoming an increasing issue with regards to resources and resource management. With this in mind, Gunson has included implementation strategies for sustainability within the Coburn Project.

EPA's Position

The EPA has released a Position Statement outlining the EPA's views on matters of environmental importance in relation to sustainability. The Position Paper No. 6 titled Towards Sustainability was published in August 2004. The paper outlines recent thinking about the way to achieve the goal of sustainability (EPA 2004b). It is directed towards the particular circumstances of Western Australia, with a growing population and a growing economy based largely on the use of natural resources, as well as a range of problems that are the direct consequence of past practice (EPA 2004b). It sets out a range of criteria to judge whether proposed activities are consistent with attaining the goal of sustainability and recognises that the transition to a future sustainable society will involve many changes (EPA 2004b).

Commensurate with these views, the recent EP Act amendments have included a set of principles which underpin the environmental protection component of sustainability. See Section 7.1.4 for further details.

7.1.2 Key Issues

Through the MMSD project, five interlinked issues critical to the mining industry's response to sustainable development were identified. These are:

- management of large volume wastes;
- mine closure planning;
- environmental legacy;
- environmental management systems; and
- biodiversity.

These issues are discussed below:

Management of Large Volume Wastes

The main large volume wastes to be produced by the Project will be overburden and tailings.

"Overburden" comprises the material located below the topsoil and subsoil, and above the orebody, that needs to be removed to allow excavation of the ore. The stripping ratio for the Amy Zone ranges from an average of 0.3 (i.e. 0.3 parts of overburden to 1 part of ore) in the southern section of the orebody to an average of 0.6 in the northern section of the orebody, The overburden will be returned directly to the mine void as backfill.

Tailings from the concentrator(s) will consist primarily of sand and minor quantities of clay and water. Sand tailings will be produced at a rate of 2,180 tph for each 2,200 tph concentrator, dewatered using cyclones and stacked in the mine void prior to rehabilitation

The estimated quantity of the tailings and their proposed management is outlined in Table 2.1 and Sections 2.3.4.1 and 2.9. Appendix F also discusses the management and rehabilitation of tailings.

Mine Closure Planning

The mine life of the Project is projected to be 20 years. Gunson recognises that appropriate planning and adequate provisioning for closure is required to ensure that the decommissioning and closure process occurs efficiently with regards to all aspects of sustainability. To commence the planning phase, Gunson has developed a Conceptual Closure Plan in accordance with the ANZMEC & MCA (2000) mine closure guidelines. The plan is presented as Appendix H.

In addition to closure planning, Gunson will undertake progressive rehabilitation of the mined areas to ensure that final mine closure is completed within a timely manner and successfully meets the closure objectives as outlined in Table 1 of Appendix H.

Additional information on mine closure is presented in Section 2.12.3.

Environmental Legacy

Even when every effort is made to prevent environmental legacies from developing, all mine sites experience environmental incidents such as minor hydrocarbon spills.

Any environmental incidents and contamination will be addressed in a timely manner, so as to reduce the risk of long-term environmental legacies. Any environmental legacies that remain at the end of project life will be addressed through the closure planning process so that no unacceptable public liability remains.

Environmental Management Systems

Gunson has commenced preparation of its EMS for the Project by developing a preliminary risk assessment and an Environmental Management Plan.

EMS development and implementation will continue through the life of the Project. It is expected that environmental procedures and other management measures developed as part of the EMS will progressively replace those presented in the EMP as part of Gunson's commitment to continual improvement.

COMMITMENT 2

The Proponent will develop and implement an Environmental Management System as part of the overall management system for the Project.

Biodiversity

The biodiversity issues with regards to the Project are linked to the location of the proposed mine. Situated within the transition zone between the South West Botanical Province and the Eremaean Botanical Province (Beard 1990) there is potential for a temporary decrease in local biodiversity with the removal of vegetation and fauna through the mining process. Transition zones of botanical provinces are recognised as having an unusual suite of speciation.

The means by which Gunson has maintained, and will act to maintain, the biodiversity of the area include:

- Developing an understanding of the existing landscape by undertaking flora, vegetation, fauna surveys in addition to the rehabilitation benchmarking of surrounding landscapes.

- Identifying successful rehabilitation indicators in the rehabilitation benchmarking exercise.

- Implementing the use of local seed stores during rehabilitation and monitoring the success and use of seed at nominated intervals (see Table 1 of Appendix F).

- Implementing fire and weed prevention strategies in accordance with the Weed, Fire, Vegetation and Flora and Vertebrate Fauna Management Plans provided as Appendix O.

To maintain the local biodiversity and prevent habitat fragmentation for as long as possible during the mining process, Gunson will only clear vegetation as required. Clearing in this manner will leave the majority of vegetation preceding the mine face (for use by native species) for the maximum amount of time.

In addition, Gunson will de-stock the Coburn pastoral lease for several years and undertake introduced predator control, thereby relieving pressure on local biodiversity from introduced fauna.

Sections 4.1.2 and 7.10 also provide information in relation to biodiversity and the Project.

COMMITMENT 3

The Proponent will de-stock the Coburn pastoral lease for a minimum of several years, and longer if permission is granted by the Pastoral Board, and undertake introduced predator control.

The Proponent will develop and implement an Environmental Management System as part of the overall management system for the Project.

7.1.3 ICMM Guiding Principles

The ICMM has developed a framework for sustainable development that comprises the following principles:

1. Implement and maintain ethical business practices and sound systems of corporate governance;

2. Integrate sustainable development considerations within the corporate decision-making process;

3. Uphold fundamental human rights and respect cultures, customs and values in dealing with employees and others who are affected by our activities;

4. Implement risk management strategies based on valid data and sound science;

5. Seek continual improvement of our health and safety performance;

6. Seek continual improvement of our environmental performance;

7. Contribute to conservation of biodiversity and integrated approaches to land use planning;

8. Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products;

9. Contribute to the social, economic and institutional development of the communities in which we operate; and

10. Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders.

Gunson is not a member of the ICMM, but is adopting the above principles to guide it in developing sustainability. The actions the Company initially proposes to implement in this regard are outlined in Appendix M, and are based on the suggestions provided by the Minerals Council of Australia guidance for implementation of the ICMM principles (MCA 2004).

It is noted that some of these principles and the associated elements cover non-environmental issues, such as health and safety. These have been included in the list of principles and elements in Appendix M for completeness, but have not been addressed in any detail as they fall outside the scope of this PER.

7.1.4 EPA Principles of Environmental Protection

As indicated in Section 7.1.1, the Environmental Protection Act was amended in 2003 to include five principles, which form the core set for the EPA in relation to environmental protection. These principles are listed in Table 7.1, along with a summary of the way in which Gunson has, or proposes to, address these principles in the development and implementation of the proposed Project.

Table 7.1
Principles of Environmental Protection

EPA Principle	Project Application
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 the application of the precautionary principle, decisions should be guided by: (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk-weighted consequences of various options.	Gunson has undertaken a wide range of studies to ensure that the environmental risks associated with the proposed Project are understood as much as possible and can be managed in an environmentally acceptable manner. These have included: • A preliminary risk assessment conducted in 2003 during the early stages of the BFS to identify any potential environmental "fatal flaws" or significant environmental risks. The environmental risk assessment was updated in 2005. The outcomes of these assessments were used to identify the environmental factors relevant to the proposed Project and the scope of work required to address these factors. See Section 6 for further details. • An environmental and economic evaluation of options for mining and processing methods, tailings disposal and water recovery, haul road alignments and power supply. The options considered by Gunson are discussed in Section 2. • A comprehensive range of environmental and other studies including extensive stakeholder consultation. The results of these studies were used to predict environmental impacts and develop environmental management plans. These impacts are discussed in Section 7 to 10. The draft EMP developed for this Project is provided as Appendix O. Where some uncertainty still remains, Gunson has committed to conducting further studies, as outlined in Sections 7 to 9, and in the commitments listed in Section 11. In particular, Gunson has committed to staging development of pit 10. This means that Gunson will not commence development of Pit 10 until further technical, hydrogeological and ecological studies are completed and it can be demonstrated that the potential impacts associated with Pit 10 can be managed in an environmentally acceptable manner (see Commitment 1). In addition, Gunson has committed to developing an EMS for the proposed Project (Commitment 2), which will assist the company in environmental risk management. This aspect is also addressed under Elements 4.1 to 4.4 of the ICMM sustainability framework, as presented in Appendix M.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Gunson has addressed the principle of intergenerational equity in its Sustainability Policy, which states that the company will practice continual improvement through the application of new technology, innovation and best practices in its operations for the benefit of future generations. The range of environmental and social benefits that would result from the implementation of the Project is outlined in Section 3. These include contributing funds and support for scientific research in the SBWHP.

Table 7.1 (cont.'d)

EPA Principle	Project Application
2. (cont.'d)	Further information on the way in which Gunson has addressed the principle of intergenerational equity is provided in Appendix M, which outlines the way in which the company has addressed the ICMM framework for sustainable development. Relevant components include Element 6.3, Element 7.3 and Element 9.3. In addition, Gunson has made a strong commitment to progressive rehabilitation of areas disturbed by the proposed Project (Commitment 4) and to environmental monitoring programmes (see Sections 7 to 10 and Appendix O). The outcomes of these programmes will be used in the continual improvement in the environmental management of the Project.
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	In addition, Gunson's Sustainability Policy includes a commitment to contributing to minimise the impact of its operations on the environment and biodiversity (see Figure 1.3). The way in which Gunson has addressed conservation of biodiversity and ecological integrity is discussed in Sections 4.1.2, 7.1.2 and 7.10. Key components include contributions to scientific research and baseline studies, weed and feral animal control, destocking of the Coburn pastoral lease for at least several years, progressive rehabilitation and the use of local seed in revegetation. In addition, this principle is addressed under Elements 7.1 – 7.3 in Appendix M.
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 or abatement. (c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets, and the ultimate disposal of any wastes. (d) Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and response to environmental problems.	Gunson's Sustainability Policy includes a commitment to contributing to initiatives to promote production, use and recycling of metals and minerals in a safe and environmentally responsible manner. Gunson's commitment to minimise, reuse and recycle waste is outlined in Section 8.5.3 and the draft Liquid and Solid Waste Management Plan provided in Appendix O. The management of any contaminated sites remaining at Project closure is addressed in the draft Conceptual Closure Plan (see Appendix H). Gunson has made provision for rehabilitation and closure of the mine site, as outlined in relation to Element 6.5 in Appendix M. Other relevant elements in Appendix M include Element 2.6 and Elements 8.1 to 8.5.

Table 7.1 (cont.'d)

EPA Principle	Project Application
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.	Gunson's commitment to minimise, reuse and recycle waste is outlined in Section 8.5.3 and the draft Liquid and Solid Waste Management Plan provided in Appendix O. The principle of waste minimisation is also addressed in Element 6.4 in Appendix M.

7.2 LAND SYSTEMS AND LANDFORMS

7.2.1 Objectives and Standards

Environmental Objectives

- Rehabilitate the land to a state that is safe, stable, non-erodible and visually congruent with surrounding, undisturbed land.

Relevant Standards

- ANZMEC & MCA (2000) Strategic Framework for Mine Closure.

7.2.2 Definition of Issues and Impacts

The Project comprises land units, or landforms, from the Nerren, Nanga, Snakewood, Sandplain and Tarcumba land systems. As described in Section 4.1.1.3, these systems consist of level to undulating sandy plains and occasional dunes with deep sand soils covered by moderately dense acacia and other shrublands, mallee woodlands or heathy scrublands. At a regional scale, the systems fit into a broad land type described as 'sandplains with acacias, mallee and heath'.

The classification of an area into different land systems is conducted based on a range of factors such as topography, soils and vegetation. These characteristics will be modified within the Project footprint. For example, the mining and tailings backfill process will develop a flatter landscape, with smaller hills and shallower gullies than currently exist, particularly in the southern portion of the Project Area. The structure, species composition and species cover of vegetation will also be modified as the revegetated areas progress from colonisers to a climax community (see Section 7.6).

The area of the Nanga, Nerren and Sandplain land systems within the Carnarvon Basin and within the Project Area is presented in Table 7.2. This table also provides an estimate of the area of each land system likely to be disturbed by Project development (the area within the Project footprint).

Table 7.2
Land System Areas

Land System	Area (ha)		
	Within Carnarvon Basin[1]	Within Project Area	Within Project Footprint
Nanga	348,500	10,956	4,660
Nerren	154,700	2,264	430
Sandplain	986,600	1,852	607
Snakewood	82,700	474	35
Tarcumba	18,300	62.7	2.5

Note: 1. As calculated by Payne, Curry & Spencer (1987)

These data indicate that:

- Less than 4,660 ha (43%) of the Nanga land system within the Project Area and less than 1.3% of the system within the Carnarvon Basin will be disturbed by Project development.
- Less than 430 ha (19%) of the Nerren land system within the Project Area and less than 0.28% of the system within the Carnarvon Basin will be disturbed by Project development.
- Less than 607 ha (33%) of the Sandplain land system within the Project Area and less than 0.0006% of the system within the Carnarvon Basin will be disturbed by Project development.
- Less than 35 ha (7.4%) of the Snakewood land system within the Project Area and less than 0.0004% of the system within the Carnarvon Basin will be disturbed by Project development.
- Less than 2.5 ha (4%) of the Tarcumba land system within the Project Area and less than 0.0001% of the system within the Carnarvon Basin will be disturbed by Project development.

Therefore, when placed in a regional context, no land system is expected to be significantly disturbed as the result of the Project.

Topographic and other data will be collected prior to mining to guide design of the rehabilitated landform. The rehabilitated landform will be visually congruent with landforms adjacent to the Project Area.

7.2.3 Management

Impacts on the landforms of the Project Area will be minimised through progressive backfilling and rehabilitation of disturbed areas. The Rehabilitation Plan developed for the Project is provided as Appendix F. The plan describes the landform design process.

COMMITMENT 4

The draft Rehabilitation Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will rehabilitate areas disturbed during the construction and operation of the Project on a progressive basis.

7.3 SOILS

7.3.1 Objectives and Standards

Environmental Objectives

- Rehabilitate the soil profile so that it can sustain a stable ecosystem.

Relevant Standards

- ANZMEC & MCA (2000) Strategic Framework for Mine Closure.

7.3.2 Definition of Issues and Impacts

The major issues identified in relation to soils are topsoil and subsoil management, identification of dispersive soils and rehabilitation of the disturbed soil profile.

Topsoil and Subsoil Management

The characteristics of the topsoil and subsoil of the Project Area are described in Section 4.2.3. At the surface of the soil profile exists a layer of highly mobile sand that consists of coarse grained particles with single-grained fabric of depth varying from 1 cm to 15 cm. The topsoil comprises the top 10 cm of the soil profile and consists predominantly of sand with a small percentage (<13%) of clay and silt. The topsoil also contains decaying vegetative material, plant roots and seeds. The subsoil comprises the next 90 cm of the soil profile and also consists predominantly of sand with a small percentage (<13%) of clay and silt. However, within the subsoil the amount of vegetative material and seeds decreases significantly, with plant root proportion decreasing with soil depth.

The topsoil and subsoil of the Project Area footprint will be removed prior to mining and infrastructure establishment. This disturbance affects the soil profile and processes by destroying the earthy fabric of the sands and forming material with a single-grained fabric. This predisposes them to accelerated wind erosion.

Rehabilitation

There is a range of issues that could arise with the rehabilitation process if the soil profile is not returned in an effective manner. Some of these issues include:

- Poor recruitment of native species;
- A soil profile which inhibits root development;
- A soil profile with decreased moisture retention capacity;
- The dispersion of clays in sub-soils, which has the potential to decrease stability;
- A soil profile which inhibits the vertical infiltration of water; and
- Accelerated wind erosion.

A negative result would cause a reduction in the health and vigour of the revegetation, which would compromise the intended post-mining land use in the longer term.

However, Gunson is aware of the issues and have obtained specialist advice from D.C. Blandford and Associates Pty Ltd on soil management. It is intended to remove the top 10 cm of soil separately to the underlying 90 cm of subsoil and replace these materials in the same order over the reshaped tailings, thereby recreating the subsoil and topsoil profile. Experience from other mineral sand mines elsewhere indicates that such an approach has a high expectation of success.

It is also intended to classify all soil as to its dispersive nature prior to mining. This will ensure that any dispersive soils encountered are returned to the base of the mine pit.

The undisturbed soil profile can contain up to 40% of fine-grained particles (<0.212mm) which contribute to the retention of soil moisture within the profile. It is anticipated that up to two-thirds of the fine-grained particles will be removed from the soil during processing. The loss of these fines from the lower soil profile (> 1m below surface), and the loss of soil fabric, is unlikely to greatly impact on

the success of the rehabilitation programme (D. Blandford, pers comm.). A monitoring plan will be implemented by Gunson to compare the particle size distribution, density, and soil moisture in undisturbed analogue sites and the reconstructed profile.

In addition, Gunson has obtained independent peer advice on the design of the draft Rehabilitation Plan from a recognised specialist in rangelands management for this region. The advice received is that rehabilitation of the mine is possible and can be managed to ensure successful revegetation of mined areas.

7.3.3 Management

Management of soils is described in the draft Rehabilitation Plan which is presented in Appendix F.

COMMITMENT 5

The Proponent will implement a soils characterisation programme to identify any potentially dispersive soils and ameliorate any impact to the rehabilitated soil profile.

COMMITMENT 6

The Proponent will implement a soils monitoring programme to assess the capabilities of the reconstructed soil profile and compare them with the soil characteristics of the original and analogue profiles.

7.4 SURFACE WATER

7.4.1 Objectives and Standards

- Maintain the integrity, functions and environmental values of natural surface water drainage;
- Minimise the footprint of disturbance during the life of the Project;
- Minimise the transport of salt, sediment and other pollutants from mine areas;
- Post-mining efforts should establish stable, sustainable landforms consistent with the existing landscape; and
- Rehabilitate the Project Area and any other affected areas by the mining operations to a standard consistent with the intended post-mining long-term land use.

Relevant legislation and standards include:

- Conservation and Land Management Act;
- EP Act;
- Rights in Water and Irrigation Act;
- *Soil and Land Conservation Act* 1945;
- Water and Rivers Commission Act;
- ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality; and
- ANZMEC & MCA (2000) Strategic Framework for Mine Closure.

7.4.2 Definition of Issues and Impacts

In general, the existing Project Area is internally draining and has few surface water features due to low rainfall, high evaporative conditions, and inferred high infiltration capacity dunal soils. It has no defined watercourses, permanent fresh-water bodies, or birridas (seasonally inundated, saline lakes). There are no known sensitive surface water features within the proposed mining area.

The catchment area upstream of the Project Area is relatively small and will likely produce little runoff during storm events. Most rainfall typically ponds in depression areas and evaporates, or infiltrates rapidly.

The potential impacts have been identified as localised to the Project Area and are readily manageable.

7.4.3 Management

No management plan for surface water flow is required. As discussed above, there are no defined watercourses, permanent freshwater bodies, or birridas (seasonally inundated, saline lakes), within the Project Area. Further, due to low rainfall, high evaporative conditions, and high infiltration dunal soils there is little need for active management in relation to surface water. However, Gunson is committed to rehabilitating the final landform to a state that is safe, stable, non-erodible and compatible with that of the surrounding undisturbed areas. The reconstruction of the final landform will be designed to minimise erosion and to re-establish natural water infiltration regimes.

During construction and operation of the Project surface water runoff from roads and other non contaminated hard surfaces will be channelled into a sediment retention basin, stored and allowed to evaporate. This will reduce the possibility of localised flooding, erosion and movement of sediment into neighbouring properties.

In areas where runoff may be potentially contaminated (i.e. fuel storages), water will be channelled into a separate retention ponds where it can be tested for levels of contaminants and treated

as necessary before release to natural water courses or recycling into the process. Drainage systems will be designed to withstand the extreme effects of storm and flooding activities. They will also be designed and constructed to prevent leakage into the groundwater.

Erosional events identified during rehabilitation monitoring and site visits will be assessed and remediated as soon as practical. Methods and techniques for managing surface water will be reviewed in light of new data as a part of the Gunson commitment to continuous improvement. Corrective action will be taken should performance not achieve nominated targets.

7.5 GROUNDWATER

7.5.1 Objectives and Standards

The main objectives in regard to groundwater for the Project are as follows:

- Maintain the quality of groundwater to ensure that existing and potential users, including ecosystem maintenance are protected;
- Maintain the integrity, functions and environmental values of the local hydrogeology; and
- Ensure that the beneficial uses of groundwater by others can be maintained.

Relevant legislation and standards include:

- Conservation and Land Management Act;
- EP Act;
- Rights in Water and Irrigation Act;
- Rights in Water and Irrigation Regulations 2000; and
- Water and Rivers Commission Act.

7.5.2 Definition of Issues and Impacts

The geological stratigraphy of the Project Area is not uniform and comprises a series of confined and unconfined aquifers that occur beneath the Project Area and surrounding environs. It is proposed that process water supplies for the Project be abstracted from these confined aquifers.

A summarised version of the existing hydrological environment and key issues is provided below. For further detailed information, refer to Appendix D.

Confined Aquifers

There are five major confined aquifers beneath the Project Area. These comprise the Cretaceous Windalia Radiolarite, Cretaceous Windalia Sand Member, Birdrong Sandstone, Devonian Kopke Sandstone and Ordovician Tumblagooda Sandstone. These aquifers are termed ‘confined’ as the movement of water within the aquifers is restricted by confining (overlying) aquitards. A visual summary of the local stratigraphy is provided as Table 2 of Appendix D.

