Mining of Yarloop Reserve 31900

PUBLIC ENVIRONMENTAL REVIEW

CABLE SANDS (W.A.) PTY. LTD.
A.C.N. 009 137 142

MINING OF YARLOOP RESERVE 31900

PUBLIC ENVIRONMENTAL REVIEW

Prepared for

Cable Sands (WA) Pty Ltd

by

Welker Environmental Consultancy

June 98

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Client: Cable Sands Pty Ltd

Report	Version	Prepared by	Submitted to Client	
			Copies	Date
Draft Report	1	C Welker	1	22/05/98
Draft report to EPA	2	C Welker	1	29/06/98
Final Report	3	C Welker	1	30/06/98

AN INVITATION TO COMMENT ON THE MINING OF YARLOOP RESERVE 31900

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

This Public Environmental Review (PER) proposes the mining of titanium minerals in Reserve 31900 at Yarloop. The proponent for the proposal is Cable Sands (WA) Pty Ltd. In accordance with the requirements of the *Environmental Protection Act,* 1986 a PER has been prepared which describes this proposal and its likely effects on the environment. The PER is available for public review for eight weeks from 6/7/98 to 31/8/98.

Comments from Government agencies and from the public will help the Environmental Protection Authority (EPA) to prepare an assessment report in which it will make recommendations to the Government.

Why write a submission?

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

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

Why not join a group?

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

Developing a submission

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

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; 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 submissions to be analysed:

- attempt to list points so that the issues raised are clear. A summary of the submission is helpful.
- refer each point to the appropriate section, chapter or recommendation in the PER.
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering.
- attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

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

The closing date for submission is 31/8/98

Submissions should be addressed to:

Environmental Protection Authority
8th Floor, Westralia Square
141 St Georges Terrace
PERTH WA 6000

Attention: Ms Melinda Phillips

EXECUTIVE SUMMARY

Cable Sands (WA) Pty Ltd proposes to mine mineral sands in a portion of Reserve 31900 (19.7 ha) which is currently vested with the Shire of Harvey for the purpose of rubbish disposal and sand extraction. Mining will be for a period of about 16 months at the current mining rate at Yarloop and will involve disturbance of about 9.1 ha of which 6.1 ha is native vegetation.

The EPA has determined that this proposal will be assessed under Part IV of the *Environmental Protection Act 1986* as a Public Environment Review (PER) in accordance with administrative procedures established under that Act. This PER has been prepared in accordance with guidelines issued by the EPA (refer Appendix 1).

A mining proposal at Yarloop, which included mining within the Reserve 31900, was previously assessed by the EPA (Bulletin 838, 1996) who recommended that mining on Reserve 31900 should not proceed on the basis that mining in Reserve 31900 would compromise its objective to ensure that the abundance, diversity, geographic distribution and productivity of vegetation community types 3b and 20b are protected. The Minister for the Environment subsequently issued an approval for this proposal to proceed but excluded that part of the proposal that related to mining in the reserve (refer Appendix 2).

Since this decision of the Minister, the proponent has conducted detailed botanical studies of the vegetation in Reserve 31900 and found that the threatened community (3b) is not present in the area to be mined. This area (6.1 ha) is part of a continuum between vegetation types 3b and 20b.

The use of the reserve as a rubbish tip and sand pit has lead to the introduction of weeds and other threatening processes. This has reduced the overall conservation value of the reserve and is a major threat to the eastern portion, which has higher conservation value. The current proposal provides an opportunity to apply resources for rehabilitation and management to restore vegetation values in a large proportion of the reserve.

The current proposal involves additional components not included in the previous Yarloop Mine proposal. These components are:

- rehabilitation, protection and management of unmined areas (about 10.6 ha) in the reserve currently degraded to varying degrees by present and past activities associated with the rubbish tip and sand pit; and
- the acquisition by the proponent of about 10 ha of nearby land with vegetation of comparable or higher conservation value for inclusion in the conservation estate.

ENVIRONMENTAL MANAGEMENT

Cable Sands (WA) Pty Ltd (the proponent) is committed to best practice environmental management and has successfully rehabilitated more than ten mine sites since commencing operations. The proponent is committed to amending its existing Environmental Management and Monitoring Plan for the Yarloop mine to address mining in Reserve 31900. The modified plan will be in accordance with the requirements of the Department of Environmental Protection (DEP), the Department of Conservation and Land Management (CALM) and the Department of Minerals and Energy (DME).

The plan will address management and monitoring practices for native vegetation, fauna, dieback, surface water, dust, noise and Aboriginal heritage.

Cable Sands has recently achieved certification of its environmental management system to the ISO 14001 standard and is the first mineral sands company to achieve this milestone.

ENVIRONMENTAL FACTORS

The EPA guidelines require the consideration of 12 environmental factors, the most significant of which is vegetation communities. Other environmental factors have been previously addressed in the assessment of the Yarloop Mine proposal and have not substantially changed with the proposal to mine Reserve 31900.

A summary of the potential impacts and management for all environmental factors is presented in a table at the end of this summary.

VEGETATION COMMUNITIES

If the proposal was not implemented the value of the vegetation of Reserve 31900 would continue to deteriorate irrespective of whether the tip is relocated. In addition, the implementation of System 6 update recommendations and formation of conservation reserves in the area would be much slower and vegetation with comparable or better value adjoining the reserve would not be secured for the conservation estate.

The proponent is committed to the following management measures to facilitate the achievement of the EPA objective for vegetation communities:

- prepare and implement a rehabilitation plan for the whole reserve in consultation with CALM;
- fence and reduce the operational area of tip (if not relocated) to a reasonable minimum;
- minimise disturbance to vegetation;
- fence external boundary of Reserve 31900 to restrict public access; and
- acquire about 10 ha of nearby private land with vegetation of comparable or higher conservation value for incorporation into the conservation estate.

If the proposal was implemented, the following medium to long term biodiversity and nature conservation outcomes are anticipated:

- substantially improved conservation value and viability of the reserve;
- incorporation of a portion of Location 826 (approximately 10 ha) with comparable or higher vegetation values into the conservation estate.
- no significant loss of biodiversity over the whole reserve;
- a small loss of biodiversity in the eastern portion of the reserve by the clearing of the vegetation continuum between vegetation types 20b and 3b.
- the maintenance of significant conservation value which would be a better complement for the reserves to the north of Burney Road.

OTHER ENVIRONMENTAL FACTORS

Noise abatement and suppression procedures will be employed at the mine to ensure that statutory environmental noise standards are met. The separation distance between mining and noise sensitive premises is greater under this proposal than for the present Yarloop Mine.

Vegetation buffers will be maintained and vegetated bunds will be established between the mine and the South West Highway to reduce the impact of visual amenity.

The proposal will be an insignificant source of greenhouse gases but all reasonable and practicable means will be used to reduce emissions.

Summary of the environmental issues, potential impacts and management

FACTOR	EPA OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	MANAGEMENT	PREDICTED OUTCOMES
BIOPHYSICAL					
Vegetation Communities	To maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	The values and condition of vegetation vary across the reserve. The eastern side of the reserve has significant conservation value. The reserve is subject to substantial threatening processes as result of the presence and operation, within the reserve, of a tip and sand pit.	About 6.1 hectares of vegetation with significant conservation value will be cleared.	Rehabilitation of mined and unmined areas of the reserve to improve vegetation values. About 10 ha of land with vegetation of comparable conservation value will be acquired for incorporation into the conservation estate.	Overall the reserve will have increased conservation value in the long term. Increased protection, security and management of vegetated areas with conservation value
Declared Rare and Priority Flora	To protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950.*	Declared Rare or Priority Flora have not been located in the reserve.	No impact	Refer to vegetation communities above.	No impact.
Fauna	To maintain the abundance, species diversity and geographical distribution of fauna	Faunal values of the reserve are low.	A small amount of Jarrah Forest habitat will be cleared.	Refer to vegetation communities above.	Improved habitat in the reserve for fauna in the long term.
Specially Protected (Threatened) and Priority Fauna	To protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950*	Unlikely to be present or dependent on habitats in the reserve.	Negligible.	Refer to vegetation communities above.	Negligible
Landform and Rehabilitation	To establish stable sustainable landform consistent with surroundings To ensure proposal area and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long term land use.	Substantial areas of the reserve are degraded and subject to threatening processes. Refer also the vegetation communities above.	NA	Application of rehabilitation procedures in mined and unmined areas consistent with long term land uses and conservation values. Rehabilitation plan to be prepared and submitted for approval.	Refer vegetation communities above.
POLLUTION MANAGEMENT					
Particulates/Dust	To ensure that particulate emissions, both individually and cumulatively, do not cause an environmental or health problem. To use all reasonable and practicable measures to minimise the discharge of particulate wastes.	Adjoins an existing sand mining operation. The nearest residence is 1 km away.	Potential visible emissions and nuisance.	Dust suppression procedures applied in accordance with good industry practice.	Negligible

FACTOR	EPA OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	MANAGEMENT	PREDICTED OUTCOMES
Greenhouse gases	To ensure that greenhouse gas emissions, both individually and cumulatively, do not cause an environmental or health problem. To use all reasonable and practicable measures to minimise the discharge of greenhouse gases.	NA	Minor release of greenhouse gases.	All reasonable and practicable measures will be taken to reduce energy consumption.	Minor release of greenhouse gases.
Surface water quality	To maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters	The reserve does not contain any significant watercourses. No significant amount of acid generating materials in the ore body.	Potential offsite release of turbid water and hydrocarbon spillages.	Water will be use in a closed circuit and offsite discharge of waste water will not occur. Fuel storage areas to be bunded	No significant impact
Noise	To ensure noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.	The surrounding environment is rural but the proposal adjoins the South West Highway.	Noise emissions have the potential to breach noise regulatory levels at sensitive premises.	Restrictions on mine operations at night. Noise suppression equipment on equipment and construction of noise bunds.	Compliance with noise statutory standards.
SOCIAL SURROUNDINGS					
Visual amenity	Visual amenity of the area adjacent to the project should not unduly be affected by the proposal.	Surrounding landscape is rural with wooded areas. The mine adjoins the South West Highway. Nearest residence is 1 km away.	The visual amenity road users and neighbours may be potentially affected.	Vegetation buffers and vegetated bunds would be established between the mine and the South West Highway and neighbours.	Visual amenity would not be unduly affected
Aboriginal culture and heritage	To ensure that the proposal complies with requirements of the *Aboriginal Heritage act 1972*. To ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Aboriginal sites unlikely to be present	No impact	Production will cease if sites are discovered.	Compliance with the Aboriginal Heritage Act 1972.

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1. INTRODUCTION

This environmental review describes a proposal to mine, manage and rehabilitate areas of Reserve 31900 about 2 km south east of Yarloop in the Shire of Harvey (Figure 1). The town of Yarloop has a population of 587 (1991 Census).

A significant deposit of titanium minerals has been identified in Reserve 31900 adjacent to the current mining operation of Cable Sands (WA) Pty Ltd (Figure 2). This reserve is vested with the Shire of Harvey for the purpose of rubbish disposal and sand extraction. The Shire has operated the tip at Yarloop since the early 1970s and at present is reviewing options for the future use of the reserve. Although the DEP has indicated in a letter to the Shire that the terms of the current licence for the tip will not be extended, the Shire has expressed a preference for continued operation in the reserve, at least in the short term. The primary difficulty with relocation of the tip is finding an appropriate alternate site, which will satisfy the expectations of the Yarloop community and the Department of Environmental Protection (DEP).

A mining proposal at Yarloop was previously assessed by EPA (Bulletin 838, December 1996) who recommended that mining on Reserve 31900 should not proceed on the basis that mining in Reserve 31900 would compromise its objective to ensure that the abundance, diversity, geographic distribution and productivity of vegetation community types 3b and 20b are protected. The Minister for the Environment issued an approval for this proposal to proceed but excluded that part of the proposal related to mining in the reserve.

Further scientific investigations undertaken by Mattiske Consulting Pty Ltd, 1997 have questioned the presence of the threatened floristic community types and the location of floristic community type boundaries. This proposal addresses all aspects of the vegetation issues relating to Reserve 31900 and the surrounding group of reserves.

The current proposal differs from the previous proposal in number of ways including:

- mining of the resource under the active tip and degraded area on the reserve (in total about 9.1 out of 19.7 ha). Additional drilling undertaken in late 1996 and 1997 has lead to a further heavy mineral resource being found under this area.
- rehabilitation and management of Reserve 31900 (both mined and unmined areas) which is designed to provide a net benefit to the environment.
- inclusion of an area of native vegetation of comparable value adjoining the Yarloop reserves, to be acquired by the proponent, for eventual inclusion in the conservation estate if mining were to proceed in the reserve.

Mining of the resource within the reserve would extend the life of the existing Yarloop Mine by 16 months.

1.1 PURPOSE OF THIS ENVIRONMENTAL REVIEW DOCUMENT

This document has been prepared in accordance with the *Environmental Impact Assessment Procedure 1993* for EPA consideration and advice to the Minister for the Environment under section 44 of the *Environmental Protection Act 1986*.

This report has also been prepared in the form of a Public Environmental Review (PER) for the consideration of the Environmental Protection Authority (EPA) to provide advice to the Minister for the Environment.

The content of the PER includes environmental factors relevant to the proposal.

The PER is intended to provide the EPA, the public and Government agencies with an understanding of the proposal and the environmental strategies and commitments applied to address environmental factors.

The PER is subject to an eight week public review period. At the end of this period, issues raised in written submissions from the public and Government agencies are collated and transmitted to the proponent by the Department of Environmental Protection.

An opportunity is provided for the proponent to respond to the points raised and to provide a response to the EPA for its consideration. This response and points raised in submissions are conveyed along with the EPA's report to the Minister for the Environment.

The Minister releases the EPA report and any person has the right to appeal, within 14 days, against the recommendations of that report. The Minister is required to consult with other relevant Ministers before making any decision on the proposal.

Environmental issues relevant to Reserve 31900 were also addressed in detail in the Consultative Environmental Review (CER) (Cable Sands (WA) Pty Ltd, 1996) prepared for the proposal for the adjoining Yarloop mine project. Environmental factors including groundwater, radiation, noise, dust and heritage were assessed by EPA as being unlikely to compromise its objectives (EPA, 1996). The management of these factors is also addressed in detail in the Environmental Monitoring and Management Plan prepared by Cable Sands (Cable Sands (WA) Pty Ltd, 1997) and this plan has met the requirements of DEP. Given that mining operations and rate will be essentially identical to that of the adjoining Yarloop Mine, the assessment of these environmental factors is unlikely to have substantially changed but nonetheless they have been addressed in this document.

1.2 PROPONENT

Cable Sands (WA) Pty Ltd is the oldest titanium mineral mining company in Western Australia. Mining commenced in 1956 at Koombana Bay and has continued through a series of mineral deposits at Busselton, Capel, Waroona, Wonnerup and Minninup. Currently operating mine-sites are located at Benger, Yarloop and Jangardup. Extension of the Yarloop mine-site represents a continuation of the company's operations in the South West. The proposal will extend the mine life for Yarloop by approximately 16 months. The mine life of current activities to the south and east of Reserve 31900 is about 4.5 years.

1.3 RELEVANT LEGISLATION

The proposal will be subject to a number of Acts of Parliament and regulations at State and Commonwealth levels. A selection of key legislation is listed below.

- Aboriginal Heritage Act 1972.
- Australian Heritage Commission Act 1975.
- Conservation and Land Management Act 1984.
- Dangerous Goods Regulations 1992.
- Endangered Species Protection Act 1992.
- Environmental Protection Act 1986 as amended.
- Environmental Protection (Noise) Regulations 1997
- Explosive and Dangerous Goods Act 1961.
- Dangerous Goods (Storage) Regulations 1992.

- Hazardous and Toxic Substances Regulation.
- Health Act 1911 - 1979 and Regulations.
- Heritage of Western Australia Act 1990.
- Mining Act, 1978
- Mines Safety Inspection Act 1994 and Mines Safety Inspection Regulations 1995.
- Mines Regulation Act 1946 and Regulations.
- Occupational Health, Safety and Health Act 1984.
- Poisons Act 1964.
- Poisons Regulations 1965.
- Rights in Water and Irrigation Act 1945 -1982.
- Wildlife Conservation Act 1950.

International agreements or treaties and national agreements and State policies that may directly or indirectly affect this proposal include:

- Montreal Protocol on Substances that Deplete Ozone.
- Convention on Biodiversity.
- United Nations Framework Convention on Climate Change.
- National Greenhouse Response Strategy.
- National Strategy for Ecologically Sustainable Development.
- Revised Greenhouse Strategy for Western Australia.

1.4 DECISION-MAKING AUTHORITIES

The decision-making authorities (DMAs) and involved authorities that are associated with this proposal include:

1. Environmental Protection Authority (EPA)

   The EPA will consider this environmental review pursuant to section 38 of the *Environmental* Protection *Act 1986*.

2. Department of Environmental Protection (DEP)

   The DEP facilitates the preparation of this environmental review document and any subsequent formal assessment of proposals in accordance with EPA procedures. DEP is responsible for ensuring that owner/occupiers take all reasonable and practicable measures to control the discharge of waste to the environment.

3. Department of Conservation and Land Management (CALM)

   CALM protects and manages native flora and fauna and their ecosystems through the provisions of the *Conservation and Land Management Act 1984* and the *Wildlife Conservation Act 1950*. CALM may provide advice on the management of flora and fauna and has the responsibility for managing State Forests.

4. Department of Minerals and Energy (DME)

   The DME controls the activities of extractive industries by the provisions of several Acts, including the *Mining Act 1978*, the *Mines Safety and Inspection Act 1994* (previously the *Mines*

Regulation Act 1946-1974), *Petroleum Act 1967* and the *Explosives and Dangerous Goods Act 1961*. Additionally, the DME also administers mining operations disturbance of land through the *Soil and Land Conservation Act 1945* on behalf of the Department of Agriculture. The DME will provide advice to the EPA/DEP on environmental and mining procedures.

5. 5. Shire of Harvey

   Reserve 31900 is currently vested with the Shire of Harvey for rubbish disposal and sand extraction. The proponent has an agreement with the Shire to obtain permission for access to the reserve for mining purposes.

1.5 COMMUNITY CONSULTATION

Two groups have been established for company community consultation. The first involves immediate neighbours to the proposed mine. The second is the wider community with an interest in the project.

Cable Sands maintains liaison with the first group as part of its mining operations at the Yarloop mine. This group will have the project explained to them in person during the public review phase of this PER. They will be informed when on-site works commence and any significant changes in operations which affect them will be communicated directly by a company representative. The first group includes:

Mr and Mrs A Jenkins

Mr and Mrs M Jenkins

Mr and Mrs A Angi

Mr and Mrs C Angi

Mr and Mrs F Venables

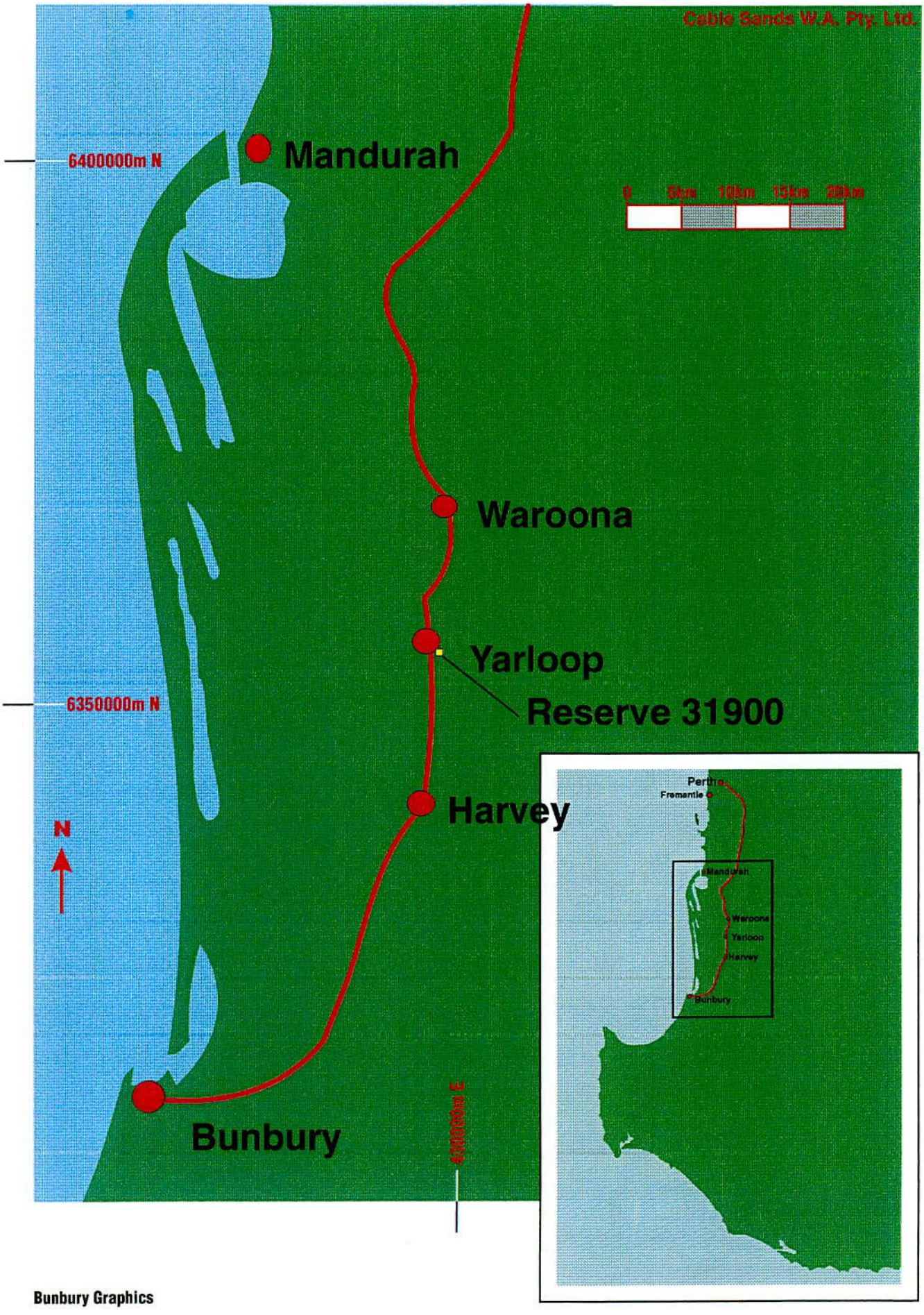
Mr and Mrs R Parrick

Mrs V Armstrong

The wider community will be informed of the project through the requirements of the approval process and through media releases where appropriate (for example at the commencement of on-site operations). A media release will be prepared to coincide with the release of this public review document.