The most extensive aquifers in the Carnarvon Basin are the Cretaceous Birdrong Sandstone and Windalia Radiolarite. The Birdrong Sandstone lies between about 100 m and 150 m below sea level in the Project Area, while the Windalia Radiolarite possibly occurs beneath only the very northernmost part of the area. Groundwater flow within these aquifers is generally towards the west.

The Windalia Sand Member is restricted to the Shark Bay area and is not planned for development by the Project as many of the local pastoral bores utilise this aquifer. The Kopke Sandstone and Tumblagooda Sandstone formations are regional aquifers, although the latter is too deep beneath the Project Area to be economically viable for development.

Groundwater levels in the confined aquifers are not well defined, partially due to inadequate logging and aquifer definition of the private bores in the district, as well as the variable physical condition of these bores. The quality of groundwater in the confined aquifers varies both with depth and spatially. The salinity of the Birdrong and Kopke aquifers in the Project Area range between about 7,750 and 12,000 mg/L total dissolved solids. The Windalia Sand Member ranges in salinity between approximately 8,660 and 9,100 mg/L total dissolved solids.

Unconfined Aquifers

Several shallow unconfined aquifers occur in the area, predominantly in the Peron Sandstone within the northern part of the Project Area and Tamala Limestone near the coast to the west. Local Quaternary to Recent estuarine sediments in the Nilemah Embayment may also contain minor aquifers. Recent investigations suggest that the superficial sand formations in the middle and southern half of the Project Area are dry.

Short-term groundwater yields from the unconfined Tertiary sediments in the Project Area are likely to be comparatively low (below 500 kL/day). Water quality of the unconfined aquifers is variable, but generally ranges from saline in the Project Area to hypersaline in the north.

Hamelin Pool and Nilemah Embayment

Located outside the Project Area, Hamelin Pool and the Nilemah Embayment are significant physiographic features of the Shark Bay area. The location of these areas in relation to the Amy Zone is provided on Figure 7.1. The location of algal mat and stromatolite areas is also indicated on this figure.

Hamelin Pool is a unique marine environment with a restricted tidal interconnection to the Indian Ocean and high evaporation rates causing hypersaline conditions. The Pool is fringed by extensive sublittoral and intertidal platforms and shell coquina beach ridges that are subjected to relatively small tidal fluctuations.

The Nilemah Embayment is located at the southern-most apex of Hamelin Pool and is underlain by a succession of marine sand and clay beds. Beneath the salinas and topographic depressions, the clay sub-crops or outcrops on the landward side of the beach ridge within the Nilemah Embayment. The clay forms a physical and evaporative barrier in the water table aquifer and shallow groundwater environment.

The water table environment in these areas comprises of a mixture of evaporated meteoric water and seawater that is responsible for the *"reasonably homogenous brine at depth"* (BMR, 1990). Local groundwater of meteoric origin would be derived from aquifers in the superficial formations surrounding the embayment. The BMR study data suggests that the shallow groundwater becomes increasingly saline from about 65,000 mg/L TDS just south of the Denham Road to about 200,000 mg/L beneath clay pans and associated salinas in the Embayment.

Studies undertaken in the early 1990s have shown that tidal influences extend inland several hundred metres from the beach and shallow carbonate-rich brackish to saline groundwater discharges below the high-tide mark during low tide. These groundwaters are of meteoric origin entering the flow system through the shell coquina beach ridges, and mix in the marine environment beneath the beach.

The shallow groundwater flow system described for the Nilemah Embayment is repeated along the coast to the northeast. However, the stromatolites occur within a different groundwater discharge catchment than the Project Area and Nilemah Embayment. Where stromatolites occur in Hamelin Pool, carbonate-rich shallow groundwater discharges from the base of the shell coquina beach ridges at low tide and following heavy rain.

Investigations

A series of discreet hydrogeological investigations have been conducted on groundwater systems beneath the Project Area (refer to Section 3 of Appendix D). This involved drilling programmes on both the superficial formations and confined aquifers. The superficial drilling programme comprised construction of multipeizometers and test production bores at three separate sites. The confined aquifer drilling programme comprised the construction and test pumping of a production bore and multipeizometer to provide hydrogeological data on the Windalia Sand Member, Birdrong Sandstone and Kopke Sandstone.

In addition to the drilling programmes, a comprehensive census was undertaken on a total of 58 bores in the surrounding district to define the scope of potential impacts on other groundwater users. The census comprised the collection of historical data on existing bore locations, construction, groundwater levels and groundwater quality. The key findings of the investigations are:

- There are variations in the groundwater qualities in the area. Generally, the salinities of the confined aquifers decrease with depth.

- The superficial aquifer is mostly dry apart from a thin saturated layer in parts of the northern section of the Project Area.

- The Toolonga Calcilutite and Gearle Siltstone/Alinga Formation are regarded as confining aquitards, although several slightly to moderately permeable zones are present below a clayey upper contact in the Toolonga unit.

- The main aquifers beneath the Project Area above the Dirk Hartog Group include (from bottom to top) the Kopke Sandstone, Birdrong Sandstone and Windalia Sand Member with the Muderong Shale between the upper two units. The Windalia Radiolarite may also occur beneath the northern end of the Project Area instead of the Windalia Sand Member. Apart from the larger shale content in the Kopke Sandstone in DMB1, the lithological sequence is very similar to that reported from stratigraphic hole Coburn 1. A full set of aquifer parameters have been derived from the Birdrong and Kopke Sandstones.

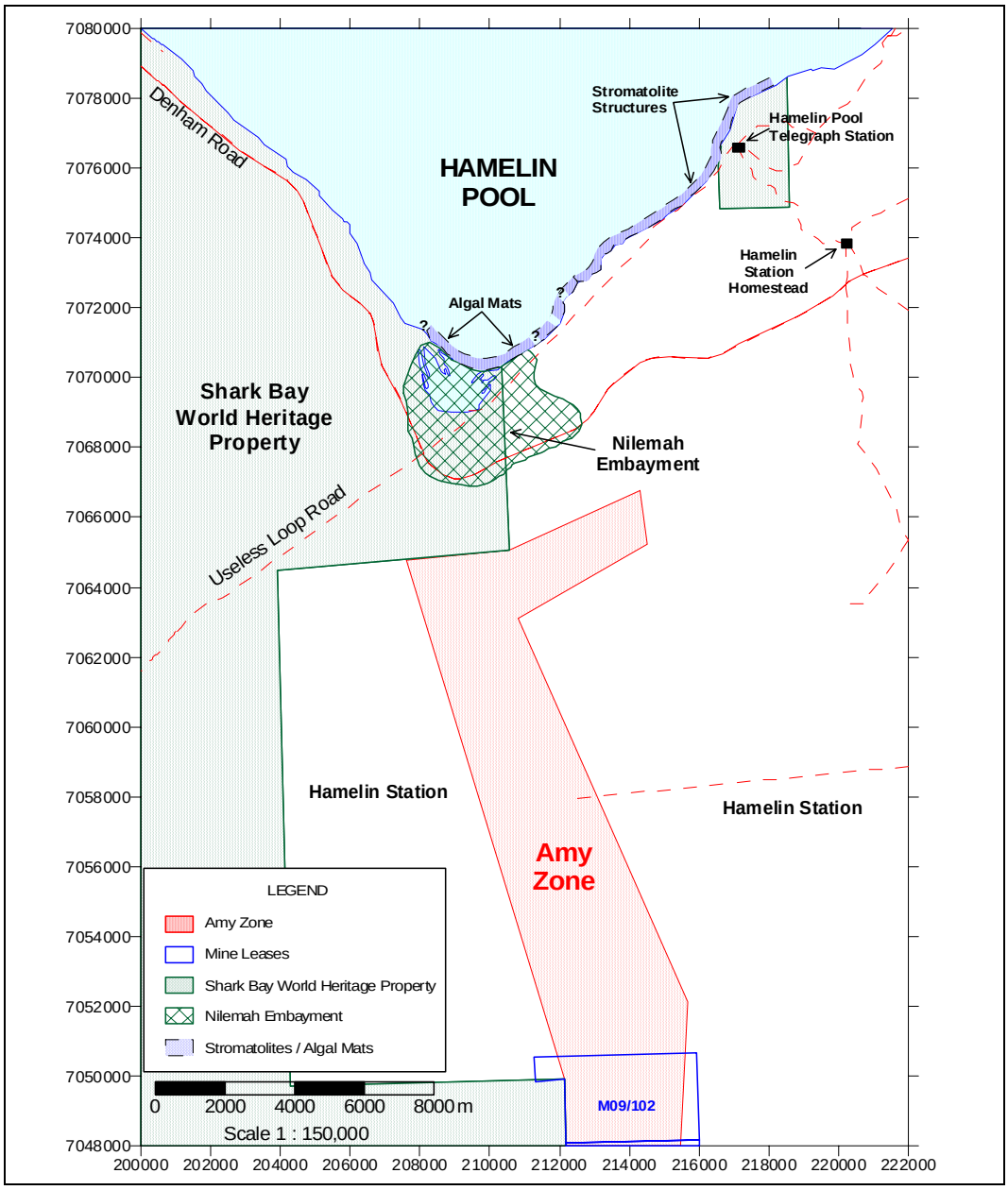

Figure 7.1: Proximity of Nilemah Embayment and Hamelin Pool.

- There are eight artesian bores within the census area (within a 50 km range of the Project Area): Nanga View Homestead, Nilemah Artesian No. 1A, Hamelin Pool Telegraph Station Caravan Park, Hamelin Homestead No 2, Spinifex Bore (including two old bores), Sweeney Mia Bore, Carbla Homestead and Six Mile Well

- Groundwater is utilised locally for pastoral, domestic and road maintenance purposes.

- The closest non-artesian bores to the Project Area provide stock water on Hamelin and Coburn stations. Those on Hamelin Station are operated by windmills, while those on the Coburn Station are equipped with diesel-driven Mono (shaft-turbine) pumps.

- It is difficult in many bores to determine from which confined aquifer system groundwater is being abstracted however, interpretations made from available data indicate that the majority of bores within the radial census area of 50 km may be extracting from the Windalia Sand Member and Birdrong Sandstone to the south-east, east and north-east; and from the Windalia Radiolarite and Birdrong Sandstone to the north-west.

Assessments

The following findings have been derived from the groundwater investigations:

- Conceptual mine water recovery strategies have been developed utilising the low permeability pit floor and swales between the overburden piles as collection traps. Mine water recovery rates depend on the thickness of sand beneath the drain floors and the rate of tailings discharge. These rates are likely to vary significantly depending on short-term factors such as sand stacker locations in the pit (i.e. proximity to floor drains in the pit).

- A net deficit in the mine water balance will necessitate a make-up supply to maintain the processing operations. The amount of make-up water required for processing will be dependent on the losses from the mine water circuit caused by seepage into the superficial sand formations. This make-up water will be sourced from the deep confined aquifers.

- The magnitude of drawdown impacts in bores that intersect only the Windalia Radiolarite or Windalia Sand Member are expected to be less than those intersecting the Birdrong Sandstone and Kopke Sandstone. Actual drawdown impacts will depend on the local and regional characteristics of vertical hydraulic connections between the Windalia Sand Member and the Birdrong Sandstone.

- Pumping groundwater at 11GL/annum will draw down the bore water levels in several private bores by a predicted maximum amount of between zero metres drawdown at Cape Well Bore, Beethen Outcamp Well and Natta Outcamp Bore and 8.9 m at Hamelin Spinifex 1 bore during the mine life. Apart from Hamelin Spinifex 1 bore (on Hamelin Station), none of the existing artesian bores are likely to stop flowing. The pressures of artesian bores within 20 km of the Project Area are likely to be reduced during the latter stages of the mine's life.

- The nearest possible groundwater-dependent ecosystem is likely to be the salina and estuarine ecology associated with the Nilemah Embayment at the northern end of the mine. The groundwater beneath the embayment is primarily rainwater derived, suggesting the contribution to this system from Hamelin Pool is minimal, if any. Potential impacts from the dissipation of saline groundwater mounds within the Project are recognised. Further study and development of mitigation measures will be undertaken well prior to mining reaching these areas.

- It is also highly unlikely that the algal mats or stromatolites along the shoreline of Hamelin Pool are dependent on regional groundwater given that they, and the near-shore shallow groundwater system, are reliant on the saline water in Hamelin Pool for water level and nutrients. No changes as a result of the Project to either the water quality or groundwater hydraulics are likely to reach the Hamelin Pool shoreline as there is no hydraulic connection between the aquifers beneath the Project Area and Hamelin Pool.

- Mine water is expected to mound beneath the active sand stacker areas due to seepage into the adjoining superficial sand. These mounds are likely to be above the Toolonga basement contact and will flatten quickly away from the pit area. It is the development of these mounds that allow relatively high rates of water recovery except where the rate of stacker advance is too fast for the necessary hydraulic gradients to develop. Under these conditions, it is recognised that additional water recovery strategies will be required.

- Residual mine water mound heights will only be significant where they might lead to water levels less than about 5 m from the surface. Most of the roots from natural vegetation are located within the uppermost 1 to 2 m, but several mallee species have deeper root systems that may reach 5 to 10 m depth. Several areas of thin superficial sand cover have been identified at the southern and northern ends of the Amy Zone. These areas will require specific monitoring of both water levels and vegetation.

Pit dewatering will only be required for mining of the northern-most parts of the orebody. The abstraction of groundwater for pit dewatering and the local drawdown in water table is considered unlikely to affect vegetation as site investigations show that no species are groundwater dependant. Mounding of saline mine water beneath the backfilled pit is unlikely to affect adjacent vegetation because their roots are shallow and generally well above the mounded water table.

The key issues relating to groundwater and the Project from a local and regional perspective are summarised as Table 7.3.

Table 7.3
Summary of Potential Impacts on Groundwater

IMPACT	SOURCE
Local	
Mounding	
Mounding of the water table in the superficial formations and within the root zones of vegetation stands	Disposal of sand and slimes tailings in slurry form
Residual process water mounding and discharging through shallow aquifers into the Nilemah Embayment with some portion of the discharge ultimately reaching Hamelin Pool	Disposal of sand and slimes tailings in slurry form
Drawdown	
Drawdown impacts within the superficial formations	Pit dewatering in the northern project area
Regional	
Drawdown	
Removal of groundwater from the regional confined aquifer systems	Large-scale abstractions at rates exceeding the estimated recharge and throughflow beneath the Project Area
Temporary deficits in recharge compared to abstraction	Large-scale abstractions of groundwater from storage in unconfined zones of the regional aquifer systems
Drawdown impacts within the confined aquifer systems on other users of groundwater	Large-scale abstractions from the Birdrong Sandstone and Kopke Sandstone
Propagation of drawdown impacts from the regional confined aquifer systems vertically upwards into the water table aquifer	Large-scale abstractions from confined aquifers

7.5.3 Management

Groundwater management will be required for both environmental and economic reasons. Environmentally, to ensure that groundwater abstraction does not adversely affect regional groundwater resources and dependent ecosystems. Economically, to minimise groundwater use and maximise recovery for recycling. It will be in the proponent's commercial interest to recover and recycle as much water as is practical.

Identification of management issues and development of mitigation strategies are detailed in the draft report on Groundwater Resource Impact Assessments provided in Appendix D. It is proposed that the mitigation strategies are staged using the following approach:

- mapping of the vegetation and typical depths of root penetration;
- the installation of multipiezometers to characterise thickness of the superficial formations and depths to the water table;
- use of the additional knowledge to refine the potential risks;
- monitoring of actual water table mounding;
- where appropriate, maintain active drains in the pit(s) adjacent to areas at risk in order to intercept and abstract tailings water locally contributing to the mounding; and
- where appropriate review the mining plans to increase the duration of mining and reduce the height of residual mounding.

Monitoring bores to be located between the mine and sensitive areas will provide early warning of need for remedial action.

Gunson has made a commitment to finalising the Groundwater Management Plan (Commitment 7) in consultation with relevant stakeholders. In addition, a number of commitments have been made in the Groundwater Resource Impact Assessments, which is provided as Appendix D, in relation to further groundwater studies and other aspects. These are documented as Commitments 8-20.

COMMITMENT 7

The draft Groundwater Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. Gunson will implement the Groundwater Management Plan during the construction, operation and decommissioning of the Project.

COMMITMENT 8

The Proponent will operate the borefield in line with the Project's groundwater licence operating strategy.

COMMITMENT 9

The Proponent will remain within the licensed allocation as defined by the Licence to Take Water current at the time.

COMMITMENT 10

The Proponent will trial and implement robust, practical and secure tailings water recovery strategies that strongly promote and demonstrate groundwater conservation principles.

COMMITMENT 11

The Proponent will implement monitoring programmes, particularly in the initial three years of the project, that enable the magnitudes and dimensions of the water table mounding beneath the sand-stackers to be characterised.

COMMITMENT 12

The Proponent will implement investigation and monitoring programmes in known areas of potential environmental risk due to water table mounding encroaching on the root zones of vegetation stands.

COMMITMENT 13

If monitoring indicates the mounding will reach the root zones in sensitive vegetated areas, the Proponent will undertake additional mitigation measures as required to minimise long term impacts.

COMMITMENT 14

The Proponent will develop practical operating strategies linked to the sand-stackers that would facilitate the retention and tailing waters abstraction from localised in-pit drains required to limit environmental risks to nearby vegetation stands.

COMMITMENT 15

The Proponent will implement investigation and monitoring programmes within the Nilemah Embayment to refine the understanding of the hydrogeology, stratigraphy and shallow groundwater environments.

COMMITMENT 16

The Proponent will review mining plans to reduce the rate of northern pit development (Pit 10), the number of sand-stackers in operation and the magnitudes of the residual mounds.

COMMITMENT 17

The Proponent will investigate and monitor the vertical hydraulic gradients and hydraulic conductivities within the Alinga Formation and Toolonga Calcilutite to assess impacts from the confined to the unconfined aquifer systems.

COMMITMENT 18

The Proponent will establish a multipiezometer network in the confined aquifer systems that provides a robust pre-development baseline and enables an accurate assessment of local and regional drawdown impacts.

COMMITMENT 19

The Proponent will develop and implement a communication strategy to broadcast to individual pastoralists the predicted drawdown impacts on their production bores.

COMMITMENT 20

The Proponent will maintain supply to existing groundwater users that are adversely impacted by drawdowns resulting from the process water borefield operation.

7.6 VEGETATION

7.6.1 Objectives and Standards

Project objectives include:

- Minimise the impacts on the abundance, species diversity, geographic distribution and productivity of plant communities;
- Protect DRF, consistent with the provisions of the Wildlife Conservation Act;
- Protect flora listed under the Schedules of the EPBC Act; and
- Protect flora of other conservation significance (e.g. undescribed taxa, range extensions, outliers).

Relevant legislation and standards include:

- EPBC Act;
- Wildlife Conservation Act;
- EPA Position Statement No. 2 (Environmental Protection of Native Vegetation in Western Australia, 2000);
- EPA Position Statement No. 3 (Terrestrial Biological Surveys as an Element of Biodiversity Protection in Western Australia, 2002); and
- EPA Guidance Statement No. 51 (Terrestrial Flora Surveys for Environmental Impact Assessment in Western Australia, 2004).

7.6.2 Definition of Issues and Impacts

Comprehensive survey work was carried out to map the distribution of the vegetation communities in the Project Area and to determine the potential for mining to impact on native flora.

Approximately 5,745 ha of vegetation will be cleared and rehabilitation progressively over the 20-year mine life. An assessment of the potential impacts due to clearing on each of the plant communities present in the Project Area is provided below.

- **Plant Community E1**

  Plant community E1 comprises a Low Open Woodland of *Eucalyptus selachiana* and *Eucalyptus roycei* with occasional emergent *Banksia ashbyi* over *Calothamnus formosus* subsp. *formosus* and *Acacia ramulosa* var. *ramulosa* over *Lamarchea hakeifolia* var. *brevifolia, Malleostemon pedunculatus* and *Melaleuca eulobata* over *Triodia danthonoides.*

  This community is considered to be regionally significant as it is endemic to the Shark Bay region. It covers an area of nearly 300 ha within the Project Area in an area towards the northern end of this area (Figure 4.6b).

  Approximately 200 ha (nearly 67%) of this community within the vegetation survey area will be cleared through the development of Pit 10 and associated infrastructure (Figure 4.6b).

- **Plant Community E2**

  Plant community E2 is a Low Open Woodland of *Eucalyptus selachiana* and *Eucalyptus fruticosa* with occasional emergent *Eucalyptus mannensis* subsp. *vespertina* and *Eucalyptus roycei* over *Acacia ramulosa* var. *ramulosa, Acacia ligulata* and *Eremophila maitlandii* over mixed annual species.

  This community may be considered regionally significant as it is endemic to the Shark Bay region. The survey area contains 846.8 ha of this vegetation community, towards the northern end. Of this, 199.1 ha, or 23.5%, will be cleared through the development of Pit 10 and associated infrastructure (Figure 4.6b).

- **Plant Community E3**

  Plant community E3 comprises a Low Open Woodland of *Eucalyptus fruticosa* and *Eucalyptus obtusiflora* subsp. *obtusiflora* over *Acacia xiphophylla, Acacia ramulosa* var. *ramulosa* and *Acacia ligulata* over mixed Chenopod species.