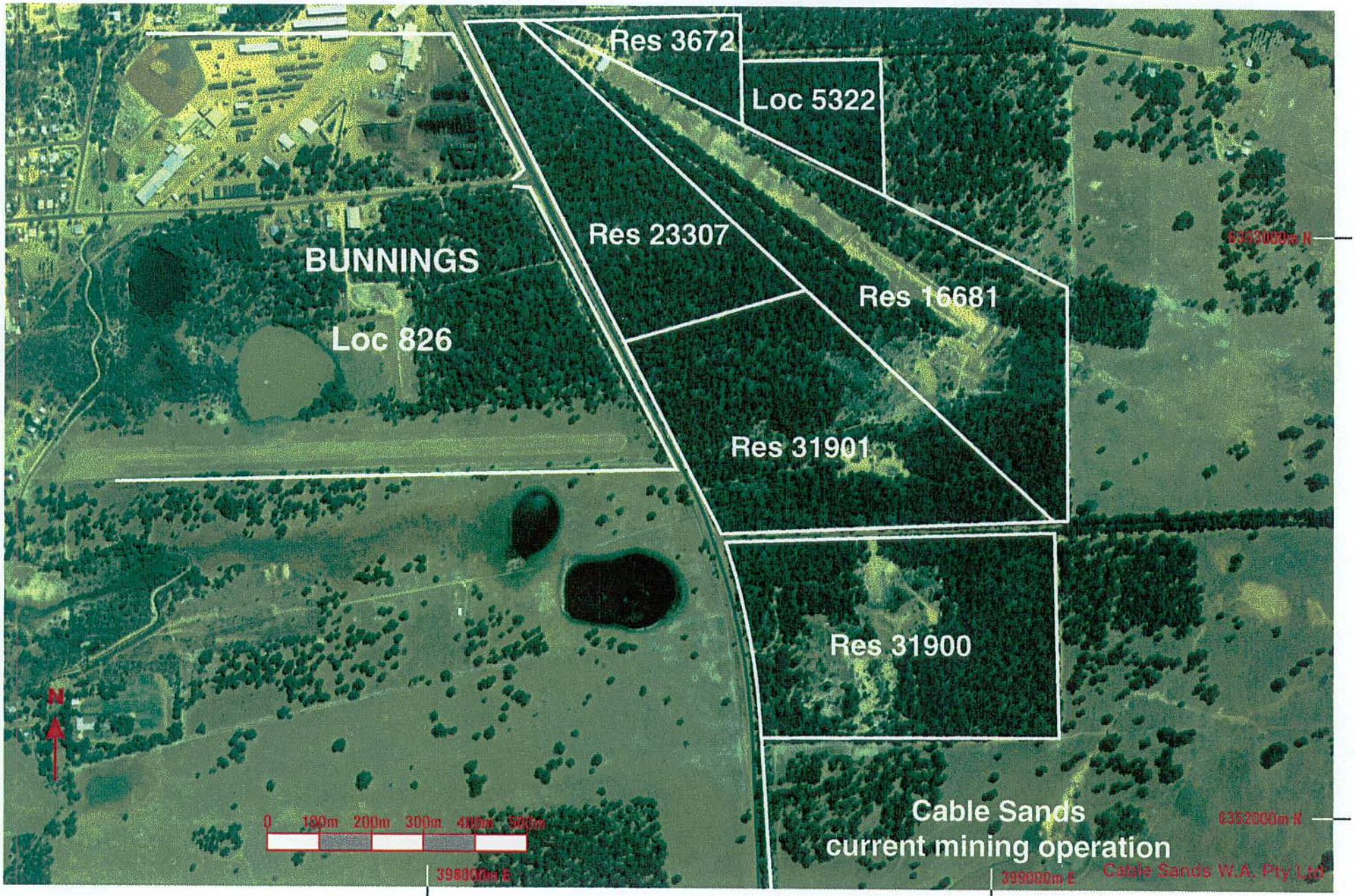
Any communication additional to that outlined above will be decided on an as needed basis.

Figure 1 - Location of Proposal Area



Bunbury Graphics

Figure 2 - Aerial photograph showing Reserve 31900 location



2. DESCRIPTION OF THE PROPOSAL

The proposal involves the mining of mineral sands in Reserve 31900 and is an extension of the existing mining operations at Yarloop. The area of disturbance in the reserve is anticipated to be about 9.1 ha of which 6.1 ha has native vegetation of conservation significance.

The key characteristics of the proposal together with those of the existing mining operation are shown in Table 1.

Table 1. Key proposal characteristics

Element		Proposal	Current Yarloop Mine
Life of project (yrs)		1.4	4.5
Orebody (tonnes HMC)		178,000	566,000
Mine pit depth (m)	max	21	23
	typical	13-18	6-17
Area of disturbance (ha)		9.1	84.9
Typical mine operation		7 days per week (24 hr day)	7 days per week (24 hr day)
Major components		Development restricted to ore body area and degraded area. Mined and unmined areas rehabilitated. No major infrastructure located on the reserve.	Two orebodies, slime dams, water dam, wet treatment plant, thickener, concentrate towers, workshops, offices, access roads and substation
Mining rate (tpa HMC)		126,000	126,000
Max mining rate (tpa HMC)		200,000	200,000
Earthmoving	topsoil (m^3)	18,000	170,000
	Overburden (m^3)	310,000	1,188,000
Water supply	source	Borefield at Brockman Road, SWIC	Borefield at Brockman Road, SWIC
	Annual requirement (ML)	803	803
Fuel storage (kL)		35	35

2.1 ALTERNATIVES TO THE PROPOSAL

In the assessment of this proposal it is important to compare the impacts of the proposal not proceeding on the conservation values of the reserve. These impacts are addressed in detail under the environmental factor of vegetation communities.

2.2 OBJECTIVES OF THE PROPOSAL

The main objectives of the proposal to mine Reserve 31900 are:

- to extract 178,000 tonnes of heavy mineral concentrate (HMC) identified within the reserve;
- to rehabilitate mined areas and improve the condition of vegetation in the degraded unmined areas in the reserve;
- to improve the level of protection for vegetation communities in the reserve over the long term by removing threatening processes from the reserve; and
- to enhance the conservation estate in the Yarloop area by providing additional areas of land with vegetation of significant conservation value.

2.3 MINING LEASE M 70/49

A mining lease M70/49 which was granted to Cable Sands at Yarloop on the 18 September 1986 includes Reserve 31900. The layout of the proposal is shown Figure 3.

2.4 MINING AND PRIMARY SEPARATION OPERATIONS

2.4.1 Mining process

The reserve area will be dry-mined over a 16-month period using similar equipment and techniques to those currently in use at the Yarloop mine. The maximum depth of mining is anticipated to be 21 m with typical depths being between 13 m and 18 m. The area of disturbance will be kept to a minimum.

The steps in this process of extraction of heavy mineral sands are described briefly below.

1. Following appropriate seed collection, areas will be cleared of vegetation for mining. Clearing of vegetation will be kept to a practical minimum and appropriate use made of any timber harvested. Any cleared vegetation debris that cannot be used in rehabilitation areas or otherwise salvaged will be burnt in accordance with fire restrictions and relevant smoke control guidelines.
2. Topsoil will be stripped, where practicable, in two stages using scrapers. The top 5-10 cm will be removed firstly along with the understorey vegetation and stored separately. The next 10-20 cm will also be removed for separate storage. Care will be taken to ensure that topsoil from the reserve is stored separately from topsoil from adjacent farmland areas to prevent weed infestation. The storage of topsoil will be kept to a practical minimum and used as required in the rehabilitation of mined areas to re-establish vegetation.
3. Overburden, which is of sufficient depth to be handled independently of the ore, is removed by earthmoving equipment, eg front-end loaders, bulldozers and scrapers. The overburden will be used in the construction of slime dams, stockpiled for later replacement or will be used to fill areas already mined. In total it is anticipated that about 310,000 m^3 will be removed.
4. The ore is mined using similar earthmoving equipment and fed into rotary trommels with 50 mm and 4.5 mm screens to separate large rocks, roots and gravel. The fine fraction is then pumped as a slurry to the Primary Separation Plant where heavy mineral concentrate is separated by conventional wet gravity methods. Heavy mineral concentrate will be dewatered and stockpiled at the mine site prior to being trucked to the Cable Sand's Secondary Separation Plant at North Shore, Bunbury. The tailings separated in the Primary Separation plant are returned to areas requiring rehabilitation.
5. Clay is removed using a thickener tank and the clean water is recycled as far as practicable. The resultant thickened clayey slurry is allowed to dry in one of a number of slimes dams constructed for this purpose.
6. The mined area is recontoured to blend in with the existing landscape using the dried clay, overburden and tailing sand. Topsoil is then replaced and vegetation re-established to a standard consistent with the existing vegetation values of the reserve (refer Section 6.1.3).

2.4.2 Mining schedule

Mine site development will commence as soon as possible after appropriate approvals are received to allow mining. Mining will be integrated with the current operations at Yarloop and will continue in the reserve at current production rates of up to 200,000 tpa HMC. The intention at this stage is to mine the reserve with the plant retained in its current location. Delays have meant that there will be some mining south of Black Rock Road prior to mining in the reserve. Upon completion of mining in

the reserve, the plant will move to the area south of Black Rock Road and the remainder of the southern area will be mined.

After backfilling in the reserve, the mined area will be used for slimes dams to allow incorporation of clays which will facilitate rehabilitation. Mined areas will be recontoured and rehabilitation established over the subsequent growing seasons.

Initially the mining and primary separation operations will be undertaken on a 24 hours per day and six days per week basis, however this may vary depending on production requirements.

2.5 INFRASTRUCTURE

Mining of Reserve 31900 will use the mining infrastructure that has been established for the current Yarloop operations. There will be no major mining infrastructure located on the reserve. Details of some key aspects of this infrastructure are given below.

2.5.1 Water supply and usage

The water supply established for the Yarloop mine will service the reserve operation. Make-up water is pumped into a storage dam from a series of shallow bores in the surficial formation and will be supplemented with water purchased from South West Irrigation. The annual water requirement for the proposal will be about 803 ML/annum.

The bores are located on Brockman Road approximately four kilometres west of the mine-site. Potable water for domestic purposes is collected in rainwater tanks if bore water is not suitable, or purchased from the Yarloop town water supply.

A dam has been constructed below the Primary Processing Plant Site predominantly using on-site materials. It has a capacity of 42,000 kL and will service all phases of the operation.

A water flow diagram for the proposal is shown in Figure 4.

2.5.2 Thickener tank

A thickener tank has been constructed to remove fine clay from the water circuit. This is located adjacent to the water supply dam.