  Plant community E3 is considered to be regionally significant as it is endemic to the Shark Bay region and locally significant where it supports the Priority Flora species *Acacia drepanophylla* (P3).

  This community covers an area of approximately 226 ha at the northeastern end of the Project Area and the central portion of the Northern Access Road Option (Figure.4.6b).

  Approximately 199 ha (nearly 24%) of this community within the survey area will be cleared through the development of Pit 10 and associated infrastructure (Figure 4.6b).

- **Plant Community E4**

  Plant community E4 is a Low Open Woodland of *Eucalyptus selachiana* and *Eucalyptus* ?*eudesmioides* over *Acacia ramulosa* var. *ramulosa, Acacia roycei, Acacia ligulata* and *Grevillea gordoniana* over *Baeckea* sp. Nanga (pn) over *Triodia danthonioides*.

  This community may be considered regionally significant as it is endemic to the Shark Bay region. It is also locally significant where it supports populations of *Grevillea acacioides* that occur as a range extension from previously recorded locations.

  There is 71.8 ha of this community within the northern end of the survey area (Figure 4.6b) and at the eastern end of the proposed Access Road (Figure 4.6d). Approximately 16.8 ha (23.4%) will be cleared for the development of Pit 10 and associated infrastructure (Figure 4.6b).

Table 7.3
Predicted area of disturbance for vegetation communities within the Vegetation Survey Area.

Vegetation Community	Significance	Area of Community Within Survey Area (ha)	Predicted Area of Disturbance	
			Area (ha)	%
E1	Regional	299.29	200.35	66.94
E2	Regional	846.81	199.14	23.52
E3	Regional/ Local	226.11	152.63	67.50
E4	Regional/ Local	71.85	16.81	23.40
E5	-	127.73	0.00	0.00
E6	Regional/Local	424.86	211.53	49.79
E7	Regional	185.28	5.25	2.83
M1	Regional/ Local	1577.76	799.38	50.67
S1	Regional/ Local	4985.74	2381.10	47.76
S2	Regional/ Local	4389.03	1426.65	32.50
S3	Regional/ Local	469.48	270.36	57.59
S4	Regional/ Local	94.86	1.44	1.52
S5	Regional/Local	11.43	0.00	0.00
S6	Regional	50.00	0.00	0.00
S7	Local	1815.49	36.83	2.03
S8	Local	433.67	36.94	8.52
S9	Local	274.19	6.86	2.50
S10	Regional/Local	3.89	0.00	0.00
Total		**16287.46**	**5745.26**	**24.28**

Note: The "Survey Area" is the area mapped by Mattiske Consulting Pty Ltd. The Survey Area is larger than the "Project Area" as it includes land that will not be disturbed by Project development.

- **Plant Community E5**

  Plant community E5 comprises a Low Open Woodland of *Eucalyptus obtusiflora* subsp. *obtusiflora* over *Acacia ramulosa* var. *ramulosa* and *Acacia galeata* over *Ptilotus obovatus* var. *obovatus* and *Triodia plurinervata*.

  It is not considered to be locally or regionally significant.

  This community covers an area of nearly 127.73 ha within the Northern Access Road Option (Figure 4.6c and d). None of this community will be cleared for the Project.

- **Plant Community E6**

  Plant community E6 is a Low Open Woodland of *Eucalyptus mannensis* subsp. *vespertina* over *Acacia ramulosa* var. *ramulosa* over *Rhagodia latifolia* subsp. *latifolia* over mixed annual species.

  This community is considered locally significant where Priority Flora species *Grevillea stenostachya* (P3) has been recorded. It may also be considered regionally significant as it is endemic to the Shark Bay region.

  The north west corner of the Project Area (Figure 4.6b) and the proposed Access Road (Figures 4.6c and d) contain 424.9 ha of plant community E6. Approximately 211.5 ha (49.8%) of this will be cleared for the development of Pit 10 and associated infrastructure (Figure 4.6b).

- **Plant Community E7**

  Plant community E7 comprises a Low Open Woodland of *Eucalyptus selachiana* over *Calothamnus formosus* subsp. *formosus* and *Acacia ligulata* over *Lamarchea hakeifolia* var. *brevifolia* over *Triodia danthonioides.*

  This plant community may be considered regionally significant as it is endemic to the Shark Bay region. It covers an area of nearly 185.3 ha in the central portion of the survey area and along the Northern Access Road Option (Figures 4.6b and d). Of this, 5.2 ha (2.8%) will be cleared for the development of Pit 9 and associated infrastructure.

- **Plant Community S1**

  Plant community S1 is a Tall Shrubland of *Calothamnus formosus* subsp. *formosus* and *Hakea stenophylla* subsp. *notialis* with occasional emergent *Eucalyptus selachiana*, *Eucalyptus roycei* and *Eucalyptus mannensis* subsp. *vespertina* with *Banksia ashbyi* over *Acacia ligulata* and *Lamarchea hakeifolia* var. *brevifolia* over *Triodia danthonioides.*

  It is considered locally significant where Priority Flora species *Acacia subrigida* (P2), *Eremophila occidens* (P2), *Grevillea rogersoniana* (P3) and *Physopsis chrysophylla*

(P3) have been recorded. It may also be considered regionally significant as it is endemic to the Shark Bay region, however aerial photograph interpretation indicates that this community covers extensive areas, including parts of the SBWHP.

This community covers 4,985.7 ha throughout the survey area and at the western end of the proposed Access Road. Of this, 2,381.1 ha (47.8%) will be cleared for the development of Pits 1 to 9 and associated infrastructure (Figure 4.6b and d).

- **Plant Community S2**

  Plant community S2 is a Tall Open Shrubland of *Calothamnus formosus* subsp. *formosus, Hakea stenophylla* subsp. *notialis* and *Acacia ligulata* with occasional emergent *Eucalyptus selachiana, Eucalyptus roycei* and *Eucalyptus mannensis* subsp. *vespertina* with *Banksia ashbyi* over *Lamarchea hakeifolia* var. *brevifolia* and *Baeckea* sp. Nanga (pn) over *Triodia danthonioides*.

  This community is considered locally significant where Priority species *Acacia subrigida* (P2), *Eremophila occidens* (P2), *Scholtzia* sp. (P2), *Grevillea rogersoniana* (P3), *Macarthuria intricata* (P3), *Physopsis chrysophylla* (P3) and *Jacksonia dendrospinosa* (P4) have been recorded. It may also be considered regionally significant as it is endemic to the Shark Bay region, however aerial photograph interpretation indicates that this community covers extensive areas, including parts of the SBWHP.

  Approximately 4,389 ha of this plant community exists throughout the survey area and at the western end of the proposed Access Road. Of this, 32.5% (1,426.6 ha) of this community will be cleared during the development of Pits 1 and 3-9 and their associated infrastructure (Figure 4.6b and c).

- **Plant Community S3**

  Community S3 comprises a Low Open Shrubland of *Acacia ligulata* and *Hakea stenophylla* subsp. *notialis* with occasional emergent *Eucalyptus selachiana* and *Eucalyptus roycei* over *Baeckea* sp. Nanga (pn) and *Stenanthemum complicatum* over *Triodia danthonioides*.

  It is considered locally significant where Priority species *Acacia subrigida* (P2), *Eremophila occidens* (P2), *Grevillea rogersoniana* (P3) and *Physopsis chrysophylla* (P3) have been recorded. It may also be considered regionally significant as it is endemic to the Shark Bay region. Existing vegetation mapping suggests that this community extends into the SBWHP.

  There are 469.5 ha of this community within the south western parts of the survey area (Figure 4.6c). Approximately 57.56% (270.4 ha) will be cleared for the development of Pits 2, 3 and 6 and associated infrastructure.

- **Plant Community S4**

  Community S4 comprises a Tall Open Shrubland of *Grevillea gordoniana* and *Acacia ligulata* with occasional emergent *Eucalyptus selachiana* over *Melaleuca eulobata, Baeckea* sp. Nanga (pn) and *Adenanthos acanthophyllus* over *Triodia danthonioides*.

  This plant community may be considered regionally significant as it is endemic to the Shark Bay region. It is also locally significant as it supports populations of *Grevillea acacioides* that occur as a range extension from previously recorded locations.

  Community S4 covers an area of 94.9 ha towards the northern end of the Project Area and western end of the Northern Access Road Option (Figure 4.6b). Of this, 1.4 ha (1.5%) will be cleared as a result of Pit 10 infrastructure.

- **Plant Community S5**

  Community S5 is a Low Open Shrubland of *Acacia subrigida* (P2) with occasional emergent *Eucalyptus* ?*eudesmioides* and *Eucalyptus roycei* with *Banksia ashbyi* over *Malleostemon pedunculatus* over *Triodia danthonioides*.

  This community may be considered regionally significant as it is endemic to the Shark Bay region. It is also considered locally important where the Priority species *Acacia subrigida* (P2) dominates this plant community. It is particularly significant as it is restricted to deep valleys, which are locally and regionally uncommon landforms.

  Approximately 11.4 ha of this community exists within the central survey area (Figure 4.6b), but none will be cleared.

- **Plant Community S6**

  Plant community S6 comprises a Low Open Shrubland of *Acacia longispinea* with occasional emergent *Eucalyptus mannensis* subsp. *vespertina* over *Melaleuca leiopyxis* and *Melaleuca eulobata* over *Malleostemon pedunculatus* over *Triodia danthonioides.*

  This community may be considered regionally significant as it is endemic to the Shark Bay region. The western end of the Northern

Access Road Option contains approximately 50 ha of this community (Figure 4.6b), but none of it will be cleared.

- **Plant Community S7**

  Community S7 is a Tall Open Shrubland of *Acacia sclerosperma* subsp. *sclerosperma* and *Acacia ramulosa* var. *ramulosa* over *Eremophila maitlandii* over *Ptilotus obovatus* var. *obovatus*.

  This community is considered locally significant where the Priority species *Acacia drepanophylla* (P3) and *Grevillea stenostachya* (P3) have been recorded within it.

  Approximately 1,815.5 ha of this community covers the central and eastern sections of both the proposed Access Road and the Northern Access Road Option (Figure 4.6d). Of this, 36.8 ha (2.0%) will be cleared as result of access road development.

- **Plant Community S8**

  Plant community S8 comprises a Tall Open Shrubland of *Acacia xiphophylla, Acacia drepanophylla* (P3) and *Acacia ramulosa* var. *ramulosa* over *Chenopodium gaudichaudianum* and *Scaevola spinescens.*

  It is considered locally significant where the Priority Flora species *Acacia drepanophylla* (P3) has been recorded.

  This community covers 433.7 ha of the north eastern survey area and central to eastern parts of the Northern Access Road Option (Figure 4.6b). Of this, 36.9 ha (8.5%) will be cleared for Pit 10 and associated infrastructure.

- **Plant Community S9**

  Community S9 is a Tall Open Shrubland of *Acacia xiphophylla* and *Acacia drepanophylla* (P3) over *Acacia grasbyi, Acacia tetragonophylla* and *Senna glutinosa* subsp. *chatelainiana* over *Ptilotus obovatus* var. *obovatus.*

  This plant community is considered locally significant where Priority species *Acacia drepanophylla* (P3) has been recorded.

  Approximately 274.2 ha of this community exists at the eastern end of the proposed Access Road, and central to eastern areas of the Northern Access Road Option (Figure 4.6d). Of this, 6.9 ha (2.5%) will be cleared for the development of the proposed Access Road.

- **Plant Community S10**

  Community S10 comprises a Tall Open Shrubland of *Physopsis chrysophylla* (P3) and *Acacia rostellifera* over *Calothamnus formosus* subsp. *formosus* and *Mirbelia* sp. Denham (pn) over *Triodia danthonioides.*

  Community S10 may be considered regionally significant as it is endemic to the Shark Bay region. It is locally significant where it is dominated by the Priority Flora species *Physopsis chrysophylla* (P3) which, on the basis of current information, appears to be restricted within the survey area. This plant community is also considered locally significant where Priority Flora species *Macarthuria intricata* (P3) has been recorded.

  The south western sections of the Project Area contain 3.9 ha of this community (Figure 4.6c), none of which will be cleared.

- **Plant Community M1**

  The pattern of plant communities differs significantly in the northern section of the Project Area compared to the southern end. The shrublands and Eucalypt patches in the north form a mosaic of locally variable communities. Often this occurs over 50 metres, which is too small to be seen on any of the included maps. This mosaic of local communities has been combined into the M1 community.

  Community M1 therefore comprises a mosaic of patches of a Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa, Acacia ligulata* and *Acacia roycei* with occasional emergent *Eucalyptus selachiana, Eucalyptus roycei, Eucalyptus mannensis* subsp. *vespertina* and *Eucalyptus obtusiflora* subsp. *obtusiflora* over *Eremophila maitlandii* and *Lamarchea hakeifolia* subsp. *brevifolia* over mixed annual species, with patches of a Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa* and *Acacia roycei* over *Melaleuca leiopyxis* and *Malleostemon pedunculatus* over mixed annuals in sands.

  This plant community may be considered regionally significant as it is endemic to the Shark Bay region. This community covers approximately 1,577.8 ha of the northern survey area (Figure 4.6b). Of this, 799.4 ha (50.7%) will be cleared through the development of Pit 10 and associated infrastructure.

In addition to clearing, vegetation within the Project Area could be affected by:

- Changes to surface drainage patterns;
- Lowering of water tables due to dewatering operations;
- Mounding of tailings seepage, resulting in localised changes to water table depths; and

- Overspray or run-off of saline water used for dust suppression.

Gunson has outlined a range of mitigation measures in the draft Vegetation and Flora Management Plan (Appendix O). In addition, strategic mine planning has allowed for the protection of the two most significant vegetation types as outlined by Mattiske (2005, Appendix J): Communities S5 and S10 (Table 7.3). The two other communities that Mattiske (2005, Appendix J) recommend retaining due to the high density of Priority Flora (S8 and S9) will be disturbed over less than 8.5% of their total area.

Weed species are likely to initially inhabit the rehabilitation areas, as identified during the Rehabilitation Benchmarking Study (Appendix E). Weed species have been found throughout the SBWHP, and the effect of these weeds on the establishment of native vegetation is unknown. The measures proposed to mitigate any negative affects are outlined in the draft Weed Management Plan (Appendix O).

The use of groundwater during the mining process and the subsequent drop in water table levels is unlikely to affect the vegetation. However, vegetation health will be monitored throughout the course of the mine life.

Groundwater mounding beneath and adjacent to the mine due to seepage of tailings water is unlikely to significantly impact on vegetation as mounding is unlikely to affect the root zone. However, some areas have been identified in which tailings seepage may occur in the vicinity of the root zone (see Figure 7.2). If seepage enters the root zone, there may be localised loss of plant condition and plant deaths. Water tables in these areas will be monitored and managed via recovery bores to minimise the risk of this occurring.

Fire has historically occurred in the Project Area and affected the vegetation communities. There is potential for fire to occur during the life of the mine. This occurrence could affect many aspects of the rehabilitation programme, and is discussed further in the draft Fire Management Plan (Appendix O). The main aim of this Plan is to minimise potential for mining operations to start fires, and to protect the rehabilitation area from bushfire.

The loss of significant amounts of vegetation due to the creation of excessive dust is unlikely. Mitigation measures to reduce dust levels are outlined in Section 8.1.3 of the PER and the draft Dust Management Plan (Appendix O). A draft Hydrocarbon Management Plan (Appendix O) has been prepared to prevent any potential leakage or spillage of hazardous materials or hydrocarbons. It is anticipated that there will be no impact on the flora and vegetation from these substances.

In addition, Gunson has purchased the Coburn pastoral lease. The company has committed (Commitment 3) to de-stock the station for several years, and more if approval can be obtained from the Pastoral Board. This will allow recovery of vegetation and flora due to decrease in grazing pressure. It is possible that the Coburn Station will subsequently be sub-leased to another pastoralist and stock levels will be capped at well levels below the carrying capacity estimated in the December 2004 Rangeland Condition Assessment Report.

Overall, impacts on local and regional vegetation are expected to be minor given the mitigation measures proposed by Gunson and the intended rehabilitation methodology.

7.6.3 Management

The Management Issues and Commitments are presented in the draft Vegetation and Flora Management Plan and draft Weed Management Plan. These are provided in Appendix O.

COMMITMENT 21

The Proponent will ensure that vegetation communities S5 and S10 are not disturbed by the Project.

COMMITMENT 22

The Proponent will implement annual vegetation surveys in locations adjacent to the areas affected by mining and in the northern section of the Project Area in order to monitor the effect of mining operations on vegetation health.

COMMITMENT 23

The draft Vegetation and Flora Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Vegetation and Flora Management Plan during the construction and operational phases of the Project.

COMMITMENT 24

The draft Fire Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Fire Management Plan during the construction and operational phases of the Project.

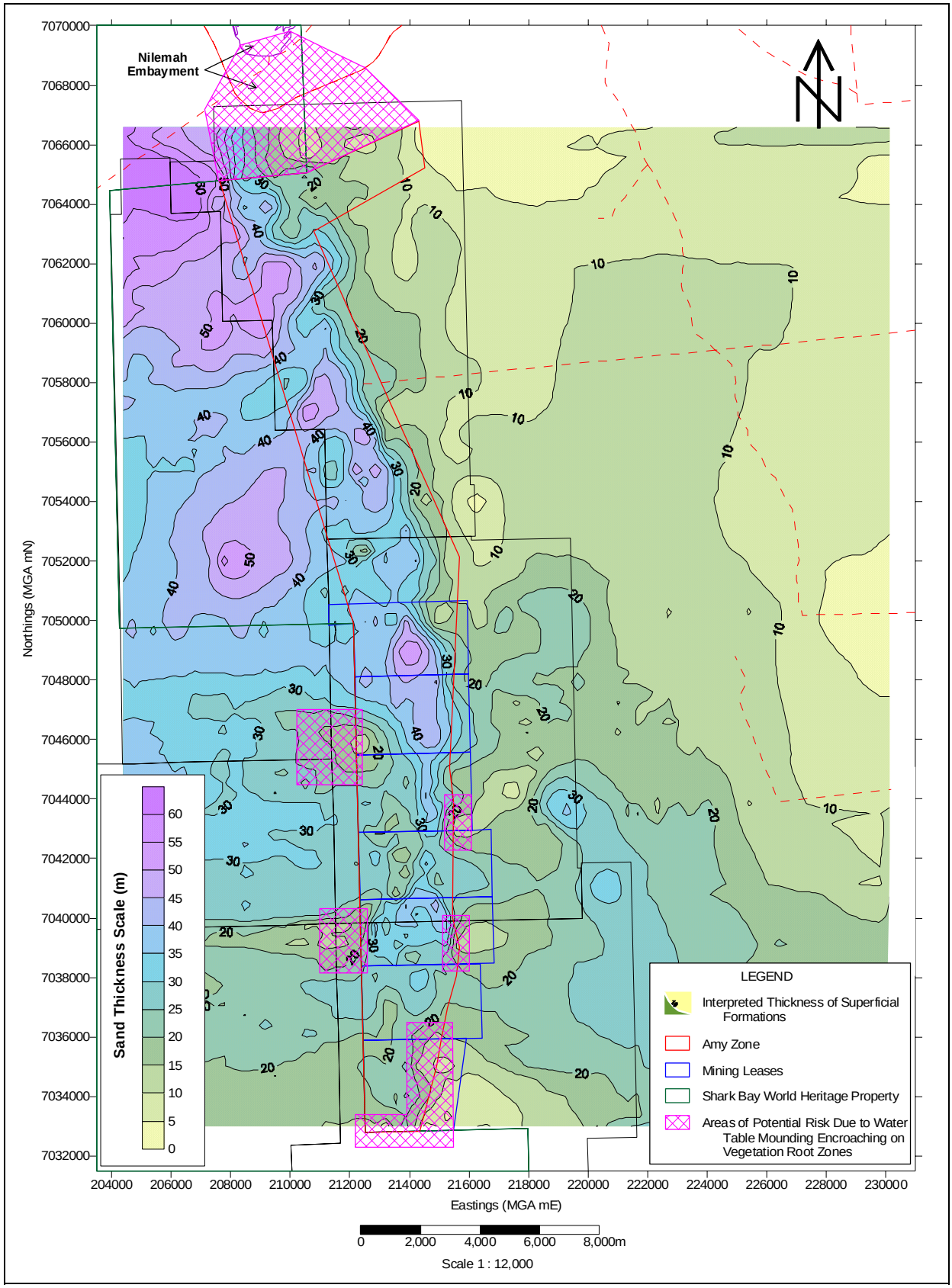

Figure 7.2: Areas of Vegetation which may be at Risk from Mounding Encroachment on Root Zones.

7.7 FLORA

7.7.1 Objectives and Standards

Project objectives include:

- Minimise the impacts on the abundance, geographic distribution and productivity of flora;
- Protect DRF, consistent with the provisions of the Wildlife Conservation Act;
- Protect flora listed under the Schedules of the EPBC Act; and
- Protect flora of other conservation significance (e.g. undescribed taxa, range extensions, outliers).

Relevant legislation and standards include:

- EPBC Act;
- Wildlife Conservation Act;
- EPA Position Statement No. 2 (Environmental Protection of Native Vegetation in Western Australia, 2000);
- EPA Position Statement No. 3 (General Requirements for Terrestrial Biological Surveys, 2002); and
- EPA Guidance Statement No. 51 (Terrestrial Flora Surveys for Environmental Impact Assessment in Western Australia, 2004).