2.5.3 Slimes dams

Slimes dams will be constructed to allow for drying of the fine clay separated by the thickener. Dams will be initially located on agricultural land and subsequently on the mined area after return of tailings. The clay from the slimes dams is eventually incorporated with tails and overburden when the landscape is re-contoured.

2.6 WORKFORCE

The operating Yarloop mine-site employs approximately 28 people. The sequential nature of Cable Sands mining operations at Yarloop provides the opportunity for continuity of employment for current personnel.

2.7 TRANSPORT OF HEAVY MINERAL CONCENTRATE

The proposed operations will result in no change to the trucking regime currently used for the Yarloop mine.

The transportation of the heavy mineral concentrate (HMC) is by truck and trailer units. The truck route will be from the mine-site south along the South West Highway to Bunbury then north along Robertson Drive and Koombana Drive to Cable Sands' North Shore Facility.

At estimated production rates and truck payloads between 42 and 58 tonnes there will be between 50 and 75 return truck journeys per week for the 1.4 year life of the proposal.

The transportation of HMC for Cable Sands is insignificant in relation to the overall traffic on the South West Highway (Cable Sands (WA) Pty Ltd, 1996).

2.8 STORAGE OF HYDROCARBONS

Hydrocarbons kept on site for fuelling the earthmoving equipment will be kept in appropriately constructed bunded areas capable of holding 110% of the largest vessel capacity.

2.9 REHABILITATION

Rehabilitation of Reserve 31900 will be a crucial part of the proposed operation to improve vegetation values in the reserve. Mining will provide the opportunity and the resources to rehabilitate the degraded areas in the reserve in addition to any areas impacted by mining.

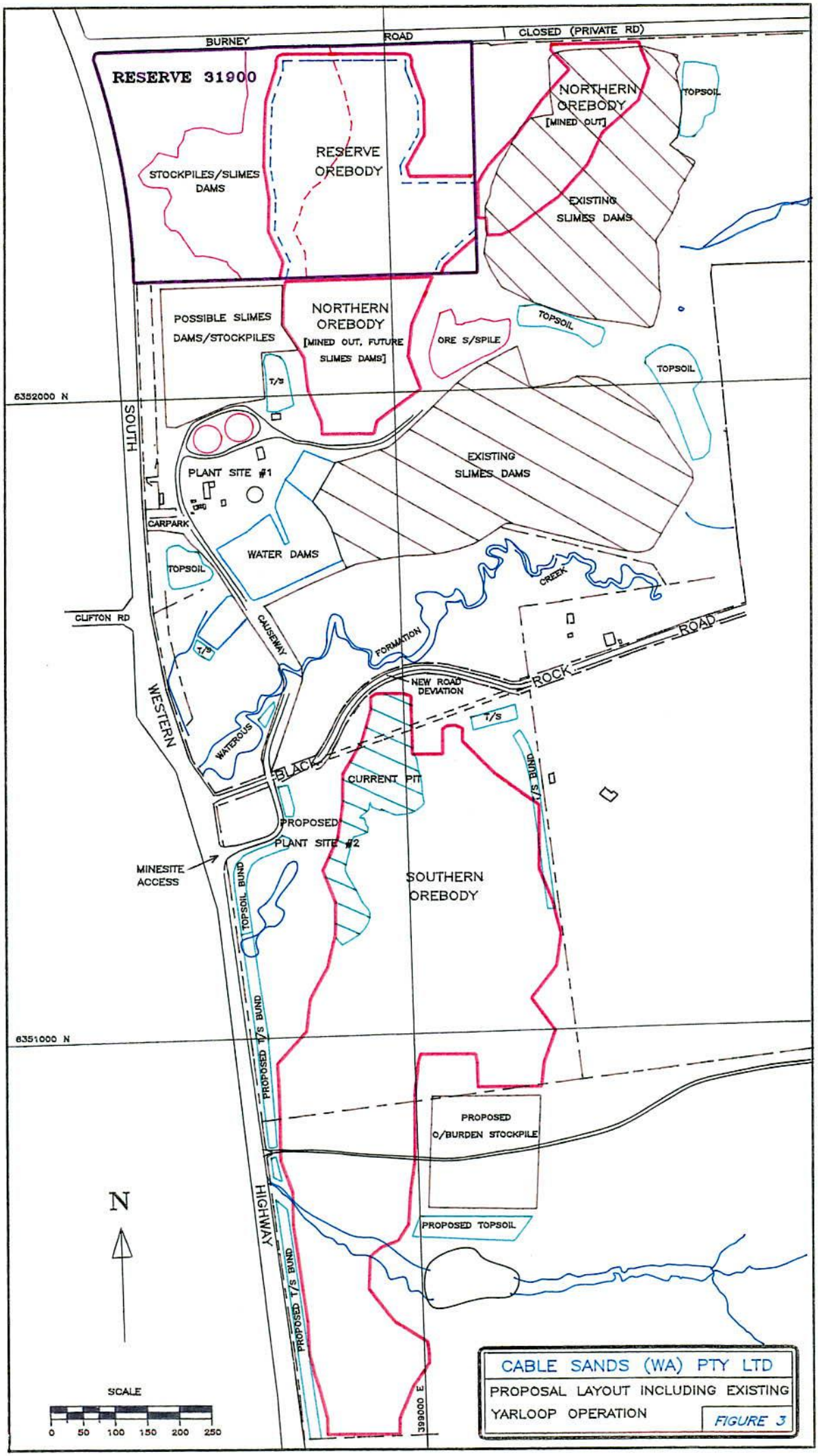
The objectives of rehabilitation will be:

- to promptly rehabilitate the mined area with native species following the mining process;
- to maximise the retention of species diversity in the rehabilitated areas; and
- to improve the condition and protection of vegetation and vegetation values in the degraded areas of the reserve not impacted by mining.

A detailed rehabilitation plan will be prepared, in consultation with CALM, prior to commencement of mining.

The rehabilitation plan will cover five areas selected on the basis of the existing condition of vegetation, land use and whether the area is subject to mining (Figure 5). A specific rehabilitation or restoration strategy will be developed for each area. Photographs of degraded areas within the reserve are shown in Plates 1, 2, 3 and 4.

The rehabilitation process consists of a number of distinct stages that are outlined in the assessment of the environmental factors - vegetation communities and rehabilitation.


BURNEY ROAD
CLOSED (PRIVATE RD)
RESERVE 31900
STOCKPILES/SLIMES DAMS
RESERVE OREBODY
NORTHERN OREBODY [MINED OUT]
TOPSOIL
EXISTING SLIMES DAMS
POSSIBLE SLIMES DAMS/STOCKPILES
NORTHERN OREBODY [MINED OUT, FUTURE SLIMES DAMS]
ORE S/SPILE
TOPSOIL
T/S
6352000 N
SOUTH WESTERN HIGHWAY
PLANT SITE #1
CARPARK
WATER DAMS
TOPSOIL
EXISTING SLIMES DAMS
CREEK
CLIFTON RD
CAUSEWAY
FORMATION
ROCK ROAD
NEW ROAD DEVIATION
T/S
WATEROUS
BLACK
CURRENT PIT
T/S BUND
PROPOSED PLANT SITE #2
MINESITE ACCESS
TOPSOIL BUND
SOUTHERN OREBODY
PROPOSED T/S BUND
6351000 N
PROPOSED O/BURDEN STOCKPILE
PROPOSED TOPSOIL
PROPOSED T/S BUND
N
SCALE
0 50 100 150 200 250
369000 E
CABLE SANDS (WA) PTY LTD
PROPOSAL LAYOUT INCLUDING EXISTING YARLOOP OPERATION
FIGURE 3