7.7.2 Definition of Issues and Impacts

A total of 231 taxa (including subspecies and varieties) from 132 genera and 51 families were recorded (Appendix J). Fourteen introduced (weed) species were recorded. None of these introduced species recorded are listed as Declared Plants, as defined by the Department of Agriculture (2004).

No plant taxa listed as Threatened pursuant to Schedule 1 of the EPBC Act were recorded in the Project Area. In addition, no plant taxa gazetted as DRF under the Wildlife Conservation Act were found within the Project Area. However, *Eucalyptus beardiana* may be present in the vicinity of the accommodation camp. Gunson will conduct further detailed ground searching to determine if it is present in the area so that it can be protected from disturbance.

Nine Priority Flora species have been recorded in the Project Area. The potential impact on these species is discussed below:

- *Acacia subrigida* is a Priority 2 tree species that is known to occur in the Shark Bay district and Southwest WA. It has been recorded in the SBWHP by Keighery et al. (2000).

  Four populations of *Acacia subrigida* have been recorded within the Project Area, within plant communities S1, S2, S3 and S5. Within community S5, this species occurs as a dominant species. Of the four known populations, only one is located within the footprint of the proposed Project and will be cleared or otherwise disturbed by the development of Pit 4.

- *Eremophila occidens* (ms) is a Priority 2 shrub species. Within the Project Area, *Eremophila occidens* (ms) is a relatively common shrub found at eight locations across three widespread communities (S1, S2 and S3). However, it has only previously been collected at two isolated areas (four collections) in the Exmouth and Shark Bay districts, including the SBWHP (Keighery et al. 2000).

  Three of the known populations *Eremophila occidens* (ms) within the area surveyed by Mattiske occur outside of the Project Area and will not be disturbed by Project development. The remaining populations will be cleared or disturbed through the development of pits 4-6 and 9, and associated infrastructure.

- *Scholtzia* sp. Folly Hill is a Priority 2 species that has previously been recorded from six locations within the northern portion of the Geraldton Sand Plains and the Shark Bay district. Within the Project Area, this species was only recorded at one location, within plant community S2 adjacent to Pit 1. It is considered to be a late successional species. as it was only found in a mature and open shrubland. This location will not be disturbed by Project development.

- *Acacia drepanophylla* is a Priority 3 species which typically occurs as a small tree. Its known distribution is from north of Hamelin Bay to just south of the Billabong Roadhouse on the North West Coastal Highway. It was recorded in the SBWHP by Keighery et al. (2000).

  Mattiske (2005) recorded *Acacia drepanophylla* at nine locations across four plant communities (S7, S8, S9 and E3). Six of these locations occur outside of the Project Area and will not be disturbed by Project development. The remaining three populations will be cleared or disturbed through the development of Pit 10 and associated infrastructure.

- *Grevillea rogersoniana* is a Priority 3 species endemic to Shark Bay and the Peron Peninsula (30 collections). It has been recorded in the SBWHP by Keighery et al. (2000).

  This conspicuous species was recorded by Mattiske (2005) at six locations across plant communities S1-S3, most commonly in tall open shrublands. The development of pits 4, 6 and 7 will clear or disturb one population each. A fourth population is located immediately to the east of the main north-south haul road, but it should be possible to avoid disturbance of this population. The remaining two populations will not be disturbed by Project development.

- *Grevillea stenostachya* is a Priority 3 species known to occur within the Project Area, the SBWHP (Keighery et al. 2000) and at a site in the Murchison 70 km east of the Project Area (Mattiske, 2005). Within the Project Area, this dense, pungent shrub is locally abundant in the three locations along the proposed access road in which it was recorded, in plant communities E6 and S7. One of these populations will not be disturbed through access road development. It may be possible to avoid disturbance of the other two populations, though some degree of clearing is expected.

- *Macarthuria intricata* is a Priority 3 species that has only been recorded at nine locations and is endemic to the Shark Bay district. It has been recorded in the SBWHP by Keighery et al. (2000).

  Macarthuria intricata is a small, intricately-branched shrub that occurs within the Project Area at only two sites, in plant communities S2 and S10. The population occurring within Community S10 will not be disturbed, but the second population will be cleared or disturbed through development of infrastructure associated with Pit 1.

- *Physopsis chrysophylla* is an erect shrub up to 5 m high that is classified as a Priority 3 species. This species has been recorded in the Geraldton Sand Plains and Shark Bay districts, including the SBWHP (Keighery et al. 2000).

  Within the Project Area, *Physopsis chrysophylla* was a relatively common species in plant communities S1, S2 and S3, and was a dominant species in community S10. Of the seven populations recorded within survey area by Mattiske (2005), three populations will be cleared or disturbed through the development of Pits 4, 6 and 9, and associated infrastructure.

  One population of *Physopsis chrysophylla* is located adjacent to a proposed concentrator site for Pit 6 and one population is located immediately to the east of the main north-south haul road. It may be possible to avoid disturbance of these populations.

  Two populations of *Physopsis chrysophylla* are located outside of the proposed Project footprint, and will not be disturbed by Project development.

- *Jacksonia dendrospinosa* is a Priority 4 species is a Priority 4 species previously recorded at nine locations in the northern section of the Geraldton Sand Plains. This small tree was uncommon in the Project Area and was restricted to mature, open shrublands in plant community S2, suggesting that it is a late successional species.

- This species was recorded at only one location within the Project Area, towards the western end of the proposed access road. It may be possible to avoid disturbance of this population.

Eight flora species were located outside their previously recorded ranges. These are *Acacia galeata, Austrostipa macalpinei, Daveisia divaricata* subsp. ?*lanulosa* (ms), *Dicrastylis soliparma, Grevillea acacioides, Grevillea stenostachya* (P3), *Trachymene coerulea* subsp. *leucopetala* and *Avellinia michelii.*

Of the above species, six have previously been recorded in the SBWHP (*Acacia galeata, Austrostipa macalpinei, Daveisia divaricata, Grevillea stenostachya, Trachymene coerulea* subsp. *leucopetala* and *Avellinia michelii*). However, it is recognised that *Avellinia michelii* is an introduced species and so has no conservation value.

7.7.3 Management

The Management Issues and Commitments are presented in the draft Vegetation and Flora Management Plan, draft Priority Flora Management Plan and draft Weed Management Plan. These are provided in Appendix O.

Measures outlined in the draft Priority Flora Management Plan and draft Vegetation and Flora Management Plan propose that seeding programmes for the rehabilitation areas will target these Priority species, thus mitigating the effect on the regional population. Future surveys will provide further information on their local population distribution and ecology.

COMMITMENT 25

The Proponent will conduct further survey work to determine whether *Eucalyptus beardiana* and *Verticordia dichroma* var. *syntoma* or other Rare or Priority Flora are present within the proposed haul road corridor and accommodation camp area.

COMMITMENT 26

Searches for Rare and Priority Flora will be conducted prior to the development of each pit and associated infrastructure to ensure that up-to-date information is considered in the detailed design of the pits and other project components during the construction and operation of the Project.

COMMITMENT 27

The draft Priority Flora Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Priority Flora Management Plan during the construction and operational phases of the Project.

COMMITMENT 28

The draft Weed Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Weed Management Plan during the construction and operational phases of the Project.

7.8 VERTEBRATE FAUNA

7.8.1 Objectives and Standards

Project objectives include:

- Minimise impacts on abundance, species diversity, geographical distribution and productivity of vertebrate fauna;
- Protect specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act;
- Protect rare and endangered species listed under the Wildlife Conservation Act;
- Protect fauna listed on the Schedules of the EPBC Act;
- Monitor and protect where possible species listed under the CALM Priority Fauna List; and
- Protect other fauna species of particular conservation significance (eg. undescribed taxa, range extensions, outliers).

Relevant legislation and standards include:

- EPBC Act;
- Conservation and Land Management Act;
- Wildlife Conservation Act; and
- EPA Guidance Statement No. 56 (Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, 2004).

7.8.2 Definition of Issues and Impacts

A desktop fauna review and three comprehensive site surveys by Ninox Wildlife Consulting (2005, Appendix K) in spring 2003, autumn 2004 and spring 2004 were completed as requested by stakeholders. These surveys identified the presence or possible presence of 15 native mammal species, four amphibian species, 69 reptile species and 81 bird species. The surveys also identified the presence of eight introduced mammal species. Most of these species have widespread distributions throughout the semi-arid region and are not restricted to individual habitats. A list of fauna species and the distribution of their habitats expected to occur in the Project Area is provided in Appendix K.

Vegetation community S3 and the eucalypt woodlands in the northern section of the Project Area are of local significance. These habitats generally supported higher species diversities and abundances of birds and reptiles.

The most likely impact on the fauna in the Project Area will come from clearing of 5,745 ha of fauna habitat over the 20 year mine life. The vegetation in the northern region of the Project Area consists primarily of low open woodland with *Eucalyptus* species being the predominant overstorey species. The southern portion of the Project Area contains vegetation ranging from Tall Shrubland, consisting primarily of *Calothamnus*, *Hakea* and *Eucalyptus* species, to Low Open Shrubland, consisting primarily of *Acacia* species.

The loss of vertebrate fauna habitat is expected to result in the localised loss of vertebrates that are too small or immobile to relocate to unaffected areas. While many of the birds, larger mammals and reptiles will be able to relocate and avoid the impact of exploration, mining and construction of infrastructure, there may be some territorial conflicts associated with competition for food resources, shelter and breeding sites. It is expected that these conflicts would be resolved over time and naturally stabilise.

Fauna may also be impacted through:

- Noise and light disturbing local populations;
- Accidental road kills; and
- Accidental drowning in process water ponds or open seepage interception trenches.

Process water ponds and open seepage interception trenches will be fenced to deter entry by fauna. Some animals, particularly smaller species, may still gain entry to these areas but should be able to escape as the sides of the ponds and trenches will not have steep slopes. However, to minimise the risk of fauna losses, Gunson will install mesh or "self rescue" mats to allow animals to exist the water. In addition, regular inspections of these areas will be conducted and any trapped animals will be released.

Other issues of concern are the presence of Malleefowl (*Leipoa ocellata*), and possible presence of the Hamelin Skink (*Ctenotus zasticus*) within the Project Area. Both species are listed as Vulnerable under the EPBC Act and Threatened under the Wildlife Conservation Act.

Malleefowl were not observed during the surveys, but their presence was recorded by their footprints and 19 nest sites which were more common in the southern section of the Project Area. Due to their mobility, the mining process is unlikely to result in the death of individual animals. However, some Malleefowl habitat and 10 of the known nesting sites will be lost during the mining process. None of these nesting sites have been used recently. This disturbance is not expected to significantly impact upon the regional Malleefowl population due to their wide distribution and presence in neighbouring pastoral leases (Section 4.1.2.2).

The draft Vertebrate Fauna Management Plan (Appendix O) proposes a range of mitigation measures aimed at increasing Malleefowl populations outside the Project Area, and increasing the rate of Malleefowl repatriation to disturbed areas.

One method of increasing Malleefowl populations, and that of other native species, is to reduce the impact of introduced predators and competitors: two factors that are known to threaten Malleefowl populations (Benshemesh 2000). To successfully achieve this outcome, Gunson proposes to conduct annual aerial baiting programmes, consistent with the Department of Agriculture protocols. In addition, as stated in Section 7.6.3, the property will be destocked for several years before stock is returned at populations well below the estimated carrying capacity of the property. This decrease in predation and grazing competition should significantly increase the populations of native species on the entire property.

A survey was undertaken in September 2004 with the specific aim of determining the presence of the Hamelin Skink (*Ctenotus zasticus*) within the Project Area. Only seven specimens have been lodged in the Western Australian Museum (Western Australian Museum, Queensland Museum and Museum and Art gallery of NT 2004), and these come from populations approximately 12 kilometres to the east of the Project Area. The known locations were visited, and habitat assessed. Only one vegetation community within the surveyed area (E5) was considered to be similar to the Hamelin Skink habitat. This habitat will not be affected by the mine and thus the Hamelin Skink is unlikely to be affected by the proposed mining operations.

Stakeholders expressed concern over the possibility of the Sandhill Frog (*Arenophryne rotunda*) being affected by the mining operations. This species was not recorded during any of the surveys, and there is only a low possibility of it occurring in the southwestern sectors of the Project Area.

Overall, impacts on the regional vertebrate fauna values is expected to be minor considering that most vertebrate fauna found in the Project Area are generally widespread in distribution throughout the semi-arid region.

7.8.3 Management

Management Issues and Commitments are presented in the draft Fauna Management Plan, which are provided in Appendix O.

COMMITMENT 29

The draft Vertebrate Fauna Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Vertebrate Fauna Management Plan during the construction and operational phases of the Project.

7.9 SUBTERRANEAN FAUNA

7.9.1 Objectives and Standards

The project objective is to conserve any significant areas of subterranean fauna by restricting impacts caused by aquifer drawdown.

Relevant legislation and standards include:

- EP Act;
- EPBC Act; and
- EPA Guidance Statement No. 54 (Sampling of Subterranean Fauna in Groundwater and Caves, 2003).

7.9.2 Definition of Issues and Impacts

Western Australian subterranean fauna exhibit high levels of endemism and many species appear to have restricted ranges. Dewatering and water supply development may impact the diversity and distribution of subterranean fauna species if they are present in the area. Stakeholders voiced concern over the potential impacts of mining operations on stygofauna both within and outside the SBWHP.

A field survey conducted by UWA Zoology in 2004 identified that no stygofauna are present in the Project Area (Appendix L). Sampling was not conducted in the southern portion as no bores existed.

7.9.3 Management

Therefore the following recommendations have been made relating to future research and management:

- Sampling of bores located in the southern section of the Project Area and identification and interpretation of data collected;
- Sampling should occur bi-annually preferably in summer and winter to reveal seasonal effects on stygofaunal presence;
- Future sampling should include sites within and outside the mining area, including the zones potentially affected by dewatering; and
- Sampling of additional bores installed during the groundwater investigation. Current data suggest that it may take weeks to months for stygofauna to re-inhabit media surrounding bores following construction and/or development.

Whilst it is considered unlikely that stygofauna will be found in the Project Area some additional sampling will be undertaken to confirm the baseline study results.

COMMITMENT 30

The Proponent will conduct a stygofauna survey in the southern portion of the Project Area using existing bores. Re-sampling of the bores located in the northern portion of the Project Area will also be conducted. If stygofauna are found to occur in these areas, then sampling outside of the Project Area will be conducted to demonstrate that these species occur outside the Project Area.

7.10 LOCAL AND REGIONAL BIODIVERSITY

7.10.1 Objectives and Standards

The Project objective is:

- Maintain the abundance and diversity of species, and geographic distribution and productivity of local and regional biodiversity.

Relevant legislation and standards include:

- EPBC Act;
- Conservation and Land Management Act;
- Wildlife Conservation Act; and
- ANZMEC & MCA (2000) Strategic Framework for Mine Closure.

7.10.2 Definition of Issues and Impacts

The Project Area is located within the Irwin Botanical District, as part of the South-western Botanical Province. It contains a vegetation system referred to as the Tamala System, which is a formation not found anywhere else in the State. In addition, the western edge of the Project Area is located within close proximity to the SBWHP.

The diversity of fauna species within the Project Area is representative of the regional area. In general, regional diversity of native mammals and amphibians is poor, with birds and reptiles both exhibiting moderately rich species diversity.

Stakeholders expressed concern of the possible impact of the proposed mining operation on the local and regional biodiversity.

The most likely impact on the biodiversity values in the Project Area will come from the loss of 5,745 ha of habitat due to clearing. Vegetation will be cleared, and fauna will lose habitat. However, a range of mitigation measures proposed by Gunson aim to limit the decrease in local biodiversity values.

Less than 25% of the vegetation within the Project Area will be disturbed (Table 7.3). The two vegetation communities highlighted by Mattiske Consulting (Appendix J) as being particularly significant will not be affected by the mining operation. The rehabilitation practices propose measures including the seeding of Priority species and progressively rehabilitating the disturbed areas. The procedures outlined in the Rehabilitation Plan (Appendix F) are expected to decrease the effect of the mining operation on local biodiversity, however reduced local biodiversity values are anticipated.

Most, if not all, vegetation communities, flora species and fauna are likely to occur outside the Project Area, therefore regional biodiversity values are unlikely to be significantly affected. In addition, regional protocols such as the proposed de-stocking will more that adequately mitigate the effect of the proposed mining operations.

7.10.3 Management

Management measures are presented in the draft Rehabilitation Plan (Appendix F), draft Priority Flora Management Plan, draft Vegetation and Flora Management Plan and the draft Fauna Management Plan, which are provided in Appendix O.

In addition, the Proponent has already committed to:

1. de-stocking the Coburn pastoral lease for several years, and more if permission is granted by the Pastoral Board;
2. controlling introduced predators;
3. staging the mining of Pit 10 until the Proponent can prove to the EPA that the side effects of mining will not affect the fundamental values of the SBWHP.

Given these mitigation measures, the regional biodiversity is not at risk from the proposed mining operation.

8.1 ATMOSPHERIC EMISSIONS

8.1.1 Objectives and Standards

The main objectives for the Project in regard to atmospheric emissions are as follows:

- Ensure that dust and other atmospheric emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem. In particular, dust emissions should not adversely affect vegetation and stromatolites within the SBWHP; and
- Use all reasonable and practicable measures to minimise airborne dust.

Relevant Standards

Air quality impacts can be assessed by comparing model predictions with appropriate ambient air criteria. A range of assessment criteria are available, and are considered in this study:

- National Environment Protection Measure (NEPM) for Ambient Air Quality. The standards defined in this measure are concentrations set to ensure that public health, amenity and the environment are protected;
- National Health and Medical Research Council (NHMRC) air quality guidelines; and
- New South Wales Impact Assessment Criteria – These are ground level concentration limits designed to be used in conjunction with dispersion modelling. If maximum predicted downwind concentrations are less than the impact assessment criteria, then there should be no adverse impacts on the environment.

The WA DoE and EPA routinely adopt (where necessary) ambient air quality guideline values in the assessment of new proposals, and in the management of both local and regional ambient air quality. As a matter of policy, the EPA and DoE have now adopted the NEPM standards for ambient air quality.

EPA Guidance Statement No.18 (Prevention of Air Quality Impacts from Land Development Sites; 2000) also provides guidance on the control of dust and smoke from land development sites.

8.1.2 Definition of Issues and Impacts

Air pollution is not a single entity, but comprises a number of pollutants, which may have separate sources and effects. In the case of the Project, the main emission with potential for off-site effects is particulate, primarily from large open sources associated with mining and stockpiling activities.

Other discharges to airshed include products of combustion of fossil fuels and include:

- On-site power generation;
- On-road and off-road vehicles;
- Construction and operation equipment; and
- Modular power generation units.

Potential sources of dust emissions in the locality of the mine are expected during:

- Clearing of vegetation;
- Topsoil removal and replacement;
- Subsoil removal and stockpiling;
- Excavation of overburden and ore;
- Wheel generated dust from machinery and vehicle movements on site; and
- Dust pick-up (wind erosion) from exposed areas, including the operational pit, areas cleared for the concentrators and offices, access roads, stockpiles and the accommodation camp.

An emissions inventory for the Project was prepared in accordance with the National Pollutant Inventory (NPI) Emission Estimation Technique (EET) Manual for Mineral Sands Mining (Environment Australia 2001) and Processing and process data for point source emissions (natural gas powered electricity generation) supplied by Energy Developments Limited (EDL). Process data was supplied by EDL to characterise emissions of CO, NO_X, PM_{10} and SO_2 arising from operation of the high efficiency modular gas-powered generator units (8 MW capacity each) to provide electricity to the concentrators. Emissions from the gas-powered generator (800 kW capacity), proposed to provide the accommodation camp's power requirements, were also quantified by EDL.

Emissions were also estimated for the parameters of CO, NO_X, PM_{10}, SO_2 and Volatile Organic Compounds (VOCs) for the following vehicle categories:

- Mobile mining equipment (dozer, front end loader, scrapers);
- Site services (cranes, forklift, off-highway 4WD site vehicles);
- Road trains for haulage of HMC product from the Project site to Geraldton; and
- On-road light 4WD vehicles to support the Project and travel to/from the minesite.

Potential sensitive receptors in relation to dust deposition include the Coburn Homestead (17 km east of the Amy Zone), Hamelin Homestead (nine kilometres northeast of the Amy Zone), vegetation within SBWHP (west of the Amy Zone) and the stromatolites at Hamelin Pool to the north of the Amy Zone.

A modelling assessment of the anticipated emissions arising from the Project at the nearest sensitive receptors was undertaken in March 2005. All major pollutants (CO, NO_X, TSP, PM_{10} and SO_2) were modelled to predict maximum downwind concentrations for comparison with the respective guidelines. The modelling study also included an assessment of dust deposition arising from operations at both of the northern and southern ends of the Amy Zone (see the Air Quality Report provided as Appendix N).

Results from the modelling study show that atmospheric emissions such as NO_X, CO and SO_2, generated from the Project represent negligible risk at nearest sensitive receptors. All of these parameters are predicted to be well below their respective assessment criteria. At Coburn Homestead, concentrations of SO_2, NO_X and CO are anticipated to be less than 0.01%, 4.9% and 0.03% of their criteria respectively. Gunson will monitor the latest developments in pollution control technology and implement where practical as part of their commitment to continuous improvement to environmental management.

Dust modelling studies have indicated that there is potential for off-site impacts, particularly given the strong southerly winds that occur during much of the year. This is mainly of potential when mining the northernmost pit (Pit 10) though modelling has indicated that the southern shores of Hamelin Pool are likely to receive a very low level of dust settlement ($1g/m^2$/month, see Figure 8.1).

Concern has been raised regarding the effect of such dust settlement on algal mats and stromatolites located around Hamelin Pool. It is difficult at present to reliably predict what effects, if any, low levels of dust settlement may have on these communities. It is anecdotally known that dust occurs in the region naturally as a result of the persistent strong winds. It is also known that stromatolites near the tourist viewing area have been exposed to high levels of dust episodically from vehicles travelling the gravel road prior to its relatively recent sealing. However, the effect of dust on these communities is not known.

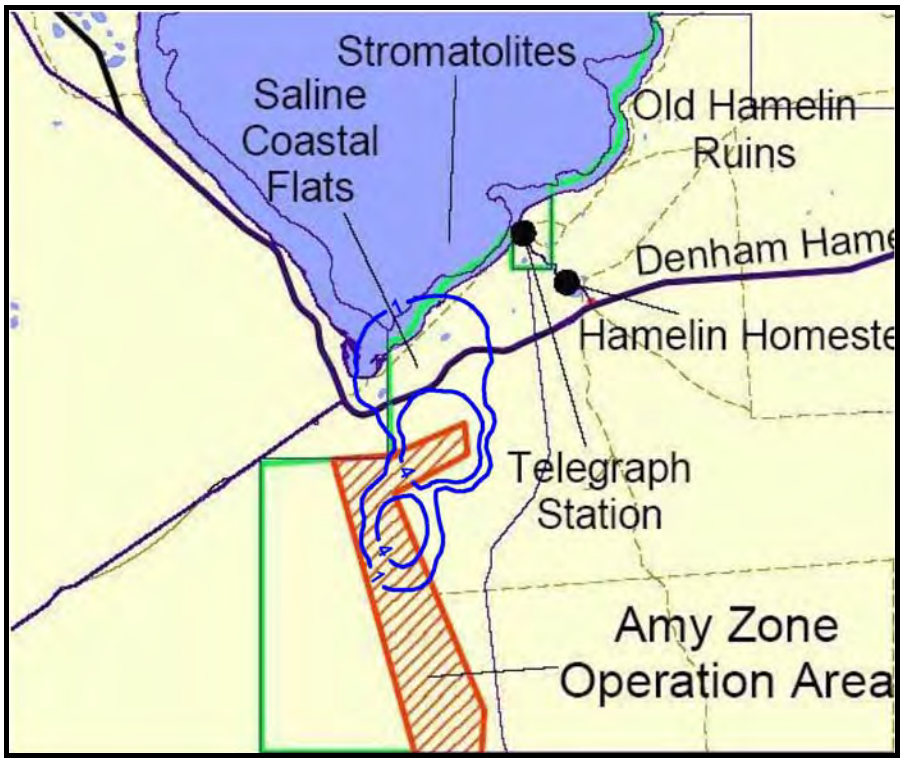

Figure 8.1: Predicted Dust Deposition Rates – Scenario 2 (Final Mining Stages)

Gunson proposes to collect baseline data on dust levels in the Hamelin Pool area and to monitor the success of dust management measures. Once data have been collected, the atmospheric model will be re-run for operation in the northern-most pit (Pit 10). If dust settlement on the southern shores of Hamelin Pool is still predicted, Gunson will research the potential effects on stromatolites.

Therefore fugitive sources of particulate (as PM_{10}) represent the greatest contributor to regional air emissions, although still well below ambient guideline criteria for public health and amenity. See also Section 10 of this PER.

It should be remembered that coarse to medium grain sand does not travel far from the mining area, and silt and clays are a very low proportion of the particulate material being mined.

Further information in relation to air emissions assessment and methodology is provided in the Air Quality Report (Appendix N).

8.1.3 Management

Management of dust emissions during construction and operation of the Project has been identified as a key concern.

Dust generation during the vegetation clearing activities will be managed by undertaking the clearing in stages to minimise the areas of exposed soil at any one time. Dust generation during the transportation of material and the operation of the mine is unlikely to have a significant impact on nearby land users, if stringent dust control measures are implemented during the construction and operational phases of the project.

Gunson recognises that dust management will be an essential component of site environmental performance, and will undertake a range of preventative measures to minimise fugitive dust sources as part of its daily operations, and provide ongoing monitoring of deposited dust levels.

The following management actions will be implemented to mitigate against the potential impacts on the surrounding sensitive receptors:

- maintaining a buffer zone of vegetation between the proposed mining areas to act as windbreaks, reducing wind velocity and dust mobilisation;
- implementing a progressive rehabilitation programme to reduce the risk of dust generation;
- visually monitoring the level of offsite particulate emissions and using dust suppression techniques, when necessary;
- ensuring exposed stockpiles are watered or sprayed where required;
- sealing the main access road to reduce dust generated by vehicles travelling on the road;
- not overloading trucks or conveyors to avoid spillages.
- regular wetting and grading of all unsealed roads;
- not disturbing topsoil until absolutely required;
- using biodegradable or inert chemical polymers/bitumen to stabilise bare soil surfaces;
- scheduling major earthworks (vegetation clearing) to the months of April and May;
- undertake a comprehensive monitoring programme; and,
- where appropriate, growing temporary cover crops to bind the soil and protect soil surface from wind.

Monitoring dust levels will be undertaken at pre-determined locations throughout the minesite and adjacent areas in the SBWHP (such as Hamelin Pool). This will include regular photographic monitoring at established control sites. Monitoring methodologies and locations of the control sites will be selected in consultation with the DoE.

Reporting of monitoring results and complaints will be provided to the DoE and included in Gunson's Annual Environment Report.

Contingency actions will be initiated when problems are identified during the monitoring programme, or an adverse impact has been determined in consultation with relevant stakeholders.

If detected, any adverse impact will be reported to the DoE and investigated by an independent suitably-qualified professional. Upon determination of the cause, a remediation strategy will be developed and implemented in consultation with the DoE.

Further information on dust management and monitoring is provided in the Dust Management Plan (Appendix O).

COMMITMENT 31

The draft Dust Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Dust Management Plan during the construction and operational phases of the Project.

COMMITMENT 32

The Proponent will collect baseline data on dust levels in the Hamelin Pool area and monitor the success of dust management measures. Baseline and monitoring data will be used to verify the atmospheric model for Pit 10 and the Hamelin Pool area. If dust settlement on the southern shores of Hamelin Pool is still predicted, the Proponent will research the potential effects on stromatolites.

COMMITMENT 33

The Proponent will integrate best practice dust management procedures in consultation with the DoE and regular monitoring and reporting of offsite impacts including vegetation and stromatolites located within the SBWHP.

8.2 GREENHOUSE EMISSIONS

8.2.1 Objectives and Standards

The objectives for the Project include:

- Minimise emissions to as low as reasonably practicable on an ongoing basis and consider offsets to further reduce cumulative emissions; and
- Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.

Relevant EPA Guidance Statements, Position Statements and other regulatory guidelines include the following:

- EP Act;
- United Nations Framework Convention on Climate Change, 1992;
- Western Australian State Greenhouse Strategy (WA Greenhouse Task Force 2004);
- EPA Guidance Statement No. 12 (Minimising Greenhouse Gases, 2002);and
- EPA Preliminary Position Statement No. 9 (Environmental Offsets, 2004).

8.2.2 Definition of Issues and Impacts

The emissions of carbon dioxide (CO_2) from fossil fuel combustion are increasing the concentration of CO_2 in the global atmosphere, which influences the global climate via the enhanced greenhouse effect. Other Greenhouse Gases (GHGs) include methane (CH_4), nitrous oxide (N_2O) and fluorinated gases, which also influence the enhanced greenhouse effect.

The international response to climate change took shape with the development of the United Nations Framework Convention on Climate Change (1992). The Kyoto Protocol officially came into effect on 16 February 2005 after Russia signalled its intent to participate in late 2004. Australia is a signatory to the Kyoto Protocol, but has not yet ratified it.

Project Emissions

An inventory of GHG emissions anticipated to arise as a result of the proposal was determined in accordance with the EPA Guidance Statement No. 12 - Guidance Statement for Minimising Greenhouse Gas Emissions. This is summarised in Table 8.1.

During the first two years of production, it is anticipated that ten road trains per day (five return trips, approximately 80t load) will be required to transport 400 t of HMC to Geraldton. This is approximately 120,000 t of concentrate per annum.

From Year 3, around 20 road trains will be used to transport 800 t per day (ten return trips, approximately 80t load) or approximately 240,000 t of concentrate per annum.

This equates to a measure of greenhouse intensity (ie. amount of GHG emissions, on a CO_2-equivalent basis, per unit production) of 0.34 tpa $CO_{2\text{-}e}$/t HMC exported (Years 1 and 2), decreasing to 0.32 tpa $CO_{2\text{-}e}$/t HMC exported for subsequent years of operation.

It can be seen from Table 8-1 that the largest contributor to the net GHG emissions profile for the proposal is for power generation (85-90% of total emissions). Gunson intends to utilise high efficiency (38-40%) variable load generator units using natural gas as the energy source for the Project. It is predicted that this will deliver significant greenhouse benefits in comparison to alternative fossil fuel sources. If power generation was to be diesel-fuelled, for instance, the use of this

fuel would result in an average of 29% higher GHG emissions (CO_{2-e}) per GJ of energy required for power generation utilities (on a full fuel cycle basis), than the current design case of using natural gas.

The clearing of land required for the Project Area, representing a total disturbance envelope of 5745.26 ha, will inevitably have some impact on the greenhouse inventory attributable to the mine as a result of removing aboveground biomass. However, due to the progressive rehabilitation of the site, the only expected emissions will be generated from power generation, vehicles and machinery and therefore considered minimal.

Over a sufficiently long period of time, these land clearing emissions have the potential to be partially or wholly offset by rehabilitation and reservation of other areas of native vegetation.

Net emissions anticipated to result from the Project are predicted to represent a minor contribution (0.1%) of the State's greenhouse emissions inventory (estimated 65.9 Million tpa in 2002, Western Australian Greenhouse Taskforce 2004).

Table 8.1
Greenhouse Gas Emissions Inventory

Source Category	Yr 1& 2 - Estimated GHG emissions (tpa CO_{2-e})	Yr 3 onwards - Estimated GHG emissions (tpa CO_{2-e})
Emissions From Mobile Equipment	1,890	3,510
Emissions From Concentrate Haulage	2,471	2,241
Emissions From Power Generation	30,686	61,371
Emissions From Site Services	651	1,280
Emissions From Light Vehicles	146	194
Emissions From Vegetation Clearing	1,089	1,333
TOTAL	**36,932**	**69,930**

Notes:
1. Calculations of estimated greenhouse gas emissions have been based on published emission factors of the Australian Greenhouse Office (AGO 2004 - Factors and Methods Workbook, August 2004).

2. The assessment conducted by URS assumed that the source of natural gas would be Compressed Natural Gas (CNG) from the DBNGP, trucked to site and liquefied for on-site use as LNG. For the purpose of this assessment, it was assumed that LNG would be used for power generation, using AGO full fuel cycle emission factors for Western Australian natural gas (AGO 2004, Table 2). Gunson has subsequently confirmed that LNG will be used for power generation. The LNG will be trucked from Karratha.

3. Gunson does not intend to undertake any blasting operations at the Amy Zone operations; therefore the inventory does not take into account GHG emissions from explosive use.

4. Emissions from power generation take into account emissions required to fuel the on-site desalination system to provide potable water.

8.2.3 Management

Throughout the operational phase of the Project, Gunson will progressively backfill and rehabilitate mined-out pits as mining progresses northwards through the Project Area.

The clearing of vegetation will be kept to a minimum and stockpiles of vegetation will not be burnt, but spread over rehabilitation areas after contouring of the final landform and prior to reseeding.

Emissions of greenhouse gases from fuel consumption will be managed through appropriate maintenance of on-site vehicles and equipment to ensure fuel consumption is optimised. Selection of high efficiency variable load power generation using natural gas for the Project will provide benefits in greenhouse and energy efficiency during operations.

Gunson is committed to undertaking an ongoing monitoring and reporting program to measure its emissions over the life of the Project. This will also include a periodic assessment to review opportunities to further improve energy efficiency and reduce greenhouse gas emissions over time.

The above assessment indicates that, through quantification of potential greenhouse gas emission using current Australian methodologies and the potential to completely offset those emissions in the long-term through rehabilitation measures, the net impact on domestic greenhouse gas emission will be minor. It can be concluded, therefore, that the proposed Project satisfies the environmental objective stated in EPA Guidance No.12 to 'ensure

that potential greenhouse emissions… are adequately addressed and best available technologies are used in Western Australia to minimise Western Australia's GHG emissions.

8.3 NOISE

8.3.1 Objectives and Standards

The primary objectives for the Project are:

- Ensure that noise emissions, both individually and cumulatively, do not adversely impact on the amenity of nearby residents by meeting statutory requirements and appropriate criteria;
- Ensure that the noise received (from the mining operation) at the neighbouring residences is within the prescribed standards of the Environmental Protection (Noise) Regulations 1997 (the Noise Regulations); and
- Ensure that noise emissions from truck movements to and from the mine site to Geraldton will comply with the EPA's Draft Statement No. 14 (Version 3) - Road and Rail Transportation Noise, with the relevant section being 5.3 "Criteria for proposed increase in road or rail traffic". Section 5.3 of the EPA Draft states:

  "The (EPA) objectives are:

  i. that the noise levels inside noise-sensitive premises associated with the proposed traffic should meet acceptable levels, or that the degree of increase in noise levels should be of low significance.
  ii. that the noise emissions of the vehicles associated with the specific proposal should comply with "best practice"."

The relevant legislation and standards include:

- Environmental Protection (Noise) Regulations 1997 ;
- EPA Draft Guidance Statement No. 8 (Environmental Noise, 1998); and
- EPA Draft Statement No. 14 (Version 3 - Road and Rail Transportation Noise, 2000).

8.3.2 Definition of Issues and Impacts

The Project Area is located to the east of the SBWHP, 17 km west of the Coburn homestead and 9 km southwest of the Hamelin homestead. These two homesteads are the nearest residences (noise sensitive premises) to the Project Area. As the mine will operate 24 hours per day, the potential noise impact from the Project is mainly during the night-time period.

The mine access road, access road turnoff and North West Coastal Highway will also be subject to increased noise levels with the movement of vehicles, transport trucks (accelerating and braking, and inappropriate use of horns) and machinery. Traffic noise will be greatest during the construction phase of the Project when the majority of the machinery required for initial project installation, will be on site.

A noise impact assessment was undertaken by Herring Storer Acoustics (HSA) using a computer modelling programme known as SoundPlan 6.1 (SoundPlan). The model was used to predict the noise propagation to any noise sensitive premises (Herring Storer Acoustics 2004). In addition, using the Noise Regulations, the noise received at the neighbouring residences was assessed by way of noise contours and single point calculations.

The input data used for the noise modelling were as follows:

- Ground contours; and
- Source sound power levels for mining equipment.

The assumptions of the model were as follows:

- Modelling was carried out under the weather conditions as listed in the EPA Draft Guidance Statement No. 8 - Environmental Noise;
- Modelling was based on the full scale mining operations at the current ground level to represent the worst case scenario;
- Modelling was undertaken for the closest point to the Coburn Homestead and mining at the northern end of the operations; and
- No modelling was required for noise from truck movements, because the noise received at any noise sensitive premises would be negligible even during the conditions with the maximum number of daily truck movements (i.e. after two years).

The results of the noise assessment predicted that the L_{A10} noise levels received at the Coburn and Hamelin homesteads would be 10 dB(A) and 11 dB(A), respectively. These levels are below the assigned L_{A10} noise level of 35 dB(A) for the night-time period under the Environmental Protection (Noise) Regulations. Therefore, the proposed mining operations will comply with regulatory requirements at all times and no noise amelioration is required.

Noise received at noise sensitive premises from the truck movements will comply with the EPA's Draft

Statement No. 14 – Road and Rail Transportation Noise.

The noise assessment is provided as Appendix P.

8.3.3 Management

Despite noise modelling suggesting that all operations (including transport of the HMC to Geraldton) comply with Environmental Protection (Noise) Regulations and EPA's Draft Statement No. 14 – Road and Rail Transportation Noise, Gunson will keep unnecessary noise emissions to a minimum. This is not only to ensure that the amenity of nearby residents is not adversely affected, but also to reduce the disturbance to local fauna by the effects of noise.

8.4 VIBRATION

8.4.1 Objectives and Standards

The main objectives for the Project are:

- To minimise the impact of machinery vibration on the environment; and
- To protect the amenity of nearby residents from vibration impacts resulting from activities associated with the proposal by ensuring that vibration levels meet statutory requirements and acceptable standards.

The relevant standards for vibration include:

- Noise, Vibration and Airblast Control - Best Practice Environmental Management in Mining booklet (Environment Australia 1998); and
- Australian Standard AS2187.2-1993.

8.4.2 Definition of Issues and Impacts

Vibration as an environmental impact has the potential to disturb soil structure, building foundations and fauna habitat, causing fauna to relocate.

Vibration from the Project will be generated by the movement of vehicles within the mining area and on transport routes. This impact however, is considered to be minimal as no blasting or drilling will be required to remove the mineral sand from the pits.

The intensity of vibration decreases with increasing distance from the source. As the Project is at least 9 km from the closest homestead, vibration generated by the mining activities is unlikely to be perceptible at the homestead. Vibration from HMC transport vehicles is also deemed to be negligible, as the frequency of vehicles will be low and the surrounding residences are at least 19 km or more away from the mine access road.

8.4.3 Management

As vibration is not a significant issue, no specific management measures are proposed.

8.5 SOLID AND LIQUID WASTE

8.5.1 Objectives and Standards

The primary objectives in regard to waste for the Project are as follows:

- Minimise any solid and liquid wastes produced as a result of the mining process;
- Integrate a waste hierarchy (i.e. avoid, reuse, reduce, reuse, recycle, treat, dispose) for waste minimisation and establish a 'closed loop' within as many waste streams as possible;
- Ensure no release of hydrocarbons to the environment, either as a result of storage or handling incidents; and
- Liquid and solid wastes should be treated on-site or disposed of off-site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on-site to prevent groundwater and surface water contamination or risk to public health.

Relevant legislation and guidelines include:

- EP Act;
- Mining Act;
- DoIR Guidelines on the Safe Design and Operating Standards for Tailings Storage (1999);
- DoIR Guidelines on the Development of an Operating Manual for Tailings storage (1998);
- ANZMEC & MCA (2000) Strategic Framework for Mine Closure;
- DoE Guidelines for Acceptance of Solid Waste to Landfill (2002); and
- DoE Contaminated Sites Management Series Bioremediation of Hydrocarbon-Contaminated soils in Western Australia (2004).

8.5.2 Definition of Issues and Impacts

Potential sources of solid and liquid waste generated from mining operations include:

- waste water, including seepage from the tailings areas and slimes trenches, and saline waste water from the desalination plant;
- hydrocarbons;
- structural waste;

- domestic waste; and
- sewage.

If these wastes are not managed in an appropriate manner, then a range of potential impacts are possible. These include the contamination of land, change in water quality of surface water and groundwater, contamination of ecological habitats and an increase in weeds.

Any impacts by saline waste water will vary both within and around the Project Area, and will be in direct relation to hydraulic movement after the waste water is returned to the soil. These impacts on water quality are indirect; there are no direct water quality impacts likely to be associated with the redistribution of waste water into the environment.

Once the abstracted groundwater enters the processing circuit, the salinity expected to progressively increase due to evaporative effects in the process water dams, stacker operations, slimes tailings disposal and tailings water recovery drains. In a local groundwater context, this increase in salinity from process water use will not result in a significant change to the groundwater quality as tests have shown that the groundwater source is already saline.

Saline water from the tailings will infiltrate through the recreated tails areas to the underlying superficial formations as recharge on its path to the final saline receiving bodies of the Indian Ocean, Freycinet Reach and Hamelin Pool. During this migration, it is anticipated that some salt will be stored with a small fraction of water within the soil. The remainder of this water will continue to migrate with the stored salts and eventually mound. The movement of the salts in and around the mound will depend on the shape of the mound. The movement of the mounds is dependent on the subsurface gradient.

Over time with rainfall, the salt stores will remobilise through the sandy soil profile and continue to migrate downwards to the superficial aquifer. During this time, vegetation is expected to recolonise the Project Area with salt stores having migrated sufficiently downwards and away from the major root zone of approximately 1 to 1.5 m.

The salt stores remaining in the tailings have little possibility of migrating to the surface of the soil profile via capillary action and deposit in the top 1 m of the soil. This is because fine clays and particulates are required for capillary action to occur. As outlined in Section 4.2.3, the soils within the Project Area have been categorised as predominantly sandy with low water holding capacities. These characteristics suggest that the likelihood of stored salt migrating to the vegetation root zone is minimal due to the lack of suitable material for capillary action to occur.

The area where salts are most likely to surface are those areas outside the Project Area where salts are stored. The migration of the subsurface seepage mounds may be to locations where they interact with the local water table(s), causing them to rise.