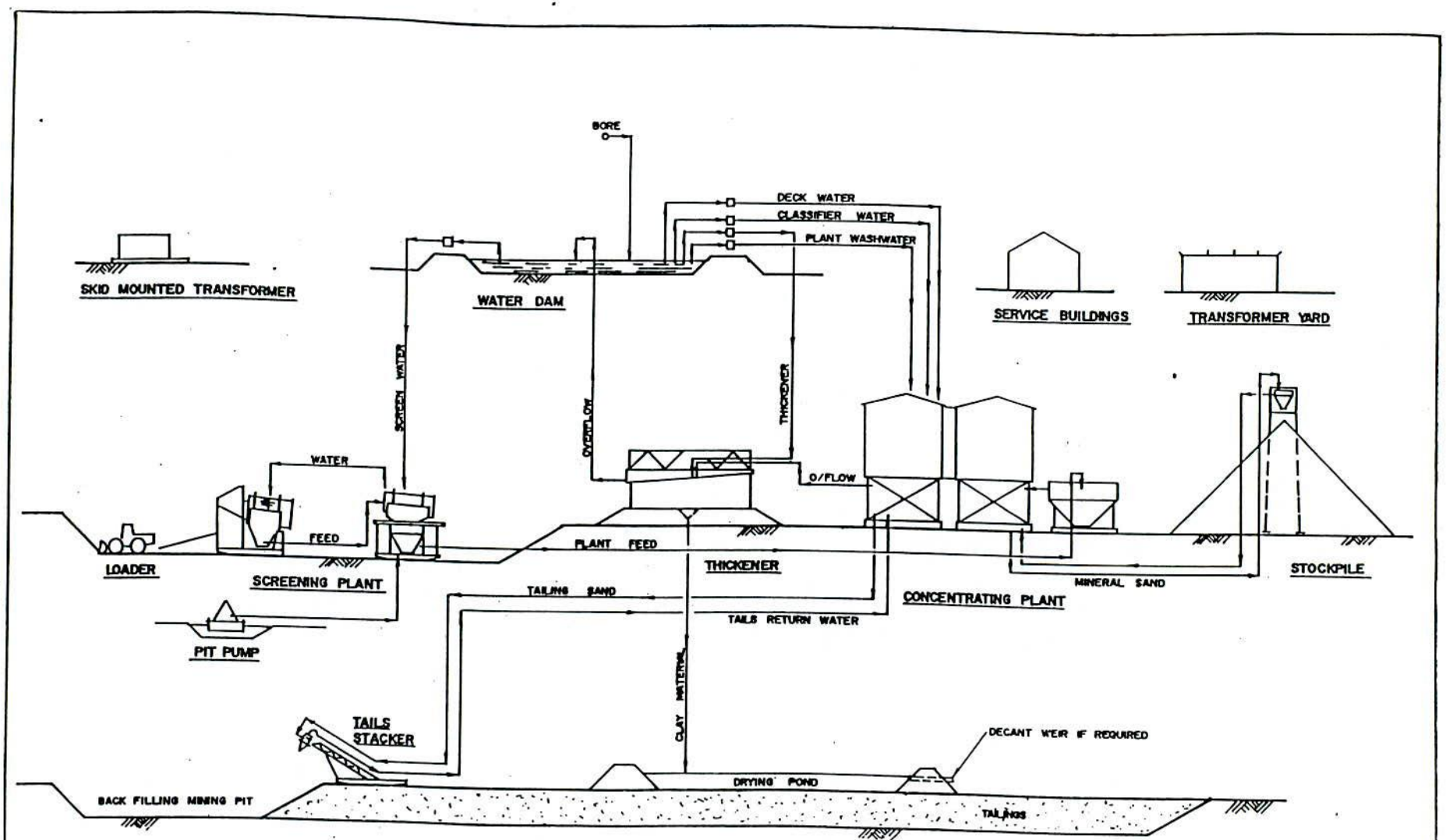
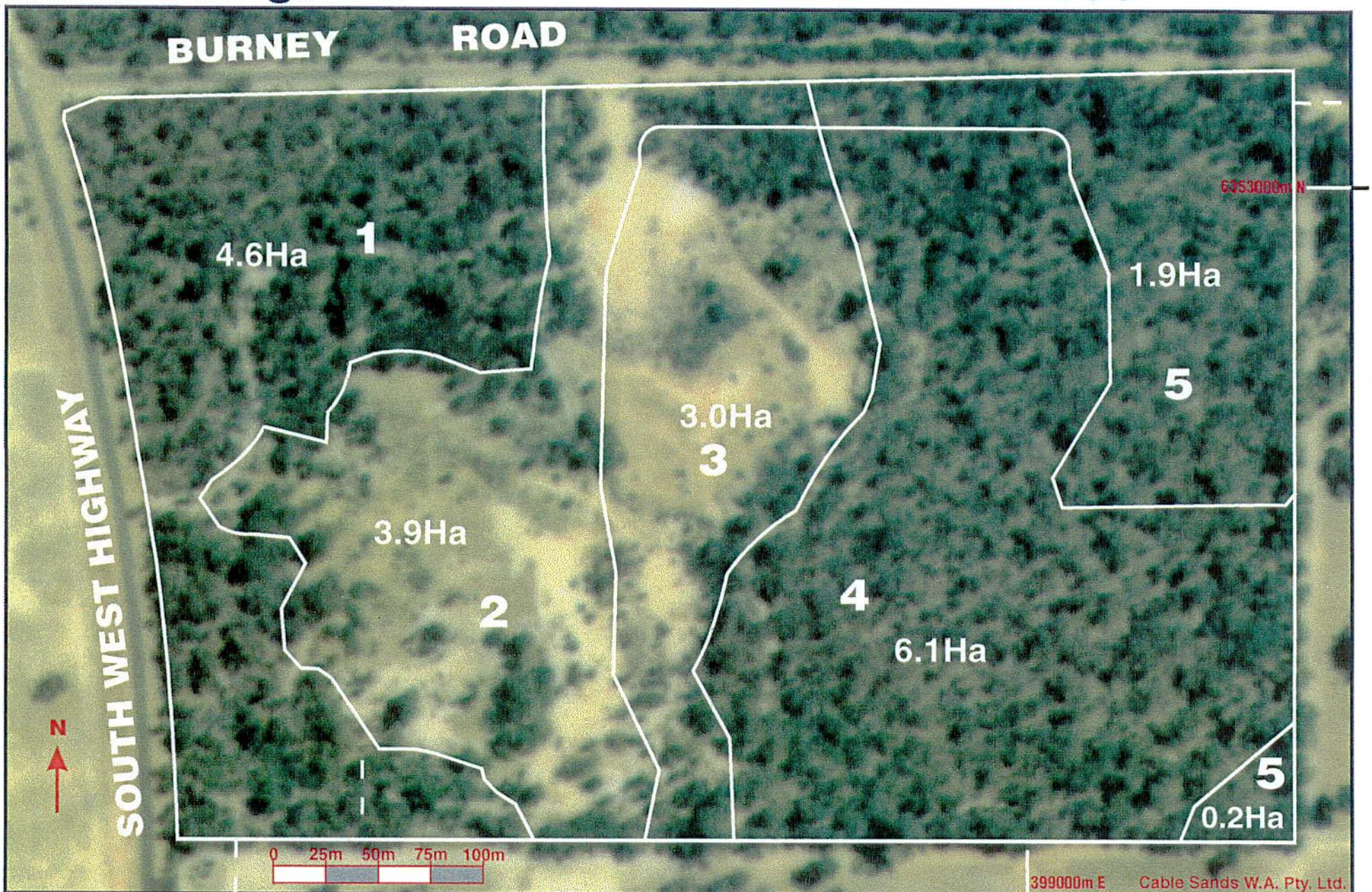


FIG. 4 YARLOOP MINESITE WATER FLOW DIAGRAM

Figure 5 - Areas within Reserve 31900



Plates 1 - 4 Areas of Reserve 31900

Plate 1
Area 1 -
Western side of
Reserve 31900

Plate 2
Area 2 -
Degraded area.

Plate 3
Area 3 -
Active rubbish
dump.

Plate 4
Area 4-5
Eastern side of
Reserve 31900.

3. EXISTING ENVIRONMENT

3.1 REGIONAL SETTING

The South-West region of Western Australia is an important mining, processing, agricultural, manufacturing, timber and tourism area.

Mining and mineral processing is a $2.8 billion industry, based largely around the alumina and titanium mineral industries. In the Yarloop area these industries are represented by Alcoa's Wagerup alumina refinery, 3 kilometres north of Yarloop, and titanium minerals mines previously operated by Cable Sands (Waroona South and Waroona North) and ISK. The region also includes Western Australia's main centres for the dairy, horticulture and timber industries. Bunnings Yarloop sawmill is one of a reducing number of timber mills throughout the south-west.

Bunbury acts as a service city and port for the industries within the area. Bunbury has a population of approximately 28,000 with over 5,000 people residing in the Australind area.

The coastal area south of Perth is dominated by two main landforms - the Swan Coastal Plain and the Darling Plateau. The Swan Coastal Plain extends for approximately 25 kilometres from the Darling Scarp to the ocean. It is composed of a series of sedimentary materials of different ages deposited over millions of years. Mineral sands mining occurs where the sorting and deposition of heavy mineral sands occurs in sufficient concentrations to make mining economically viable.

3.2 CLIMATE

The project area experiences a Mediterranean climate with hot, dry summers and mild, wet winters. Average rainfall at the nearest major meteorological station at Harvey, 14 km south of Yarloop, is 1013 mm and over 90% of this is experienced between April and October.

Average maximum temperatures, recorded at the Wokalup Research Station 20 km south of Yarloop, range from 30.9^0 C in January to 16.7^0 C in July and August. Average minimum temperatures range from 8.0^0 C in August to 16.2^0 C in February.

Winter storms bring squally winds from the north-west to south-west and summer afternoon sea-breezes are from the south-west. Hot dry easterly winds of moderate strength occur at night and early in the day during summer.

3.3 GEOLOGY

The Yarloop heavy mineral deposit is part of the Waroona shoreline (Baxter, 1977). It lies at the foot of the Darling Scarp on the Swan Coastal Plain. The deposit was once continuous but now consists of two separated occurrences of heavy minerals having been dissected by the erosional incisement of a creek off the Darling Scarp. The stranded beach sequence rich in heavy minerals is juxtaposed against a line of sea-cliffs.

The cliffs trend somewhat parallel to the line of the Darling Scarp - the cliffs do not occur in a perfectly straight line but oscillate mildly about their trend (approximately north). They are remarkably steep. Drilling information has shown that the cliffs rise as much as 12 m over a horizontal distance of only 6 m. Elsewhere the cliffs are much less steep, rising 6 m over 6 horizontal metres. The

cliffs are composed of very coarse quartz rich sandy clay containing only traces of heavy minerals. Heavy minerals have accumulated thickest close to the cliff and gradually thin westward until only a metre of heavy mineral rich sand can be recognised.

A more or less continuous sheet of laterite occurs across the top of the entire deposit. It is commonly exposed at or very near to the surface above the line of sea cliffs, covered by a thin sand sheet. West of the cliffs the lateritic horizon deepens, occurring between 5 and 10 m below the surface. Here the laterite is covered by sand and sandy clay containing low to medium heavy mineral concentrations. In an idealised model the lateritic horizon is underlain by clayish sand often with abundant heavy mineral. The relative level of the bottom of the mineralised shore is about 43 m occurring away from the sea cliff (off shore). No fossils were encountered during the drilling program. Coffee rock (indurated sand cemented by iron) is developed throughout the deposit with varying degrees of thickness and hardness.

The heavy mineral strands are underlain by a few metres of grey-brown, fine-gravelly, sandy clay. This in turn overlies dark-grey, fine sandy clay of floury texture. This horizon is many metres thick and it contains abundant fine biotite, becoming harder and more coherent with depth. It is most likely a deeply weathered schistose/granitic rock.

3.3.1 Regional geology

The Yarloop area straddles the eastern margin of the Perth Sedimentary Basin. This contains a thickness of about 6,000 m of Phanerozoic sediments downfaulted against the pre-Cambrian basement of the Yilgarn Block by the Darling Fault. The shallowest superficial formations are of Quarternary age and have a thickness of up to 90 m. These rest on an unconformity which slopes gently to the west below which there are a series of sediments of Cretaceous and Jurassic age. The youngest of these is the Leederville formation, the sediments of which thicken in a westerly direction from the scarp reaching a maximum of 170 m. This formation unconformably overlies the Cockleshell Gully Formation (early - mid Jurassic) throughout the Yarloop area.

The Quaternary is represented by a series of almost flat-lying formations each of which have sometimes complex relationships with its adjoining units both laterally and stratigraphically. The characteristics of the formations occurring in the Yarloop region are:-

Quaternary Guildford Formation. This unconformably overlies the Jandakot Beds, the Yoganup Formation and the pre-Cambrian basement east of the Darling Fault. The deposits lie in the eastern half of the Swan Coastal Plain tending to thin westwards from a maximum of 30 m. The sediments include a brown clay or sandy clay member in the east grading westwards into a more sandy member.

Yoganup Formation. This is probably a lateral equivalent of the Jandakot Beds and rests unconformably on the Leederville Formation and the pre-Cambrian rocks east of the Darling Fault. It consists of poorly sorted sands and clayey sands reaching a maximum thickness of 20 m at the foot of the scarp.

Jandakot Beds. These unconformably overlie the Leederville Formation and consist of medium to coarse sand ranging down in grain size to a clay. The beds are believed to reach a thickness of 13 m.

Cretaceous Warnboro Group. This has the inter-bedded sands and shales of the Leederville Formation as its main aquifer.

Jurassic Cockleshell Gully Formation. This occurs in the sub-surface throughout the region and consists of interbedded sand and shale.

3.4 SOILS

The reserve is situated on the eastern margin of the Swan Coastal Plain, which is characterised by undulating foothill slopes dissected by seasonal creeks and minor valleys. The landform-soil unit within the lease area is typical of the Forrestfield Unit, with laterised foothills of the Darling Scarp becoming sandier and less gravelly downslope to the west. The sandy soils occur within Reserve 31900 and sand quarrying has taken place. The sandy upper profile appears to have been formed during a period of unconsolidation by sand drifting from the adjacent Guildford landform-soil units further westward, and currently these overlie laterised Forrestfield soils.

3.5 HYDROLOGY

The proposal area lies on the eastern margin of the Swan Coastal Plain which extends in a westerly direction to the coast. The physiography of this plain varies from a slightly undulating plain to the west of the reserve and much higher relief to the east.

The plain extends between the foot of the escarpment and the eastern margins of a series of elongate low fixed dunes on the east side of Lake Preston. The main drainage which crosses the plain in a north-westerly direction is the Harvey River. This is confined to the Harvey Main Drain for much of its course across the coastal plain.

The other physiographic region lying to the east of the reserve is characterised by a relatively deeply dissected juvenile topography. This is drained by a series of westerly discharging streams including Waterous Formation Creek, Clarke and Logue Brooks as well as the Harvey stream system which discharges into the southern end of the Harvey Estuary. The natural flows of the streams are highly seasonal. The low flows in summer are principally sustained by discharges of shallow groundwater. However flows are augmented by the tail water of irrigation schemes and discharges from land drainage ditches.

3.5.1 Hydrogeology

The quaternary sediments constitute a continuous aquifer extending over the whole Swan Coastal Plain. The flow system, hydraulic characteristics and water resources have been investigated in some detail by the Geological Survey of Western Australia. The results have been recorded in a series of publications.

The Yarloop area lies within the Waroona flow system which, in common with the adjoining systems, is directly recharged by infiltrating rainfall. It also receives recharge as leakage from the many irrigation channels through the area. Groundwater movement is dominantly westerly from the Darling escarpment down-gradient towards the Harvey River and main drain. The flow pattern is complicated by easterly groundwater movement from the Myalup flow system. This originates in the aeolian dunes to the west. Groundwater discharges in the form of spring flow to streams and transpiration by vegetation.

A series of interconnected groundwater bodies within the Leederville Formation and underlying Cockleshell Gully Formation are sustained by downward leakage from the Yoganup Formation.

Groundwater quality is directly controlled by the hydraulic characteristics and, to a lesser extent, by the chemical character of the sediments. Salinities tend to be particularly high where infiltration is hindered by a high clay content such as in the Guildford and Yoganup Formations. As a general trend, the total dissolved solid content of the waters tends to increase in a westerly direction towards the Harvey drains and river. The quality of the shallow groundwater is further adversely affected by the infiltration of brackish tail water from irrigation.

3.6 RADIATION

A survey of surface gamma dose rates was undertaken in December 1994 and January 1995 over the Yarloop deposit. Gamma radiation was measured at 280 points with an average of 0.16 ± 0.08 μGy/hr. The maximum reading recorded was 0.52 μGy/hr. These rates are typical of background levels of the coastal plain. A frequency distribution of the gamma radiation levels is shown (Figure 6). The graph shows a skewed distribution typical of low level readings. The majority of the results are in the range 0.1 to 0.25 μGy/hr which is typical of natural background radiation levels in this region.

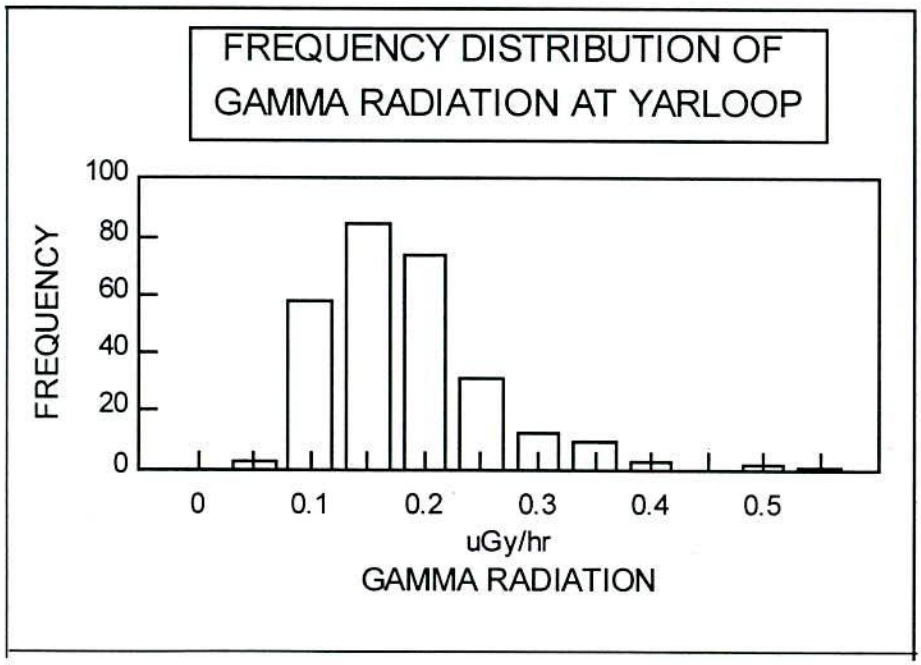


Figure 6. Gamma Radiation at Yarloop

3.7 NOISE

Background noise measurements have been taken around the Yarloop area to enable assessment of noise impacts during the mining operation. The closest neighbouring property was chosen and measurements taken between 21st March and 25th March 1996. These are shown in Table 2 below. These measurements reflect the proximity of the South West Highway to the house.

Table 2. Noise measurement (dB(A))

	Leq	Lmax	L10	L50	L90	Lmin	Temp
Weekdays							
7am - 7pm	59.7	85.0	64.1	50.3	42.6	29.0	27.5
7pm - 10pm	56.7	79.0	60.2	44.9	35.9	27.0	23.5
10pm - 7am	49.8	81.0	49.9	36.2	30.5	26.0	17.2
Weekends							
7am - 7pm	58.0	86.5	62.9	48.5	39.6	29.0	27.6
7pm - 10pm	56.0	87.5	59.5	42.4	33.8	26.5	21.1
10pm - 7am	49.1	79.0	48.9	37.8	34.0	26.5	16.0

In addition to this monitoring, noise modelling and monitoring has been undertaken for the current Yarloop mine operations.

3.8 FAUNA

A fauna assessment of the Yarloop area was undertaken during March 1996 (W G Martinick and Associates, 1996). No evidence of any gazetted rare and/or endangered or priority listed species was found during site inspections. The conclusion of the study was that fauna species which have been gazetted rare and/or endangered are unlikely to be dependent on the habitats of the area to be affected by mining.

The fauna values of Reserve 31900 are reduced because the reserve form an island of remnant vegetation with poor prospects of supporting diverse or rare fauna in the long term. The open nature of the reserve area, with only a sparse medium and tall shrub cover, would provide limited cover for species susceptible to predation by foxes.

Gazetted bird species that could visit the study area are wide ranging in daily and seasonal habits and consequently are unlikely to be affected by the mining operation.

Species observed or inferred during the fauna assessment included the Western Grey Kangaroo (*Macropus fuliginosus*), Gould's Monitor (*Varanus gouldii*), Australian Raven (*Corvus coronoides*), Darter (*Anhinga melanogaster*) and Pacific Black Duck (*Anas superciliosa*).

3.9 VEGETATION IN RESERVE 31900

Characteristics of the local and regional biophysical environment were described in the CER for the Yarloop Mine (Cable Sands (WA) Pty Ltd, 1996). Greater detail is provided below on the present status, condition and land uses of Reserve 31900 and other reserves in the vicinity which are of interest.

The condition of vegetation in the vicinity of the proposal was assessed by Mattiske Consulting Pty Ltd (1997).

Work that has been undertaken in recent years (eg Gibson et al, 1994; Keighery, 1995; Environmental Survey and Management, 1996 and Mattiske Consulting Pty Ltd, 1997) has highlighted the conservation values of vegetation in the Yarloop area. Reserves 31900, 31901, 3672 and 23307 have been interim listed for inclusion as part of the System 6 update (EPA, 1996).

3.9.1 Location

Reserve 31900 is bounded by the South West Highway to the west, Burney Road to the north and freehold land owned by Cable Sands to the east and south (Figure 2). The reserve has an area of approximately 19.7 ha.

The reserve forms part of Mining Leases 70/49. Titanium minerals mining is currently taking place on the Cable Sands owned land adjacent to Reserve 31900.

3.9.2 Flora and vegetation

Environmental Survey & Management (1996) conducted an assessment of vegetation and Mattiske Consulting Pty Ltd undertook a detailed vegetation survey of reserves in the vicinity of the proposal in August 1997. These surveys and previous investigations in adjacent bushland (Keighery, 1995) and Reserve 23307 (CALM, unpublished) have found no rare or priority listed flora in these reserves.

Mattiske Consulting Pty Ltd (1997) recorded a total of 112 vascular plant species (Appendix 3) and about 16 introduced or weed species in Reserve 31900. Previous survey work on the reserve by Environmental Survey & Management (1996) recorded 88 vascular plant species.

Two vegetation types, 3b and 20b have been recorded in the area (Gibson et al, 1994) with a 20b site having been sampled in the Reserve 31900 and a 3b site in an adjacent area north of the rifle range.

G Keighery (1995) made a boundary between these two vegetation types in the reserve from aerial photography and from comparison with adjacent areas.

Gibson et al (1994) describe floristic community type 3b as Jarrah –Marri woodlands on sandy clay soils. Floristic community type 20b is described as Eastern Banksia attenuata and or Eucalyptus marginata woodlands. Both these floristic communities are largely restricted to the eastern side of the Swan Coastal Plain and historically have undergone substantial clearing for agriculture. The dominant species for the vegetation types 3b and 20b are shown in Table 3 below (from Gibson et al, 1994 and Mattiske Consulting Pty Ltd, 1997).

Table 3. Dominant species for vegetation types 3b and 20b

	Type 3b	Type 20b
Trees	*Eucalyptus marginata, Corymbia calophylla* (occasional sites), *Allocasuarina fraseriana, Xylomelum occidentale*	*Banksia attenuata, Eucalyptus marginata, Allocasuarina fraseriana*
Shrubs	*Xanthorrhoea preissii, Xanthorrhoea gracilis. Stirlingia latifolia,*	*Grevillia wilsonii, Xanthorrhoea gracilis, Hibbertia hypericoides*
Herbs	*Phlebocarya ciliata, Mesomelaena tetragona, Drosera erythrorhiza*	*Tetraria octandra, Mesomelaena tetragona, Lomandra serica*

Based on the survey of a number of sites on the reserve, Mattiske Consulting Pty Ltd (1997) found a continuum present between vegetation types 3b and 20b. In addition, most dominant species, as

defined in Table 3, occur from east to west across the reserve. Only 23% of the species recorded were specific to either 3b or 20b vegetation type and it was difficult to separate the vegetation types on a very local scale on the presence/absence of species or the density of species at each site.

The continuum across the landscape is reflected in the species which occur at all sites and in the species which change gradually at the different sampling locations (Appendix 4). There are some species that are specific to only one location; although these do not correspond with the dominant species as defined in Table 3.

The latter is largely a result of the gradual change in the floristic components of the vegetation reflecting the subtle changes in the upper soil profiles from the sandy soils in the west to the more gravelly soils in the east. This subtle response of the vegetation to underlying soil conditions can also be seen in the northern jarrah forest through the work of Havel (1975) and Mattiske and Havel (1998).

3.9.3 Present condition

Mattiske Consulting Pty Ltd (1997) found that the vegetation of the eastern section of the reserve was of higher quality as there was little weed invasion. However, surrounding the tip and the old sand pit the weed invasion was extensive. The present management and weed infestation in the reserve presents substantial threats to vegetation values in all parts of the reserve.