There are no fresh water lenses within the Project Area that will be impacted by saline waste water infiltration. The only known potentially fresh lens is located near the Hamelin Pool stromatolites, but the mounds are not anticipated to reach the stromatolites.

The disposal of saline waste water from the desalination plant to the slimes trenches is anticipated to have an insignificant impact on the process water stream and groundwater environment as discussed in the URS 2005 Groundwater Impact Assessment (Appendix D). This is due to the small volume of waste water in comparison to the volume of tailings.

8.5.3 Management

Gunson will work to minimise, reuse and recycle wastes. Domestic solid and liquid wastes will be treated on-site or disposed off-site at an appropriate landfill facility. However, where this is not feasible, contaminated material will be managed on-site to prevent groundwater and surface water contamination or risk to public health. A Liquid and Solid Waste Management Plan is provided in Appendix O. Each type of waste that will be generated at the site and its management is summarised below.

- **Waste water**: As tailings are the main source of waste water, water will be recovered and recycled from the cyclones and from the tailings water recovery system. Water will also be recovered from the stormwater run-off from the workshops. It is proposed that waste water from the desalination plant will be discharged into the in-pit slime trenches. As discussed in Section 7 of Appendix D, to determine the direction of flow and magnitude of the tailings water mounds, multipeizometers will be installed in the superficial formations and shallow Tooloonga Calcilutite. These multipeizometers will be placed in areas identified as having potential risk to vegetation root zones by the residual water table mounding. These multipezometers will provide

data to appropriately define and manage any adverse impacts resulting from the water quality of the mounds.

- **Hydrocarbons**: Hydrocarbon products will be stored in approved bunded facilities located in the workshop compound at the mine site. (See Hydrocarbon Management Plan, Appendix O). Should a spill occur, any hydrocarbon contaminated soils would be bioremediated on site. The bioremediation of the contaminated area would be undertaken in accordance with the Contaminated Sites Management Series Bioremediation of Hydrocarbon-Contaminated soils in Western Australia (DoE 2004). All waste oils will be collected by the earthmoving contractor and recycled to an approved facility. Oily rags and filters for disposal will be recycled or disposed of at an appropriate hydrocarbon disposal facility.

- **Structural waste**: This waste will be recycled through a scrap metal merchant, where possible.

- **Domestic waste**: General refuse will be collected and disposed of to an on-site landfill. Any recyclable wastes will be collected separately and transported off-site to a recycling facility.

- **Sewage and grey water**: The camp and offices will be established with a sewerage processing system to dispose of sewerage and grey water. The sewage disposal system will be designed to comply with all relevant standards and regulations.

COMMITMENT 34

The draft Solid and Liquid Waste Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Solid and Liquid Waste Management Plan during the construction and operational phases of the Project.

COMMITMENT 35

The draft Hydrocarbon Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Hydrocarbon Management Plan during the construction and operational phases of the Project.

8.6 GROUNDWATER QUALITY

8.6.1 Objectives and Standards

The primary objectives in regard to water quality for the Project are as follows:

- Maintain or improve the quality of surface and groundwater to ensure that existing and potential users, including ecosystem maintenance, are protected; and
- Ensure that water emissions do not adversely affect environmental values or the health, welfare and amenity of people and land users, by meeting statutory requirements and appropriate criteria.

Relevant legislation and guidelines include:

- EP Act;
- Rights in Water and Irrigation Act;
- ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality; and
- Department of Environmental Protection Water Quality Protection Guidelines No.10 (Mining and Mineral Processing, Above-ground fuel and chemical storage, 2000).

8.6.2 Definition of Issues and Impacts

The geological stratigraphy of the Project Area is not uniform and comprises a series of confined and unconfined aquifers that occur beneath the Project Area and surrounding environs (Appendix D).

The Project Area groundwater is saline, ranging from 7,750 mg/L to 34, 000 mg/L. The water to be used for mine processing is 8, 900 mg/L when it is first extracted from the deep aquifer. As the water is recycled in the mine, some evaporation will occur, causing an increase in salinity. After the first year, the process water will be about 8, 959 mg/L, and after 20 years it will be about 12, 600 mg/L, making it slightly saline. Seepage from mine tailings will result in groundwater mounding but will not increase the salinity of the groundwater.

In the event of a hydrocarbon spill, there is a potential for local contamination and reduction in the quality of shallow groundwater.

Landfill leachate also has the potential to contaminate the groundwater, if not managed efficiently.

8.6.3 Management

Potentially contaminated storm or rainfall run-off will be channelled into separate retention ponds, tested and treated as necessary to prevent groundwater contamination. Drainage systems will be designed to withstand storms and flooding, and to prevent leakage into the groundwater.

Hydrocarbons will be carefully managed to prevent spills (Hydrocarbon Management Plan, Appendix O).

Groundwater monitoring will occur initially on a monthly basis and will determine the major and minor chemistry and key indicator physio-chemical parameters. A Groundwater Monitoring Programme is provided in the Groundwater Management Plan, which is provided in Appendix O.

Gunson will work to minimise, reuse and recycle wastes in order to minimise the disposal of wastes into landfill. (Solid and Liquid Waste Management Plan, see Appendix O).

9.1 PUBLIC HEALTH AND SAFETY

9.1.1 Objectives and Standards

The objectives of managing public health and safety, and in particular radiation, for the Project are to:

- Ensure that risk to the public is as low as reasonably practicable (ALARP) and complies with appropriate standards;
- Ensure that risk is managed to meet DoIR requirements and EPA criteria in respect of public health and safety;
- Ensure that solid and liquid wastes are handled and disposed of in an acceptable manner to avoid potential contamination of soil, surface and groundwater, and to keep radiological impacts as low as reasonably achievable, by complying with statutory requirements; and
- Radiological impacts to the public and environment are kept as low as reasonably achievable and comply with acceptable standards.

The legislation and guidelines relevant to public health and safety are:

- EPA Guidance for Risk Assessment and Management: Off-site Individual Risk from Hazardous Industrial Plant No. 2 (2000);
- National Standard and Code of Practice for the Control of Major Hazard Facilities (Worksafe Australia 1996); and
- Standards Australia AS/NZS ISO 14001 (1996).

The following legislation and guidelines relevant to the management of radiation are:

- Mines Safety and Inspection Act;
- *Radiation Safety Act* 1975;
- *Radiation Safety (General) Regulations* 1983;
- *Radiation Safety (Qualifications) Regulations* 1980;
- *Radiation Safety (Transport of Radioactive Substances) Regulations* 2001;
- EPA Draft Guidance Statement No. 2 (Risk Assessment and Management: Offsite Individual Risk from Hazardous Industrial Plant, 2000);
- Dangerous Goods Regulations 1992;
- Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores 1982; and
- Commonwealth Code of Practice in the Mining and Milling of Radioactive Ores, 1987 (currently being rewritten as the Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing, due for release later this year).

9.1.2 Definition of Issues and Impacts

Radiation is associated naturally with mineral sand owing to the presence of thorium and monazite. In the ore or HMC, the radiation levels are typically too low for radioactive classifications.

Radiation Advice & Solutions Pty Ltd undertook a Pre-Operational/Baseline Radiation Monitoring Programme in July 2004 using soil samples obtained by Gunson and gamma doserate readings from some 35 sites, primarily in the southern part of Amy Zone as this represents the first half of the Project life. Soil samples were analysed by external laboratory Genalysis for uranium and thorium. The survey report is presented as Appendix I. The survey report and management plan has been reviewed and approved by DoIR.

The pre-operational environmental gamma survey identified very low levels (less than two nanosieverts per hour) of above-ground radiation, consistent with local sandy soils containing very low levels of uranium, thorium, and potassium. Even locations which had been identified as containing higher grades of heavy minerals had gamma radiation doserates that were essentially no more than the cosmic ray component. This was due to the very low monazite content (and hence uranium and thorium content) in the Coburn heavy mineral suite.

Western Australian mineral sand deposits contain up to 10% heavy minerals, of which 1-3% is monazite. This in turn typically contains 5-7% of radioactive thorium and 0.1 - 0.3% of uranium, the latter being barely radioactive.

The radioactive elements uranium and thorium, and their radioactive decay products, occur mainly in monazite, an insoluble phosphate of the rare earths and thorium. They are also seen (in much lower concentrations) in zircon, xenotime and leucoxene.

The expected heavy mineral content of the ore to be mined in the Coburn Project (at 1.1%) is quite low compared with typical Western Australian mineral sand operations, and in turn, it has a very low monazite content (0.1-0.2%). As a result, the HMC to be produced in the wet concentrator is much lower in radionuclide content than the typical HMC produced at other Western Australian mines. For example, a thorium grade of less than 140 ppm is expected, compared to the typical level of 300 ppm (Hewson & Upton 1996).

Results of the sampling are summarised in Table 9.1.

Table 9.1
Summary of Pre-mining
Soil Gamma Radiation Survey

	Gamma Dose Rate (nSv/hr)
Minimum	14
Maximum	29
Average	18.8
Standard Deviation	3.66

Note: n = 35.

The average radiation level in the soil of 18.8 nanosieverts per hour is negligible, especially when compared to background cosmic radiation levels in mid-latitude locations, which average approximately 30 nanosieverts per hour. The readings obtained for the Coburn soils are consistent with sandy soils elsewhere and are a result of virtually all uranium, thorium, and potassium having been leached out by weathering. Furthermore, the surface gamma doserate levels were found to average less than 2 nanosieverts per hour.

The very low radionuclide content in ore, and the coarse median grain size (120 microns), together imply that airborne radionuclides in dust will be negligible as an environmental dose pathway.

Very low radionuclide content in ore also implies a very low increment of local gamma radiation above background, where ore intersects with the surface. It is estimated that gamma increment due to uranium and thorium in surface-exposed ore will be only in the order of a few nanosieverts per hour.

9.1.3 Management

Following surface radiation surveys on site, and from inspection of radionuclide content of the ore, it is confirmed that the operations of open pit mining and of the wet concentrator will not require radiation control. However, a Radiation Management Plan has been developed by Radiation Advice & Solutions Pty Ltd (see Appendix I). In addition, Gunson plans to conduct pre- and post-mining gamma surveys in addition to random radiation surveys during operations. The random radiation surveys will also cover the stockpiled ore, and waste and mineral transport for protection of the environment, public and employee health. The surveys will comprise:

- basic dust monitoring and gamma surveys around the HMC stockpiles; and
- basic monitoring of workers involved with the transport of the HMC.

In addition to the surveys, Gunson will implement the following to ensure that the environment, public and employee health are protected during and after operations:

- radiation training and education for employees on the issues involved with handling and storage of the material;
- waste management plan; and
- record keeping and annual reporting of HMC movement and radiation levels.

COMMITMENT 36

The draft Radiation Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Radiation Management Plan during the construction and operational phases of the Project.

9.2 SITE ACCESS AND TRANSPORT

9.2.1 Objectives and Standards

Project objectives for transportation of mineral concentrate, wastes and personnel include:

- Ensure that roads are maintained or improved and road traffic is managed to meet an adequate level of service, adequate safety standards and Department of Planning and Infrastructure requirements; and
- Ensure that traffic activities resulting from the project do not adversely impact on the social surroundings.

Relevant legislation and standards include:

- Mines Safety and Inspection Act;
- EPA Guidance Statement No. 2 (Risk Assessment and Management: Off-site Individual Risk from Hazardous Industrial Plant, 2000);
- Dangerous Goods Regulations 1992; and
- Australian Code of Practice for the Transport of Dangerous Goods by Road and Rail 1992.

9.2.2 Definition of Issues and Impacts

Gunson proposes to transport the HMC to Geraldton at a daily rate of 400 tonnes for Years 1 and 2 and 800 tonnes from year 3.

The North West Coastal Highway is a two lane major rural highway that originates at Geraldton and has the highest daily number of heavy vehicles of all major roads in the region (Main Roads WA 2005). The potential transport-related issues for the Project are as follows:

- Disturbance of amenity in relation to noise and vibration;
- Creation of dust;
- Increased traffic on the North West Coastal Highway and near Geraldton;
- Potential for spillage of HMC; and
- Potential for an accident resulting in injury or fatality.

Traffic data have been provided by Main Roads Western Australia (MRWA) over a series of 14-day periods as follows:

- Location 18709 between 6 and 19 September 2004;
- Location 00728 between 21 and 30 October 2004;
- Location 30070 between 6 and 19 September 2004;
- Location 18793 between 6 and 19 September 2004; and
- Location 07025 between 27 June and 10 July 2004.

Historical traffic data (from 1999 to 2003) have been provided by MRWA for monitoring locations 2904 and 2910 located either side of the Ajana-Kalbarri Road.

The location of these sites is provided as Figure 9.1. It should be noted that the supplied traffic count data are the actual combined total number of vehicles counted travelling along North West Coastal Highway in both the northbound and southbound directions. The traffic composition ranges from passenger vehicles through to triple road trains generally travelling between the 70 km/hr to 140 km/hr speed range (MRWA 2004 data). Table 9.2 shows the Average Daily Traffic Volume of the sites listed above.

Figure 9.1: MRWA Traffic Recording Locations on the North West Coastal Highway Transport Route.

Table 9.2
Vehicle Movements on the North West Coastal Highway over Varying Dates in 2004

Vehicle Type	Average Daily Traffic - Monday to Sunday												AADT
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	
Location 07275	397	207	29	7	0	6	10	4	12	3	47	2	488
Location 18709(1)	1687	260	121	25	1	15	14	7	19	4	77	5	1500
Location 18709(2)	1844	255	127	31	1	12	13	7	17	7	66	5	1601
Location 00728(1)	1266	161	86	6	1	20	15	15	20	1	30	39	1116
Location 00728(2)	1156	123	89	7	3	24	14	20	33	3	39	38	1041
Location 30070(1)	1163	242	77	21	1	10	12	4	21	6	87	2	1105.5
Location 30070(2)	1310	235	81	20	2	8	12	5	19	8	77	1	1194
Location 18793(1)	728	156	57	13	0	6	9	4	18	4	56	1	708
Location 18793(2)	752	144	61	15	0	5	8	3	17	8	52	1	718

Notes: *AADT is Average Annual Daily Traffic, derived by multiplying the Average Daily Traffic by the period factor of 0.67.
*All data was obtained from MRWA, Gascoyne and Mid-West offices in October 2004.
*Location 07275 is ~10 km south of the Denham Rd turn off on the North West Coastal Highway and was monitored from 27 June to 10 July 2004.
*Location 18709(1) is ~ 14.76 km north of Geraldton on the North West Coastal Highway and was monitored from 6 to 12 September 2004.
*Location 18709(2) is ~ 14.76 km north of Geraldton on the North West Coastal Highway and was monitored from 13 to 19 September 2004.
*Location 00728(1) is ~ 28.5 km north of Geraldton on the North West Coastal Highway and was monitored from 21 to 26 October 2004.
*Location 00728(2) is ~ 28.5 km north of Geraldton on the North West Coastal Highway and was monitored from 26 to 30 October 2004.
*Location 30070(1) is ~ 33.15 km north of Geraldton on the North West Coastal Highway and was monitored from 6 to 12 September 2004.
*Location 30070(2) is ~ 33.15 km north of Geraldton on the North West Coastal Highway and was monitored from 13 to 19 September 2004.
*Location 18793(1) is ~53.24 km north of Geraldton on the North West Coastal Highway and was monitored from 6 to 12 September 2004.
*Location 18793(2) is ~53.24 km north of Geraldton on the North West Coastal Highway and was monitored from 13 to 19 September 2004.

Table 9.3
Monthly Counts of Average Annual Daily Traffic on the North West Coastal Highway between 1999 and 2003

Month	Average Annual Daily Traffic							
	Location 2910				Location 2904			
	Year 1999/2000	Year 2000/2001	Year 2001/2002	Year 2002/2003	Year 1999/2000	Year 2000/2001	Year 2001/2002	Year 2002/2003
July	1,258	982	977	1,023	912	852	944	998
August	1,116	858	795	824	814	759	788	825
September	1,087	887	840	843	806	782	792	804
October	1,073	819	811	826	717	721	730	736
November	986	694	722	692	547	558	585	569
December	937	694	733	680	544	580	603	592
January	930	653	667	661	529	535	552	590
February	717	564	588	571	402	403	419	450
March	753	576	638	568	346	438	502	472
April	1,088	841	784	823	701	697	691	730
May	859	701	788	758	593	593	674	675
June	786	710	729	765	613	634	672	703
Average	966	748	756	753	627	629	663	679

Note: * Location 2910 is ~ 33.63 km south of the Ajana - Kalbarri Road on the North West Coastal Highway.
* Location 2904 is ~ 0.03 km north of the Ajana - Kalbarri Road on the North West Coastal Highway.

Comparing the historical traffic data in Table 9.3 and 9.4 with Years 1 and 2 of the proposed mining operations (ten return trips involving B-Double [7+ axles, 4 groups] vehicles per day) (Table 9.5) and the various Average Annual Daily Traffic (AADT) volumes and percentages, the increase of vehicles on the North West Coastal Highway from the mine site equates to one additional vehicle every two hours and twenty four minutes over a 24 hour cycle. A similar comparison with Year 3 onwards of operations (20 return trips involving B-Double Double [7+ axles, 4 groups] vehicles per day), (Table 9.6) and comparing the various AADT volumes and percentages, the increase of vehicles on the North West Coastal Highway from the mine site equates to one additional vehicle every one hour and twelve minutes over a 24 hour cycle.

In addition to adding an increased number of B-double vehicles, the percentages estimated for future road use Tables 9.5 & 9.6) has been calculated using an estimated population growth rate of 6%.

Table 9.4
2004 Average Total Daily Traffic Volumes on the North West Coastal Highway (Monday to Sunday)

	SLK Along North West Coastal Highway							
Vehicle Type	14.76		28.5		33.15		53.24	
	ADT	**%**	**ADT**	**%**	**ADT**	**%**	**ADT**	**%**
Cars	1,766	76.3%	1,276	76.3%	1,237	72.1%	740	69.6%
Cars towing caravans	226	11.1%	149	8.9%	239	13.9%	150	14.1%
Rigid Vehicle	163	6.6%	95	5.7%	102	6.0%	75	7.0%
Articulated Semi Trailers	48	2.3%	79	4.7%	48	2.8%	36	3.4%
Articulated B-Double	4	0.2%	2	0.1%	7	0.4%	6	0.6%
Articulated Road Trains	69	3.3%	71	4.2%	84	4.9%	56	5.3%
	2,275	100.0%	1,672	100.0%	1,716	100.0%	1,064	100.0%

Note: *ADT is Average Daily Traffic and SLK is Straight Line Kilometre.
Source: ADT Traffic data provided by MRWA, Gascoyne and Mid-West offices in October 2004.

Table 9.5
Estimated Average Total Daily Traffic Volumes on the North West Coastal Highway for Years 1 to 2 of Mine Life (Monday to Sunday)

	SLK Along North West Coastal Highway							
Vehicle Type	14.76		28.5		33.15		53.24	
	ADT	**%**	**ADT**	**%**	**ADT**	**%**	**ADT**	**%**
Cars	1,984	76.0%	1,434	75.9%	1,390	71.9%	832	69.0%
Cars towing caravans	290	11.1%	168	8.9%	268	13.9%	169	14.0%
Rigid Vehicle	173	6.6%	107	5.6%	115	5.9%	84	6.9%
Articulated Semi Trailers	61	2.3%	89	4.7%	53	2.8%	41	3.4%
Articulated B-Double	17	0.6%	12	0.7%	14	0.7%	17	1.4%
Articulated Road Trains	87	3.3%	79	4.2%	94	4.9%	63	5.2%
	2,611	100.0%	1,889	100.0%	1,934	100.0%	1,206	100.0%

Source: *ADT Traffic data provided by MRWA, Gascoyne and Mid-West offices in October 2004.

Table 9.6
Estimated Average Total Daily Traffic Volumes on the North West Coastal Highway for Years 3 to 6 of Mine Life (Monday to Sunday)

	SLK Along North West Coastal Highway							
Vehicle Type	14.76		28.5		33.15		53.24	
	ADT	**%**	**ADT**	**%**	**ADT**	**%**	**ADT**	**%**
Cars	2,229	75.8%	1,611	75.6%	1,562	71.4%	935	68.6%
Cars towing caravans	326	11.1%	188	8.8%	301	13.8%	190	13.9%
Rigid Vehicle	194	6.6%	120	5.6%	129	5.9%	94	6.9%
Articulated Semi Trailers	69	2.3%	100	4.7%	60	2.7%	46	3.4%
Articulated B-Double	27	0.9%	23	1.1%	29	1.3%	28	2.1%
Articulated Road Trains	98	3.3%	89	4.2%	106	4.9%	71	5.2%
	2,942	100.0%	2,131	100.0%	2,187	100.0%	1,363	100.0%

Source: *ADT Traffic data provided by MRWA, Gascoyne and Mid-West offices in October 2004.

The additional B-Double vehicle traffic generated by transporting the concentrate from the mine site to Geraldton is considered minimal in relation to the volume of traffic already utilising the highway. It is estimated that the net increase of trucks travelling towards Geraldton as a result of the Project is one additional truck every one hour and twenty three minutes.

9.2.3 Management

The selected road to transport the HMC from the mine site concentrator to the North West Coastal Highway is the Mine Access Road. The management of the mine access road will include:

- Monthly inspections of road conditions and random reports from the transport personnel and other road users; and
- Grading of the road annually or on an as-need basis to ensure that the road condition is safe for use.