For rehabilitation purposes the reserve has been split into the following five areas (Figure 5):

1. Area 1 -an area of native vegetation (approximately 4.6 ha) with varying degrees of disturbance on the western edge the reserve adjoining the tip. This area has significant conservation value owing to the presence of the vegetation Type 20b using the classification system of Gibson *et al* (1994). This area will not be mined.
2. Area 2 - an area of the active rubbish tip and degraded land previously used for sand extraction covering an area of about 3.9 ha and operated by the Shire of Harvey to serve the Yarloop community. This area will not be mined but will be used for stockpiles prior to rehabilitation.
3. Area 3 - an area of the active rubbish tip and degraded land previously used for sand extraction and covering an area of approximately 3.0 ha in the centre of the reserve. This area would be mined.
4. Area 4 - an area of native vegetation (approximately 6.1 ha) on the eastern side of the reserve and has significant conservation value. This vegetation appears to be a continuum between Type 3b and 20b. This area would be mined.
5. Area 5 - an area of native vegetation (approximately 2.1 ha) on the eastern side of the reserve and has significant conservation value. This vegetation appears to be a continuum between Type 3b and 20b. This area would not be mined.

The orebody is located in the Areas 3 and 4 and includes the sand quarry and part of the area used for rubbish disposal.

3.10 Reserves north of Burney Road

Reserve 31900 is the southernmost of a group of reserves on the eastern side of the South West Highway at Yarloop. There are four reserves, north of Burney Road, which together form a relatively large area of native vegetation. These reserves (Reserve 31901, Reserve 23307, Reserve 3672 and Reserve 16681) are discussed below and are shown on Figure 2.

Mattiske Consulting Pty Ltd (1997) recorded 97 vascular plants from 62 genera in the reserves north of Burney Road. Reserve 31901 had been burnt in the summer of 1995. Vegetation type 3b is restricted to the eastern section and 20b to the western side of these reserves.

There appeared to be even less distinction between these two vegetation types than was observed in Reserve 31900 with most species occurring through out both vegetation types (Mattiske, 1997).

3.10.1 Reserve 31901

Reserve 31901, vested with Main Roads Western Australia as a sand pit, is immediately north of Burney Road and bounded by the South West Highway to the west. The area of this reserve is 19.1 ha. Substantial disturbance has occurred in this reserve in two areas from the following activities:

- a sandpit established by MRWA;
- by an unauthorised rubbish tip; and
- gravel removal.

Weed infestation (mostly Watsonia) is also found along the access track to the sandpit.

3.10.2 Reserve 23307

Reserve 23307 is unvested with the purpose as National Park and has an area of 12.95 ha. This reserve is in good condition with the exception of an area of approximately 0.5 ha which was cleared in 1996 to establish a parking bay adjacent to the highway.

CALM has initiated the process of changing the status of Reserves 31901 and 23397 to A class vested with the National Parks and Nature Conservation Authority (NPNCA) for the purpose of conservation. This process has been delayed due to native title issues not specific to Yarloop.

3.10.3 Reserve 16681 and 3672

Reserve 16681 is unvested with the purpose of rifle range and has an area of 21.37 ha. Approximately 11.5 ha of the site contain vegetation that is in good condition and the remainder has been cleared for the rifle range or degraded by other activities.

Reserve 3672 is unvested with the purpose of timber and has an area of 3.4 ha. The vegetation on this reserve is in good condition.

3.10.4 Conservation status of Yarloop reserves

None of the reserves at Yarloop are currently vested or managed for conservation purposes. With current vesting the protection of conservation values of each reserve is not guaranteed. The implementation of the proposal is likely to accelerate protection through appropriate changes of purpose and vesting of the Yarloop reserves.

Reserves 31901 and 23307 are likely to be vested in the NPNCA in the near future. Combined with Reserve 3672, approximately 30 ha would have some degree of protection for conservation purposes.

The remaining areas totalling 35 ha are unlikely to be included in the conservation estate in the near future and/or may not be in a condition suitable for inclusion in the conservation estate.

Reserve 31900 is vested with the Shire of Harvey for the purpose of rubbish disposal and sand extraction.

3.11 PRIVATE LAND ADJOINING THE YARLOOP RESERVES

There are two areas of freehold land with significant uncleared areas adjacent to the Yarloop reserves. The first of these is a section of Location 826, currently owned by Bunnings, located west of the South

West Highway opposite Reserve 23307. There is approximately 15 ha of native vegetation on the eastern side of this block facing Johnston Road and South West Highway. The vegetation is in excellent condition and is similar to that in the Yarloop reserves east of the highway (Keighery, 1995). Additional work by Mattiske (1997) surveyed this area and assessed the presence of floristic type 20b. Mattiske Consulting Pty Ltd is conducting a further flora survey of this land to prepare a detailed description of its flora characteristics.

The second area is Location 5322, immediately east of Reserve 3672 and north of Reserve 16681. The vegetation is in good condition and has identifiable examples of floristic types 3b and 20b. There is less disturbance and less weed species than Reserve 31900 (Mattiske, 1997).

3.12 ABORIGINAL HERITAGE

The Department of Aboriginal Affairs was contacted in relation to the proposed mining operation. No recorded Aboriginal Heritage sites were listed for the project area.

Previous communication with the department has indicated that the likelihood of sites occurring is usually influenced by factors such as availability of water, access to raw materials (eg. quartz or chert), the presence of prominent features and level of prior disturbance or development of the land. Based on these considerations it is unlikely that there are unrecorded sites in the project area.

3.13 EUROPEAN HERITAGE

The project area does not contain any sites which are listed with the Heritage Commission or the National Trust.

4. ENVIRONMENTAL MANAGEMENT SYSTEM

Cable Sands (WA) Pty Ltd has demonstrated a commitment to sound environmental management over a long period. The company has successfully rehabilitated more than ten mine sites since commencing operations.

Cable Sands has recently modified its Environmental Management System to meet the requirements of ISO 14001. Certification to that standard was confirmed in July 1997 making Cable Sands the first titanium minerals company in the world and the first Australian mining company to have mining operations certified to that standard.

Cable Sands is implementing best practice environmental management which included the preparation and implementation of an Environmental Management and Monitoring Plan for the Yarloop mine, covering all phases of the project - construction, operation and decommissioning/rehabilitation.

The EMMP will be amended to address management practices for environmental factors which are the subject of this PER.

The plan will address procedures to address the following matters:

- rehabilitation of the mined and unmined areas in the reserve;
- protection and management of the reserve to enhance vegetation values;
- weeds and vermin control;
- dieback hygiene procedures;
- dust control;
- noise management and monitoring;
- radiation monitoring and
- decommissioning.

Environmental management system commitments

1. Incorporate environmental aspects of Reserve 31900 into the Yarloop Environmental Management and Monitoring Plan (EMMP).

2. Report environmental performance on an annual basis.

5. ENVIRONMENTAL FACTORS

Interactions of the proposal with the existing environment will result in changes to this environment. The EPA guidelines for this proposal have identified 12 preliminary environmental factors that should be addressed (Appendix 1):

The proposal extends the period of mining in the Yarloop area and the mining operations, method and rate are identical to the adjoining Yarloop mining project which was previously assessed by the EPA (EPA, 1997a) and approved by the Minister for the Environment in 1997. Consequently the assessment of noise, surface water quality, dust, visual amenity and radiation environmental factors are essentially unchanged from that presented in the CER for the Yarloop mining project (Cable Sands (WA) Pty Ltd, 1996). Cable Sands has made commitments for this proposal that are similar to those provided for the Yarloop mining project.

The following section addresses the EPA objectives, assessment areas, potential impacts, management commitments and criteria that relate to the environment relevant to this proposal.

6. BIOPHYSICAL ENVIRONMENTAL FACTORS

6.1 VEGETATION COMMUNITIES AND DECLARED RARE AND PRIORITY FLORA

EPA objectives

To maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.

To protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*.

6.1.1 Applicable assessment standards or procedures

In its assessment of the previous Yarloop mining proposal the EPA indicated that two recent methods had been developed to assess the removal of remnant vegetation. These methods were:

1. Urban Bushland Strategy, prepared principally for the Perth metropolitan area, which prescribed criteria that indicated that the Government's aim is to conserve a minimum of 10% of each vegetation complex which should be regionally reserved in not less than five separate areas. The highest level of protection is in a Crown Reserve but the Strategy does not dismiss other mechanisms available in the planning system.
2. A method entitled Environmental Evaluation of Native Vegetation in the Wheatbelt of Western Australia - Principles and Criteria Used to Appraise Land Clearing Proposals prepared by Environs Consulting Pty Ltd and Dr G F Craig for DEP. This method was developed for clearing applications for agriculture land use in the Wheatbelt.

   This method prescribes the following relevant representation criteria for threatened plant communities:

- Local level - remnant vegetation should be retained if, within a 15 km radius, less than 20% of the original cover of any plant community is in national parks and reserves and on other Crown land or Remnant Vegetation Protection Schemes covenants.
- Regional level - remnant vegetation should be retained if it includes vegetation communities not well conserved in the region compared to the cover represented in the Interim Biogeographical Representation in Australia.

Procedure used in this assessment

The current proposal involves:

- the acquisition of land with comparable or higher vegetation values to be included in the conservation estate. Cable Sands has ; and
- a detailed rehabilitation plan and protection measures which will result in the establishment, restoration and maintenance of native vegetation in mined and unmined areas currently being degraded by weeds and uncontrolled access.

A provisional procedure has being developed which builds on the above EPA procedures by enabling the consideration of existing and potential vegetation values and threatening processes (Table 4) within the reserve and its surrounds under the following scenarios:

1. No change, ie the proposal is not implemented.
2. The implementation of the proposal with rehabilitation and protection of mined and unmined areas and incorporation of a portion of Location 826 (about 10 ha) into the conservation estate.

The application of the above procedure has been on the basis of the following definitions.

- Hydrological value means the extent to which vegetation is important in maintaining the natural hydrological cycle and groundwater tables.
- Biodiversity is the variety of all living things, including plants, animals and micro-organisms. Beattie (1995) further defined biodiversity by the genetic component, the species component and the ecosystem component.
- A vegetation association according to Specht *et al.* (1974) is a series of climax plant communities which may be grouped together and which have:
  i. the same structural characteristics; and
  ii. the same species as dominants in the uppermost stratum but possibly different floristic composition in the lower strata.
- A vegetation complex is a group of plant communities and vegetation types that consistently occur together in an area and reflect both the underlying soil and landforms and climatic conditions. A complex may consist of one or more structural formations.
- A vegetation community or a plant community consistently has the same structure and floristic composition.
- A floristic type is a community type that consistently supports a similar floristic composition. The latter can be determined by a range of statistical techniques based on either presence/absence or quantity data.

6.1.2 Assessment and management

The area considered for assessment of this environmental factor is the Forrestfield Vegetation Complex as described by Heddle *et al*, 1980.

Declared Rare or Priority Flora have not been located during surveys of the reserve (Environmental Survey & Management, 1996 and Mattiske Consulting Pty Ltd, 1997). Consequently, the implementation of the proposal will not threaten the viability of any Declared Rare of Priority Flora.

6.1.3 If the proposal proceeds

A portion of Location 826 will be purchased by the proponent and provided to the Government for inclusion in the conservation estate. The conservation value of vegetation on this land is highly significant as it contains community type 20b, which is considered poorly reserved by Gibson et al (1994).