The mine access road and the associated intersection with North West Coastal Highway will have appropriate signage displayed either side of the access road / North West Highway intersection, together with some road widening to safely accommodate B-Double turning movements into the high vehicle speed environment.

Management of the road modifications and signage requirements will be the responsibility of both Gunson and MRWA, with Gunson initiating contact with MRWA to commence the road reconstruction process.

9.3 VISUAL AMENITY

9.3.1 Objectives and Standards

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

The standards which are mainly focussed around the post-mining remediation activities on visual amenity of the Project and Project Area, are as follows:

- National Strategy for Ecologically Sustainable Development 1992; and
- ANZMEC & MCA (2000) Strategic Framework for Mine Closure.

9.3.2 Definition of Issues and Impacts

The Project Area is a relatively remote and undisturbed site. The Project will change the landscape in the Project footprint. However, due to the undulating terrain and local key movement corridors located away from the site, visual impact is expected to be minimal.

The Coburn homestead is located approximately 17 km east of the Amy Zone orebody and the Hamelin homestead is located approximately 9 km northeast of the northern end of the Amy Zone, as shown in Figure 1.2. During daytime operations, the southern section of the Project is highly unlikely to be visible from the homesteads and the Denham to Overlander Road due to the undulating nature of the dunes and the presence of a vegetation buffer surrounding the Project. Dust generation in the southern section during the construction and operation of the mine is also unlikely to be visible from the homesteads and Denham to Overlander

Road, as stringent dust control measures will be implemented during these phases of the Project. The northern section of the Project is unlikely to be visible from the homesteads. However, there is potential for the northern portion of the Project to be visible from some sections of the Denham to Overlander Road and regional high points, as the Project is less than 5 km from the road and the vegetation is quite sparse. The Dust Management Plan is presented in Appendix O.

At night time, there will be night-glow generated from the lights at the operations, which may be visible from the homesteads as there are few other sources of light in the area.

Travel routes in the vicinity of the Project (such as the Denham to Overlander Road) are amongst the most important community 'sensitive receptor' sites. The linear nature of such 'movement corridors' means that they need to be considered in terms of direction of travel, traffic density and volume, type of traffic, foreground to midground closure beside the road alignment and road surface.

It is anticipated that the Project will not reduce public amenity, given the isolation of the Project, distance to movement corridors and nearest residents, and intervening topography and vegetation.

9.3.3 Management

The visual modification of the landscape will be managed through progressive rehabilitation of the Project footprint (see Appendix F).

To manage night-glow generated from the Project, the level of lights used will be as low as safety permits.

9.4 ABORIGINAL HERITAGE

9.4.1 Objectives and Standards

The objectives for the Project in relation to Aboriginal Heritage are:

- Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act and EPA Guidance Statement No.41, (Assessment of Aboriginal Heritage, 2004); and
- Ensure that changes to the biological and physical environment resulting from the project do not adversely affect the cultural associations of the area.

The relevant legislation and standards are:

- Aboriginal Heritage Act; and
- EPA Guidance Statement No. 41 (Assessment of Aboriginal Heritage, 2004).

9.4.2 Definition of Issues and Impacts

As discussed in Sections 4.1.3.5 and 4.2.12, a number of Aboriginal heritage studies have been undertaken both within the Amy Zone and on adjacent properties in relation to the Project (Section 4.2.12). Only one archaeological site has been recorded, which is located near the proposed access road. The alignment of this proposed road has been diverted so as to avoid any disturbance to the site.

Gunson has undertaken extensive consultation with the Yamatji Land and Sea Council, the DIA, the Nanda Aboriginal Working Group, the Malgana Aboriginal Working Group and other Aboriginal people with an interest in the area.

Following consultation, Gunson conducted aboriginal heritage surveys of the Project Area. These surveys commenced in 1999 and further surveys are scheduled for mid-2005. The surveys have included representatives of the Nanda and Malgana peoples, as well as other Aboriginal people with an interest in the area.

9.4.3 Management

Gunson will ensure that an Aboriginal heritage survey is conducted on all project areas prior to any ground disturbing activity takes place. This policy is as a result of extensive consultation with the Nanda people (which is confirmed in a confidential agreement dated September 2004), Malgana people, and other Aboriginal people with an interest in the area.

Management of any Aboriginal heritage sites will be in accordance with the Aboriginal Heritage Act and the Draft Aboriginal Heritage Management Plan provided as Appendix O.

COMMITMENT 37

The draft Aboriginal Heritage Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Aboriginal Heritage Management Plan during the construction and operational phases of the Project.

9.5 EUROPEAN HERITAGE

9.5.1 Objectives and Standards

The objective for the Project in relation to the protection of European heritage is to ensure that changes to the biological and physical environment resulting from the Project do not adversely affect historical and cultural associations with the area and comply with relevant heritage legislation.

The applicable standards for European heritage are:

- EPBC Act;
- *Australian Heritage Commission Act* 1975;
- World Heritage Convention; and
- World Heritage Management Principles Register of National Estate (RNE).

9.5.2 Definition of Issues and Impacts

There are no European heritage sites known to occur near or within the southern portion of the Amy Zone with the exception of the SBWHP.

The groundwater mounding from the mine tailings is unlikely be confined to the Project Area, and may travel towards Hamelin Pool when the mining reaches the northern sections. However, there is no hydraulic connection between Hamelin Pool and the Project Area. Therefore, there is not expected to be any changes to either the water quality or groundwater hydraulics at the Hamelin Pool shoreline.

9.5.3 Management

No specific management is required.

9.6 ADJACENT LAND USERS

9.6.1 Objectives and Standards

The objective for the Project in relation to adjacent land users is to minimise any direct or indirect impact from the operations.

Standards applicable for the management of impacts on surrounding land users are as follows:

- National Strategy for Ecologically Sustainable Development 1992;
- ANZMEC & MCA 2000, Strategic Framework for Mine Closure;
- Environmental Protection (Noise) Regulations 1997;
- EPA Guidance Statement No. 8 (Environmental Noise);
- EP Act; and
- NEPM for Ambient Air Quality.

9.6.2 Definition of Issues and Impacts

The potential issues that may impact upon surrounding land users are as follows:

- Dust created during construction and operations may travel onto surrounding properties;
- Noise created by machinery movement (including trucks transporting HMC) may travel and impact on amenity;
- Reduction in groundwater quantity and increase in groundwater salinity; and
- Disturbance to pastoral activities.

The main mining activities that have the potential to cause dust emissions include topsoil removal; excavation, dumping, stockpiling and transfer of ore and overburden; machinery and vehicle movements; and dust pick-up from exposed areas. Water sprays will be used as required across work zones and unsealed areas to suppress dust. Therefore, dust generation from the Project is unlikely to have a significant impact on nearby land users, as stringent dust control measures will be implemented.

The results of the noise assessment predicted that the L_{A10} noise levels received at the Coburn and Hamelin homesteads would be 10 dB(A) and 11 dB(A), respectively. These levels are well below the assigned L_{A10} noise level of 35 dB(A) for the night-time period under the Environmental Protection (Noise) Regulations 1997. Therefore, there will not be any noise impacts to adjacent land users.

The findings of the groundwater study indicated that drawing groundwater from the deep aquifers at the Amy Zone will have drawdown impacts on the network of private bores in the local region. However, the existing artesian bores are not expected to stop flowing as described in Section 7.5.2.

9.6.3 Management

The management of dust, noise and groundwater are presented in the Draft Environmental Management Plan (Appendix O).

9.7 CONSERVATION VALUES

9.7.1 Objectives and Standards

The objectives of the Project in relation to conservation values are:

- Protect the environmental values of areas identified as having significant environmental attributes; and

- Ensure that conservation values of the Project Area are adequately represented in SBWHP or elsewhere.

The applicable standards for the protection of conservation values are:

- EPBC Act;
- Conservation and Land Management Act; and
- EPA Guidance Statement No. 49 (Assessment of Development Proposals in Shark Bay World Heritage Property, 2000).

9.7.2 Definition of Issues and Impacts

The Project is located adjacent to the SBWHP. No significant direct impacts to these areas are anticipated. Indirect impacts may occur due to, for example, wildfire, weed infestation, dust and groundwater mounding. Refer to Section 10 of the PER for an assessment of Commonwealth MNES.

Groundwater mounding is expected within the Project Area. As described in Section 7.5.2, residual mine water mound heights are only significant where they might lead to water levels less than about 5 m from the surface. Most of the roots from natural vegetation are located within the uppermost 1 to 2 m, but several mallee species have deeper root systems that may reach 5 to 10 m depth. Several areas of thin superficial sand cover have been identified at the southern and northern ends of the Amy Zone. These areas will require specific monitoring of both water levels and vegetation to minimise adverse impacts on vegetation communities via groundwater recovery bores.

The modelling undertaken as part of the air quality assessment shows that there is the potential for dust to be deposited at the southern end of Hamelin Pool when mining operations occur at the northern end of the Project Area. The peak modelled deposition rate was predicted to be 1.2 g/m^2/month. It is predicted that there is a low risk to Hamelin Pool, as Gunson will implement measures to minimise fugitive dust sources and will undertake ongoing monitoring of deposited dust levels at the boundary of the Project Area and at Hamelin Pool.

9.7.3 Management

Management of conservation values for this Project is described in the Vegetation and Flora Management Plan**,** Priority Flora Management Plan, Dust Management Plan, Vertebrate Fauna Management Plan (all Appendix O) and Rehabilitation Plan (Appendix F).

In addition, and as previously stated throughout the PER, Gunson proposes to seek conduct further studies before accessing the northernmost pit (Pit 10), therefore ensuring protection of SBWHP values in this area.

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10.1 BACKGROUND

The EPBC Act provides a national framework for the protection of Matters of National Environmental Significance (MNES) and the conservation of Australia's biodiversity (DEH 2004). Under the EPBC Act, an action requires the approval of the Commonwealth Environment Minister if the action has, will have, or is likely to have a significant impact on any of the MNES. The MNES relevant to the proposed Project are:

- World Heritage properties;
- National Heritage:
- Listed threatened species or communities; and
- Migratory species protected under international agreements.

The proposed Project was evaluated against data contained in the DEH database on MNES and assessments were made on whether a significant impact was likely using the Administrative Guidelines for determining whether an action has, will have, or is likely to have a significant impact on MNES.

The Administrative Guidelines state:

In order to decide whether an action is likely to have a significant impact, it is necessary to take into account the nature and magnitude of potential impacts…it is important to consider matters such as:

- *all on-site and off-site impacts;*
- *all direct and indirect impacts;*
- *the frequency and duration of the action;*
- *the total impact which can be attributed to that action over the entire geographic area affected, and over time;*
- *the sensitivity of the receiving environment; and*
- *the degree of confidence with which the impacts of the action are known and understood.*

Each of the MNES matters relevant to the Project is assessed in turn in the following sections.

10.2 WORLD HERITAGE PROPERTY

The Amy Zone is located adjacent to the southeastern boundary of the SBWHP. The property was listed in 1991 on the basis that it met all four of the 'natural' criteria set out by the United Nations Educational, Scientific and Cultural Organisation (UNESCO). These criteria are:

1. Outstanding examples representing the major stages of the earth's evolutionary history.
2. Outstanding examples representing significant ongoing geological processes, biological evolution and human interaction with the natural environment.
3. Containing unique, rare or superlative natural phenomena, formations or features of exceptional natural beauty.
4. Important and significant habitats where threatened species of animals and plants of outstanding universal value from the point of view of science and conservation, still survive.

The risk of impacting on the SBWHP and the way in which these issues will be managed is outlined below.

10.2.1 Criterion 1

Existing Environment

The stromatolites located at Hamelin Pool are known as living fossils with the living microbes still building stromatolites at Hamelin Pool having similarities to the earliest life forms which dominated the earth for three billion years. The presence of these within the Shark Bay area meets the first criteria where the age of the stromatolites represent evolutionary history.

Potential Impacts

Surface Water

There are no sensitive surface water features within the SBWHP that occur close to the Project Area. However, Hamelin Pool, to the north of the Project Area, has a unique marine environment including rare stromatolites which are located approximately 5 km northeast of the northernmost tip of the Amy Zone. Birridas, saline coastal flats and lagoons also occur along the coastline southwest of Hamelin Pool.

The hypersaline environment supporting the stromatolites are created and sustained by the Faure Sill, where the accumulation of marine organism skeletons amongst the seagrasses north of Hamelin Pool has created the sandbar effect of the sill and in turn restricts tidal exchange in Hamelin Pool and sustains hypersaline conditions critical for the survival of the stromatolites (Shark Bay World Heritage Property website 2004).

The saline coastal flats informally referred to as the Nilemah Embayment are approximately 4 km northwest of the northernmost tip of the Amy Zone.

It is highly unlikely that there will be any impact upon the surface water landforms outlined in Criterion 1, due to:

- the distance between the Amy Zone and the above mentioned coastal features;
- the proposed water management system that will be implemented by Gunson to recover and recycle water; and
- the porosity of the soils.

It is anticipated that any surface water that escapes from the mine drainage system will be quickly absorbed into the soil or evaporated.

Groundwater

Groundwater within the superficial formations in the Project Area is restricted to a thin layer at the base overlying low permeability clay of the Toolonga Calcilutite. This low permeability will enhance the recovery of mine water and assist in minimising their size. These mounds will develop beneath the pits and dissipate after tailing operations are complete.

An extensive mound of residual mine water will develop beneath four stacker units in the northern part of the Amy Zone. This mound will dissipate within the superficial formations and flow northwards (down-gradient) toward the Nilemah Embayment. Some interactions around the fringes of the embayment between the residual mound and vegetation are possible without careful management and mitigation measures.

It is expected that the evaporative cycle within the Nilemah Embayment (salt flats) will prevent any superficial brackish mine water reaching Hamelin Pool. A hydraulic barrier of marine clay within the geological profile beneath the embayment is also expected to restrict the migration of groundwater northwards.

Dust

Potential dust deposition impacts on the stromatolites at Hamelin Pool were considered as part of the air quality impact assessment (provided as Appendix N of the PER). A modelling assessment of the anticipated emissions to atmosphere arising from the proposed Project at the nearest sensitive receptors, including Hamelin Pool to the north of the Amy Zone, was undertaken.

Deposited dust levels are predicted to be below NSW EPA impact assessment criteria at the extremities of Hamelin Pool. The NSW EPA is the only environmental protection body in Australia to have criteria on dust deposition; hence modelling was carried out using the NSW EPA criteria (see Section 8.1 for further details).

The conservative modelling undertaken to date indicates predicted concentrations to be well below respective guidelines at Hamelin Pool (see Section 8.1 and Figure 8.1). However, the effect of dust settlement on algal mats and stromatolites located around Hamelin Pool cannot be confirmed until baseline data on dust levels in the Hamelin Pool area and data from the Project's dust monitoring programme have been collected and used to verify the atmospheric model (see Commitment 31). If dust settlement on the southern shores of Hamelin Pool is still predicted, Gunson will research the potential effects on stromatolites prior to developing Pit 10.

Gunson recognises that dust management will be an integral component of site environmental performance, and will undertake a range of preventative measures to minimise fugitive dust sources as part of its daily operations.

10.2.2 Criterion 2

Existing Environment

There are two main natural aspects of the Shark Bay area that meet Criterion 2. These are:

- the large seagrass beds located within the Shark Bay waters; and
- the location of the area within three climatic zones and two major botanical provinces.

The seagrass beds modify the whole ecosystem by directly influencing the chemistry, biology and geology of the Bay (Shark Bay World Heritage Property website 2004). One example is the accumulation of skeletons of marine organisms living amongst the seagrasses north of Hamelin Pool that has created the Faure Sill. The sandbar effect of the sill in turn restricts tidal exchange in Hamelin Pool and sustains hypersalinity levels critical for the survival of the stromatolites (Shark Bay World Heritage Property website 2004).

The two botanical provinces are the eucalypt-dominated South West province and the acacia-dominated Eremaean province. The amalgamation of the provinces mean that the area is scientifically important for determining factors which limit species distribution and abundance with many

species being at the end of their range (Shark Bay World Heritage Property website 2004).

Potential Impact

No impact on the seagrass beds is anticipated due to the distance between the Project Area and the seagrass beds.

The floristic component of the two major botanical zones will not be affected by the Project. Impacts to individual plants are possible as a result of groundwater level and salinity changes in the vicinity of the mine, and as a result of excessive dust generation.

Groundwater

Mine water returned to the aquifer via seepage from the mine process will seep through the soil profile.

Mine water returned through tailings will mound beneath the mine and may also mound in and adjacent to the SBWHP.

However, due to the expected depth of the groundwater when it reaches the SBWHP, and the relatively shallow root zone expected for the vegetation in this region, no adverse impact is expected on the vegetation within the SBWHP.

Dust

The Project Area is influenced by southeast trade winds, which generate southerly winds for the majority of the year (see Appendix N). Therefore, the potential for windborne dust arising from the Project is predicted to be predominantly in a northerly to north-east direction. This would direct any dust generated away from the main land component of the SBWHP.

There is potential for soil particulate movement from the Project Area to SBWHP, which could adversely affect local areas of vegetation. The conservative modelling results undertaken to date indicate predicted concentrations to be well below respective guidelines at these receptors, and maximum off-site dust concentrations to be to the east of the Project Area, indicating minimal risk to vegetation within the SBWHP. Gunson is committed to ongoing management of dust from fugitive sources (exposed areas, etc) as part of the project.

As indicated previously, Gunson recognises that dust management will be an integral component of site environmental performance, and will undertake a range of preventative measures to minimise fugitive dust sources as part of its daily operations.

10.2.3 Criterion 3

Existing Environment

The Shark Bay area contains a wide array of natural features that are generally arid landscapes. These range from peninsulas (Peron Peninsula, and Heirisson and Bellefin Prongs), islands (Dirk Hartog Island, Bernier Island Dorre Island) and many bays. Other significant features include Shell Beach, the birridas and lagoons and the contrasting colours of the dunes and cliffs of Peron Peninsula (Shark Bay World Heritage Property website 2004).

Potential Impacts

No impact on these natural features is anticipated as the Project Area is a significant distance from the majority of unique, rare or natural phenomena, formations or features of exceptional natural beauty which, within the Shark Bay area, are predominantly coastal features. All operations undertaken as a part of the Project will be to the south and east of the SBWHP.

10.2.4 Criterion 4

Existing Environment

The peninsulas and islands of Shark Bay provide fauna refuge habitats. Of Australia's 26 species of mammals that are threatened with extinction, five are found on the Bernier and Dorre Islands Nature Reserve. Though once widespread, four of these species now occur naturally nowhere else in the wild. Shark Bay also has 13 threatened reptile species, three rare bird species, one eighth of the world's dugong population and significant loggerhead turtle rookeries. It is also an important area for migratory species such as the humpback whale and wading birds from Siberia and parts of Asia. (Shark Bay World Heritage Property website 2004).

Potential Impact

No impact on these species is expected.

10.3 NATIONAL HERITAGE

Existing Environment

On 1 January 2004, the EPBC Act was amended to include new Commonwealth powers to regulate Australia’s natural, cultural and indigenous heritage. The amendments include “National Heritage places” as a new matter of national environmental significance, and establish a National Heritage List and a Commonwealth Heritage List. The National Heritage List comprises natural, cultural and indigenous places that are of

national heritage value to the Australian nation. The Commonwealth Heritage List comprises natural, indigenous and historic heritage places owned or controlled by the Commonwealth.

Both lists have been viewed on the DEH website and results have shown that the Shark Bay World Heritage Property is a Declared Property on the Australian Heritage Database (Place ID no. 105020) and an Indicative Place (Place ID no. 105686) on the National Heritage List. The Shark Bay area was not listed on the Commonwealth Heritage List on the DEH website, but the primary management objectives for World Heritage properties are part of Australia's general obligations under the World Heritage Convention (Shark Bay World Heritage Property website 2004).

Furthermore, the Western Australian and Commonwealth Governments signed an Agreement in 1997 on the administrative arrangements for the SBWHP. This agreement provides for the protection and management of the Property by the Western Australian Government in accordance with Australia's obligations under the World Heritage Convention (Shark Bay World Heritage Property website 2004).

Potential Impact

No impact on National Heritage is expected.

10.4 THREATENED SPECIES AND COMMUNITIES

The DEH database on MNES identified six threatened species possibly occurring within 1 km of the general SBWHP – Amy Zone interface. No TECs were reported. The identified threatened species comprise:

- two reptile species - the Hamelin Skink (*Ctenotus zastictus*) and the Western Spiny-tailed Skink (*Egernia stokesii badia*).
- three bird species - the Slender-billled Thornbill (*Acanthiza iredalei iredalei*), the Thick-billed Grasswren (*Amytornis textiles textiles*) and the Malleefowl (*Leipoa ocellata*).
- a flora species - Beard's Mallee (*Eucalyptus beardiana*).

The Western Spiny Tailed Skink and the Beard's Mallee are both listed as 'Endangered' under the EPBC Act. The remaining species are listed as 'Vulnerable' under the Act.

These species are discussed below.

Hamelin Skink

Like the Western Spiny-tailed Skink, the Hamelin Skink is a small to medium-sized reptile. Skinks live in open environments, climb trees and rocks, or burrow beneath the ground. They mainly feed on insects, spiders and other small arthropods (Storr, Smith & Johnstone 1981).

The Hamelin Skink is reportedly endemic to a small area of *Eucalyptus-Triodia* between Hamelin and Coburn Stations (Storr & Harold 1990). A survey was undertaken by Ninox in September 2004 (Appendix K) to determine if the known habitat of the Hamelin Skink existed within the Project Area and east of the Project Area. The survey, also undertaken with Mattiske for vegetation community identification purposes, revealed that the preferred *Eucalyptus-Triodia* community did not exist within the Project Area but did exist east of the Project Area. Therefore, it is anticipated that this species will not be impacted by the Project.

Western Spiny-tailed Skink

Information on the Western Spiny-tailed Skink on the Western Australian Museum, Queensland Museum and Museum and Art Gallery of NT Reptiles Database (2004) indicate that this species has not been recorded within the Project Area. The Reptile Database also indicated that this species is confined to mainly the Gascoyne and Mid-West regions.

This species was not observed during any of the Ninox fauna trapping surveys of the Project Area, but may occur in the area. However, this species is mobile and, given the slow advance of the mining operation proposed for approximately 1-2 km per annum northwards, it is anticipated that there is likely to be little to no impact on the species.

Slender-billed Thornbill

The Slender-billed Thornbill has a range extending from the Carnarvon to Shark Bay areas, east to Wiluna and south-east to Port Augusta and the Flinders Ranges. It often occurs in saltbush and near dry salt lakes, samphire on the margins of inland salt lakes, on the coast in mangroves, and in scrubby vegetation of the Nullarbor Plain. This species was not observed during the surveys undertaken by Ninox and it is not anticipated that the project will impact on the species or its habitat.

Thick-billed Grasswren

The Thick-billed Grasswren is currently restricted to the Shark Bay area. It occurs in acacia dominated shrublands, dense shrub associations in drainage

depressions, and *Triodia* spinifex with acacia shrubland components. In acacia dominated shrublands, shrub clumps of high foliage density appear important determinants of Thick-billed Grasswren presence. This species was not observed during the surveys undertaken by Ninox and it is not anticipated that the project will impact on the species or its habitat.

Malleefowl

The Malleefowl is typically found in semi-arid 'scrub land' of very dry low eucalypt woodland. This species lives and moves on the ground but can also be found 'roosting' in low bushes. Malleefowl are known to occur within the Project Area as 'mounds' or nests have been observed during site visits. Observations by Ninox during the fauna surveys have indicated that the mounds are not currently active. The mining activities and removal of Malleefowl habitat is expected to result in the localised loss of this species from the mining area. Malleefowl mounds will be unable to be relocated in order to avoid the impact of exploration, mining and construction of infrastructure. No loss of individual Malleefowl due to direct mining operations is expected due to their mobility.

However, the local populations of Malleefowl should benefit from Gunson's commitment to de-stock the property and conduct introduced predator control programmes. Management of Malleefowl is outlined in the Vertebrate Fauna Management Plan (Appendix O).

White-bellied Sea Eagle

The White-bellied Sea Eagle prefers and is more likely to occur at coasts, islands, estuaries, inlets, large rivers, inland lakes or reservoirs rather than further inland (Pizzey & Knight 1997). Accordingly, it is very unlikely that this species would be impacted by the project.

Eucalyptus beardiana

Eucalyptus beardiana is endemic to Western Australia and is restricted to a small area of sand plain between the Murchison River and Shark Bay. This species was not observed within the Project Area during any of the flora and vegetation surveys undertaken by Mattiske Consulting. Further surveying for this species will continue and as a result, it is unlikely that this species will be impacted by the project.

10.5 MIGRATORY SPECIES

The DEH database on MNES identified two migratory species possibly occurring within 1 km of the general SBWHP – Amy Zone interface. These are the Rainbow Bee-eater (*Merops ornatus*) which is protected under the JAMBA[1] and the White-bellied Sea Eagle (*Haliaeetus leucogaster*), which is also a listed Marine Species under the EPBC Act.

The White-bellied Sea Eagle (*Haliaeetus leucogaster*) may occur in the Project Area. However, as indicated in Section 10.4, this species is very unlikely to be impacted by the project.

The presence of the Rainbow Bee-eater *Merops ornatus*) in the Project Area was recorded by Ninox during the spring 2003 and spring 2004 surveys. As described by Storr (1990), the Rainbow Bee-eater is a scarce breeding visitor to the Shark Bay region, indicating that the species does visit other sites in the region, not just the Amy Zone. In addition, this species is mobile and, given the slow advance of the mining operation of approximately 1-2 km per annum northwards, it is anticipated that there is likely to be little to no impact on the species.

10.6 CONCLUSION

Analysis of the potential impacts to the values of the SBWHP has shown that some risk to the values of the Nilemah Embayment and the stromatolites on the southern shores of Hamelin Pool may be posed by groundwater mounding and atmospheric dust from operations at Pit 10. In recognition of this potential risk, Gunson has staged the Project such that mining of this pit will only occur if it can be demonstrated, on the basis of further investigation and monitoring to be carried out, that these values can be protected.

No loss of listed species or threatened ecological communities is anticipated as a result of the Project.

It is therefore concluded that the Project, as proposed and including Gunson's management commitments, will not adversely affect any MNES.

[1] The DEH has advised that this species is included in the Annex to JAMBA. It was added after the agreement was signed and so is not reflected on the Australian treaty Series entry which describes the original agreement text and annex (J. Ferris, pers. comm.).

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Gunson has made a number of commitments in regarding the environmental management of the proposed Project. Table 11.1 lists these commitments and provides information on the actions and timing proposed in relation to the implementation of the commitments.

Table 11.1
Consolidated Environmental Management Commitments

Commitment	Proposed Actions	PER Section	Timing		
			Construction	Operation	Closure
1	Prior to the development of Pit 10, the Proponent will: • Demonstrate that successful rehabilitation of mined lands in the southern portion of the Project Area (Pits 1-6) is possible. The standards to be achieved to demonstrate "successful rehabilitation" will be defined by the completion criteria provided in the Project's rehabilitation plan. • Conduct further hydrogeological investigations to verify the expected water balance and groundwater model for Pit 10, so as to prevent adverse impacts to marine life within the Shark Bay World Heritage Property. • Conduct further investigations into the potential impacts on vegetation and root zones to verify that vegetation within the Shark Bay World Heritage Property will not be adversely impact by the development of Pit 10. Conduct further dust investigations to verify that the stromatolites at Hamelin Pool will not be adversely impacted by the development of Pit 10.	2.3.1.3		✓	
2	The Proponent will develop and implement an Environmental Management System as part of the overall management system for the Project.	7.1.2	✓	✓	
3	The Proponent will de-stock the Coburn pastoral lease for a minimum of several years, and longer if permission is granted by the Pastoral Board, and undertake introduced predator control.	7.1.2	✓	✓	
4	The draft Rehabilitation Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will rehabilitate areas disturbed during the construction and operation of the Project on a progressive basis.	7.2.3	✓	✓	✓
5	The Proponent will implement a soils characterisation programme to identify any potentially dispersive soils and ameliorate any impact to the rehabilitated soil profile.	7.3.3	✓	✓	

Table 11.1 (cont.'d)

Commitment	Proposed Actions	PER Section	Timing		
			Construction	Operation	Closure
6	The Proponent will implement a soils monitoring programme to assess the capabilities of the reconstructed soil profile and compare them with the soil characteristics of the original and analogue profiles.	7.3.3		✓	✓
7	The draft Groundwater Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. Gunson will implement the Groundwater Management Plan during the construction, operation and decommissioning of the Project.	7.5.3	✓	✓	✓
8	The Proponent will operate the borefield in line with the Project's groundwater licence operating strategy.	7.5.3	✓	✓	
9	The Proponent will remain within the licensed allocation as defined by the Licence to Take Water current at the time.	7.5.3	✓	✓	
10	The Proponent will trial and implement robust, practical and secure tailings water recovery strategies that strongly promote and demonstrate groundwater conservation principles.	7.5.3	✓	✓	
11	The Proponent will implement monitoring programmes, particularly in the initial three years of the project, that enable the magnitudes and dimensions of the water table mounding beneath the sand-stackers to be characterised.	7.5.3	✓	✓	
12	The Proponent will implement investigation and monitoring programmes in known areas of potential environmental risk due to water table mounding encroaching on the root zones of vegetation stands.	7.5.3	✓	✓	
13	If monitoring indicates the mounding will reach the root zones in sensitive vegetated areas, the Proponent will undertake additional mitigation measures as required to minimise long term impacts.	7.5.3	✓	✓	
14	The Proponent will develop practical operating strategies linked to the sand-stackers that would facilitate the retention and tailing waters abstraction from localised in-pit drains required to limit environmental risks to nearby vegetation stands.	7.5.3	✓	✓	
15	The Proponent will implement investigation and monitoring programmes within the Nilemah Embayment to refine the understanding of the hydrogeology, stratigraphy and shallow groundwater environments.	7.5.3	✓	✓	

Table 11.1 (cont.'d)

Commitment	Proposed Actions	PER Section	Timing		
			Construction	Operation	Closure
16	The Proponent will review mining plans to reduce the rate of northern pit development (Pit 10), the number of sand-stackers in operation and the magnitudes of the residual mounds.	7.5.3	✓	✓	
17	The Proponent will investigate and monitor the vertical hydraulic gradients and hydraulic conductivities within the Alinga Formation and Toolonga Calcilutite to assess impacts from the confined to the unconfined aquifer systems.	7.5.3	✓	✓	
18	The Proponent will establish a multipiezometer network in the confined aquifer systems that provides a robust pre-development baseline and enables an accurate assessment of local and regional drawdown impacts.	7.5.3	✓	✓	
19	The Proponent will develop and implement a communication strategy to broadcast to individual pastoralists the predicted drawdown impacts on their production bores.	7.5.3	✓	✓	
20	The Proponent will maintain supply to existing groundwater users that are adversely impacted by drawdowns resulting from the process water borefield operation.	7.5.3	✓	✓	
21	The Proponent will ensure that vegetation communities S5 and S10 are not disturbed by the Project.	7.6.3	✓	✓	
22	The Proponent will implement annual vegetation surveys in locations adjacent to the areas affected by mining and in the northern section of the Project Area in order to monitor the effect of mining operations on vegetation health.	7.6.3		✓	✓
23	The draft Vegetation and Flora Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Vegetation and Flora Management Plan during the construction and operational phases of the Project.	7.6.3	✓	✓	
24	The draft Fire Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Fire Management Plan during the construction and operational phases of the Project.	7.6.3	✓	✓	
25	The Proponent will conduct further survey work to determine whether *Eucalyptus beardiana* and *Verticordia dichroma* var. *syntoma* or other Rare or Priority Flora are present within the proposed haul road corridor and accommodation camp area.	7.7.3	✓		

Table 11.1 (cont.'d)

Commitment	Proposed Actions	PER Section	Timing		
			Construction	Operation	Closure
26	Searches for Rare and Priority Flora will be conducted prior to the development of each pit and associated infrastructure to ensure that up-to-date information is considered in the detailed design of the pits and other project components during the construction and operation of the Project.	7.7.3	✓	✓	
27	The draft Priority Flora Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Priority Flora Management Plan during the construction and operational phases of the Project.	7.7.3	✓	✓	
28	The draft Weed Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Weed Management Plan during the construction and operational phases of the Project.	7.7.3	✓	✓	
29	The draft Vertebrate Fauna Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement these Management Plans during the construction and operational phases of the Project.	7.8.3	✓	✓	
30	The Proponent will conduct a stygofauna survey in the southern portion of the Project Area using existing bores. Re-sampling of the bores located in the northern portion of the Project Area will also be conducted. If stygofauna are found to occur in these areas, then sampling outside of the Project Area will be conducted to demonstrate that these species occur outside the Project Area.	7.9.3	✓	✓	
31	The draft Dust Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Dust Management Plan during the construction and operational phases of the Project.	8.1.3	✓	✓	
32	The Proponent will collect baseline data on dust levels in the Hamelin Pool area and monitor the success of dust management measures. Baseline and monitoring data will be used to verify the atmospheric model for Pit 10 and the Hamelin Pool area. If dust settlement on the southern shores of Hamelin Pool is still predicted, the Proponent will research the potential effects on stromatolites.	8.1.3		✓	

Table 11.1 (cont.'d)

Commitment	Proposed Actions	PER Section	Timing		
			Construction	Operation	Closure
33	The Proponent will integrate best practice dust management procedures in consultation with the DoE and regular monitoring and reporting of offsite impacts including vegetation and stromatolites located within the SBWHP.	8.1.3		✓	
34	The draft Solid and Liquid Waste Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Solid and Liquid Waste Management Plan during the construction and operational phases of the Project.	8.5.3	✓	✓	
35	The draft Hydrocarbon Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Hydrocarbon Management Plan during the construction and operational phases of the Project.	8.5.3	✓	✓	
36	The draft Radiation Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Radiation Management Plan during the construction and operational phases of the Project.	9.1.3	✓	✓	
37	The draft Aboriginal Heritage Management Plan will be finalised with consideration of comments received during the public review period of the PER and in consultation with relevant stakeholders. The Proponent will implement the Aboriginal Heritage Management Plan during the construction and operational phases of the Project.	9.4.3	✓	✓	

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The Coburn Mineral Sand Project proposed by Gunson Resources Limited fundamentally involves a large dry earthmoving operation, and ore processing, which will occur progressively in a northerly direction along the Amy Zone ore body over a period of some 20 years.

The mine occurs adjacent the south-eastern border of the SBWHP in a floristically diverse transition zone between two botanical districts. Its northern extremity occurs within 5 km of the Hamelin Pool Marine Nature Reserve which was established to protect ancient stromatolites. The region is semi-arid and windy, evaporation is high and rainfall is sporadic and variable.

One key concern associated with the proposal is the ability to successfully rehabilitate the backfilled mine areas with vegetation to ensure stability of the land surface in the mid to long term. Other major concerns relate to the potential effect of dust, weeds, groundwater drawdown and mounding on the values of the SBWHP (including Hamelin Pool, a marine nature reserve).

The main environmental cost will be the loss of some 5,745 ha of vegetation and fauna habitat in areas to be disturbed by the mining process. Whilst this loss will be mitigated to some extent by rehabilitation of all disturbed lands, it is recognised that the original floral and faunal biodiversity and abundance is unlikely to ever be replicated, and that the area will irreversibly lose some biodiversity values locally as a result.

Many of the vegetation associations that will be disturbed have been described as regionally significant due to their high abundance of Priority Flora and unknown distribution in the broader geographic region. However mine planning has allowed for the total protection of the most significant vegetation assemblages (communities S5 and S10) and the disturbance of no more than 8.5% of the total area of the two other particularly significant communities (S8 and S9). Some Priority Flora will be disturbed, but no Declared Rare Flora will be disturbed and no plant species will be lost as a result of the disturbance.

Whilst some of the less mobile fauna individuals will also be lost during clearing operations, no threatened or vulnerable species of fauna will be lost. Most species in the Project Area are widely distributed throughout the region.

No other long-term environmental costs are anticipated as long as environmental management commitments are adhered to. Principal amongst these is the rehabilitation plan designed to stabilise the disturbed soils and return a stable vegetative cover over the mined out areas. The Proponent has expended substantial effort in determining the most appropriate rehabilitation strategy by investigating examples of rehabilitation in the region and other similar climatic areas and seeking independent peer advice. On the basis of this advice, the Proponent is confident that the mined areas can be successfully rehabilitated and that the technology and experience required is available.

Groundwater management will be required for both environmental and economic reasons. Environmentally, to ensure that groundwater abstraction does not adversely affect regional groundwater resources and dependent ecosystems. Economically, to minimise groundwater use and maximise recovery for recycling. It will be in the Proponent's commercial interest to recover and recycle as much water as is practical. Monitoring bores to be located between the mine and sensitive areas will provide early warning of need for remedial action. Pit dewatering will only be required for mining of the northern orebody. The abstraction of groundwater for pit dewatering and the local drawdown in water table is considered unlikely to affect vegetation as site investigations show that no species are groundwater dependant. Mounding of saline process water beneath the backfilled pit is unlikely to affect adjacent vegetation because its roots are shallow and generally well above the mounded water table.

Abstraction of up to 18 GL/annum will be required to meet process water supply demands. Groundwater drawdown in the northern Project Area would not affect Hamelin Pool as there is no hydraulic connection between the two bodies.

Management of dust will also be a major requirement given the windy nature of the region. The requirement will be for occupational health as well as environmental reasons. Disturbed surfaces will be stabilised using a combination of water sprays and bituminous emulsions sprayed onto the surface.

Weeds are likely to colonise all disturbed areas, particularly the rehabilitation areas. Weeds are known to occur throughout the SBWHP and it is unlikely that the Project will introduce any new species or increase the abundance of weeds in the adjacent SBWHP. However, monitoring will be performed to confirm this and a range of management actions are available if necessary.

It also needs to be recognised that the region is prone to bushfires and that such fires have potential to affect monitoring and management programmes. Gunson has developed a fire management plan to minimise the potential of their operations causing a

bushfire and to protect their rehabilitation areas in the event of a fire.

In mitigation for any reduction of biodiversity values in the Project Area, Gunson proposes to de-stock the Coburn pastoral lease for several years, and longer if permission can be obtained from the Pastoral Board. Feral goats will be removed and baiting will be undertaken to reduce introduced predators such as foxes and cats. Subsequently, and for fire management reasons, the property will be re-stocked but at a level well below the accepted carrying capacity of the land. These actions should substantially improve biodiversity values over the remainder of the property in the mid to long term and more than adequately compensate for the loss of biodiversity values in the project area.

Realisation of the Project will provide a significant economic boost to the local economy as well as provide employment in a region where unemployment is the highest in the State.

It is therefore concluded that as long as the various management plans and rehabilitation plans committed to by the Proponent are competently implemented, the Project will not result in a significant long-term adverse effect on regional biodiversity values. To the contrary, the proposed mitigation measures promise to enhance regional biodiversity values.

In addition, Gunson's commitment to conduct further technical and environmental investigations prior to developing the northernmost pit (Pit 10) reduces the minor risk posed to the values of the Nilemah Embayment and Hamelin Pool. Gunson will have some 15 years experience and monitoring data on which to clarify the impact of developing Pit 10, and will only develop Pit 10 if it can demonstrate to the satisfaction of the Minister for the Environment that impacts to the SBWHP will be acceptable.

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AAGR	Average Annual Growth Rate
ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARIA	Accessibility / Remoteness Index of Australia
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
B-Double	MRWA Vehicle Classification System (a vehicle with 7+ axles, 4 groups)
BMR	Bureau of Mineral Resources
BOM	Bureau of Meteorology
BWE	Bucket Wheel Excavator
CALM	Department of Conservation and Land Management
CCC	Community Consultative Committee
CH_4	Methane
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DBNGP	Dampier to Bunbury Natural Gas Pipeline
DEH	Department of the Environment and Heritage
DEP	Department of Environmental Protection
DIA	Department of Indigenous Affairs
DoE	Department of Environment
DoIR	Department of Industry and Resources
DRF	Declared Rare Flora
EDL	Energy Developments Limited
EET	Emission Estimation Technique
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act* 1986
EPA	Environmental Protection Authority
EPASU	Environmental Protection Authority Service Unit
EPBC Act	*Environmental Protection and Biodiversity Conservation Act* 1999
ERP	Estimated Resident Population
ESD	Ecologically Sustainable Development
fmr	Former name
GDC	Gascoyne Development Commission
GHGs	Greenhouse Gases
GRP	Gross Regional Product
GL/annum	Giga litres per annum
GL/year	Giga litres per year
ha	hectares
HM	Heavy Mineral
HMC	Heavy Mineral Concentrate
HSA	Herring Storer Acoustics
HSE	Health Safety and Environment
ICMM	International Council on Mining & Metals
IIED	International Institute for Environment and Development
JAMBA	Japanese Australian Migratory Bird Agreement
km	kilometres
km/hr	kilometres per hour
kW	kilo Watt
m	metres
ML	mega litres
MCA	Minerals Council of Australia
ML	mega litres
mm	millimetres
Mm^3	Million cubic metres
MMSD	Mining Minerals and Sustainable Development
MNES	Matters of National Environmental Significance
ms	Manuscript name

MRWA	Main Roads Western Australia
MSP	Mineral Separation Plant
MW	Mega Watt
NASA	American National Aeronautics and Space Administration
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NGOs	Non-Government Organisations
NHMRC	National Health and Medical Research Council
NO_x	Oxides of Nitrogen
N_2O	Nitrous Oxide
NSESD	National Strategy for Ecologically Sustainable Development
nSv/hr	nanosieverts per hour
PER	Public Environmental Review
PM_{10}	Particulate matter with an equivalent aerodynamic diameter of 10 microns or less
pn	Phrase name
RNE	Register of the National Estate
SAC	Scientific Advisory Committee
SBWHP	Shark Bay World Heritage Property
TEC	Threatened Ecological Community
SBWHPSAC	Shark Bay World Heritage Property Scientific Advisory Committee
SBWHPCCC	Shark Bay World Heritage Property Community Consultative Committee
SO_2	Sulphur Dioxide
sp.	species (singular)
spp.	species (plural)
subsp.	subspecies
tpa	tonnes per annum
tph	tonnes per hour
TSP	Total Suspended Particulates
UNESCO	United Nations Educational, Scientific and Cultural Organisation
var.	variety
WRC	Water and Rivers Commission (now DoE)
WHIMS	Wet High Intensity Magnetic Separator


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