Mining of the orebody identified in Reserve 31900 would result in the clearing of approximately 6.1 ha of native vegetation with significant conservation value. This area of vegetation is part of a continuum between vegetation type 20b and 3b. Biodiversity in the reserve may be temporarily reduced during the clearing phase and prior to the rehabilitation/restoration of vegetation of unmined areas.

A program of rehabilitation will be applied across the reserve in unmined areas to improve vegetation values and in mined areas with the aim of restoring vegetation values (refer Table 4) comparable with the original vegetation cover. The aim of the rehabilitation program will be to establish vegetation values by:

- encouraging the recruitment of as many local native species as is reasonably possible in rehabilitation areas;

- establishing, over a longer period, a vegetation structure that is comparable with that which exists in the reserve;
- establishing a comparable density of native species in rehabilitation areas; and
- reducing the number, abundance and occurrence of weed species.

If the Shire tip is shifted within the timeframe of mining in the reserve, Cable Sands is committed to rehabilitating or restoring vegetation values in the entire reserve. Otherwise a more confined and compact rubbish tip area (1-2 ha) will be left for the Shire of Harvey to operate.

Mining in the reserve will be a short-term land use (of the order of 16 months) but rehabilitation would continue for a longer period until acceptable to CALM.

Rehabilitation would use a range of techniques (refer Section 6.3) and it is anticipated that there would be no loss of species from the reserve as a whole.

Cable Sands would apply a protection and management regime over the medium term to the reserve that would:

- restrict access to prevent unauthorised dumping;
- remove weeds as part of the establishment of native vegetation; and
- bury existing rubbish at depth to prevent dispersal by wind.

The following biodiversity and nature conservation outcomes are anticipated in the medium term (ten years) after the implementation of the proposal:

- substantially improved conservation value and viability of the reserve as a whole;
- incorporation of a portion of Location 826 (approximately 10 ha) with comparable or greater vegetation values into the conservation estate;
- insignificant loss of biodiversity over the reserve as a whole but with some loss of structure and biodiversity in the eastern portion of the reserve;
- substantial increase in the protection and management of the reserve and a portion of Location 826;
- a small increase in the area of the Forrestfield Vegetation Complex which has been extensively cleared on the Swan Coastal Plain;
- accelerated implementation of System 6 update recommendations and impetus for formation of conservation reserves in the Yarloop area; and
- the maintenance of significant conservation value which would be a better complement for the reserves to the north of Burney Road.

Although there are a range of susceptible species present in the reserve, there is no evidence of the presence of the dieback diseases caused by fungal species, such as *Phytophthora cinnamomi*. The proposed mining operations should assist in minimising the spread and intensification of the dieback diseases through the proposed hygiene measures and through the closure of access tracks into the reserve.

A summary comparison of present and future vegetation values across the reserve and a portion of Location 826 under this scenario are presented in Table 4.

Implementation of the proposal will lead to a better environmental outcome over the medium to long term and will achieve the vegetation communities objective of the EPA.

6.1.4 If the proposal does not proceed

This scenario has been assessed on the basis of the continuation of the current situation with and without the relocation of the tip.

In addition a portion of Location 826 will not be purchased by the proponent and provided to the Government for inclusion in the conservation estate. The conservation value of vegetation on this land is significant as it contains community type 20b which is considered poorly reserved by Gibson et al 1984.

Without tip relocation

The Shire of Harvey has indicated that it wishes to continue operating a tip at Yarloop, at least in the short term, notwithstanding recent advice from DEP that further extensions to the current terms of the licence will not be granted.

Continuation of the current vesting will result in the continued use of reserve 31900 as a rubbish tip with potential for substantial impacts on the conservation values of the rest of the reserve. Weed invasion and continued uncontrolled public access to the reserve will result in progressive degradation of the reserve's values. The threat from weed infestation is increased by the presence of aggressive weeds such as *Ehrharta calycina, Ehrharta longiflora, Zantedeschia aethiopica* and *Watsonia* species.

Over time there will be a gradual increase in the size of the area disturbed by the active tip site, continued unauthorised dumping in the western area of the reserve and degradation of areas outside the tip by weed invasion and windblown rubbish.

The spread and intensification of the dieback diseases may increase because of the uncontrolled access to the reserve.

Changes in the vesting of reserves are often hard to achieve where this affects activities of State and local government agencies. The Red Book Status Report (EPA, 1993) highlighted that over a quarter of recommendations in the System 6 area had not been implemented due to unresolved issues. A significant number of these recommendations related to areas affecting State and local government interests.

In the medium term (ten years time) the biodiversity and nature conservation outcomes of this scenario are anticipated to be:

- the substantial reduction of conservation values over more than half of the reserve and the gradual degradation of the significant conservation values of the eastern portion of the reserve by weed infestation and uncontrolled access;
- private land with comparable or higher vegetation values adjoining to the reserve is unlikely to be incorporated within the conservation estate;
- delayed implementation (if not indefinite) of System 6 update recommendations; and
- considerable inertia inhibiting the formation of conservation reserves in the Yarloop area.

Table 4. Vegetation values and threatening processes associated with reserve 31900

Factor	Existing Situation		No Change - 10 yrs		Proposal Implementation - 10 yrs	
	Reserve	Loc. 826	Reserve	Loc. 826	Reserve	Loc. 826
Regional value						
Hydrological	L	L	L	L	L	L
Vegetation complex	H	H	H	H	VH	VH
Floristic types	H	H	H	H	VH	VH
Rare species	N	N	N	N	N	N
Priority species	N	N	N	N	N	N
Rare fauna	N	N	N	N	N	N
Protected fauna	N	N	N	N	N	N
Local value						
Hydrological	L	VL	L	L	L	L
Native species	M	M	L	M	H	M
Native overstorey	M	M	L	M	M	M
Native understorey	M	M	L	M	H	M
Floristic types	H	H	H	H	VH	VH
Faunal habitats	M	H	M	H	H	H
Social (aesthetic, amenity)	M	M	H	M	H	H
Extent of Threatening Processes						
Weeds	H	L	VH	M	L	L
Aggressive weeds	H	L	VH	M	M	L
Feral animals	M	M	H	H	L	L
Adjacent land use	M	L	H	M	L	L
Disturbance	M	L	H	M	L	VL
Lack of security or management	H	H	H	H	VL	VL

Note: VH - very high, H - high, M - moderate, L - low, VL - very low, N - negligible.

Tip relocation

Relocation of the tip would reduce some pressures from some threatening processes on the reserve associated with the operation of the tip.

The continual degradation associated with unauthorised dumping, weed invasion and windblown rubbish may continue reducing over time the conservation values of the reserve. The long-term (in ten years time) prognosis for the conservation values of the reserve with or without removing the tip is similar.

The portion of Location 826 is unlikely to be available for incorporation with the Yarloop reserves.

The cost of appropriate rehabilitation for the reserve would most likely be beyond the capacity of the Shire of Harvey. Given the priorities for conservation it is also unlikely that a future government land manager could apply the resources necessary to rehabilitate degraded areas totalling almost half of the reserve.

The environmental outcomes of this scenario with or without the relocation of the tip in the medium term (ten years time) are shown in Table 4.

Vegetation commitments

Refer also to rehabilitation commitments.

3. Locate infrastructure for mining and primary processing on cleared land outside Reserve 31900.
4. Acquire part of Location 826 for eventual incorporation into the conservation estate.
5. Maintain vegetation clearing to a practical minimum.
6. Fence and consolidate rubbish tip to a minimum practical area (assuming tip operations are to remain on site).

6.2 FAUNA AND SPECIALLY PROTECTED AND PRIORITY FAUNA

EPA objectives

To maintain the abundance, species diversity and geographical distribution of fauna.

To protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950*.

6.2.1 Impact assessment and management

The proposal will result in the clearing of Jarrah Forest habitats in the eastern portion of the reserve.

An inspection of Reserve 31900 has revealed that there are Jarrah Forest habitats present which are of importance to animal species native to the area (W G Martinick and Associates, 1996). No specially Rare or Priority Fauna were found and in any case such fauna are unlikely to be dependent on these habitats.

The faunal values of the reserve are likely to be lower because of the open nature of the reserve, the lack of management and the threatening processes (for example feral animals) present in the area. Gazetted bird species that visit the reserve are wide ranging in daily and seasonal habitats and are unlikely to be affected by mining.

The rehabilitation of the reserve and the addition of adjoining private land with high vegetation value to the conservation estate are likely to improve the habitat values of the area in the longer term.

Fauna and specially protected and priority fauna commitments

Refer to vegetation communities, landform and rehabilitation commitments.

6.3 REHABILITATION AND LANDFORM

EPA objectives

To establish stable and sustainable landform consistent with surroundings.

To ensure the proposal area and any other area affected by the proposal is rehabilitated to a standard consistent with the intended past mining long-term land use.

6.3.1 Rehabilitation procedure

A rehabilitation strategy will be developed for each area within the reserve (Figure 5) but many aspects of the rehabilitation procedure will be common depending on whether the area is to be mined. The following rehabilitation procedure describes generally the measures that will be applied to areas which will be mined and to those where mining will not take place.

Mined areas (areas 3 and 4)

Pre-mining - collection of seed and plant propagation material

As far as practical, a seed collection program will be implemented prior to mining to ensure that seed is collected from as many plants as possible from the area to be mined and from adjacent areas. Each collection will be labelled and stored in an appropriate manner.

Some fruits retain the seed for several months eg eucalypts and banksias, and the fruit can be collected at any time of the year. Eucalypts shed their seed once the fruit is picked and left, but banksias require heat treatment. Banksia fruits will be burnt in a fire, removed once the valves are seen to open and then plunged in cold water to open the valves fully.

Peas and wattles shed their seeds with force thereby spreading their seeds for some distance. Timing to collect these seeds can be a problem as the fruits rapidly open in hot weather or take much longer to open when the weather is cool. A method used by several seed collectors is to place a sheet under each plant to collect the seed as it is shed. However a regular check will be kept on these plants and the seed collected as soon after shedding as possible to prevent ants removing pea and wattle seeds.

Another technique, which can be used for many different plants, including peas and wattle, is to place a cloth or paper bag over the developing fruit to collect the seed as it is shed.

If insufficient seed is collected from the proposed mine area, permission will be sought to collect seed from the adjacent areas. The same methods of collection will be applied.

In addition to seed collection, rootstock material from species difficult to germinate by seed will be collected prior to clearing areas.

Pre-mining - preparation of mining areas

Clearing of vegetation will commence with removal of commercial timber and then the remaining timber will be cleared and removed. Some timber will be retained for use as habitat logs. Shrub and sedge material will be left with the topsoil to facilitate in regeneration.

Translocation of intact understorey and its soil will be used as much as practical, to provide a differing structural component and to increase the survival of some species.

The topsoil will be stripped and managed appropriately to maximise rehabilitation success when respread over mined and disturbed areas.

Post-mining - re-establishment of landform and topsoil

Overburden or tailings will be used to reform the post-mining surface levels. Some overburden from the existing mining operation (on farmland) will need to be transferred to the reserve area to restore

natural levels in the degraded section of the reserve. Any overburden from disturbed areas will be placed below topsoil to minimise the spread of weeds in the rehabilitation areas.

Slimes dams will be located on the mined areas to provide clayey material in the upper soil profile prior to topsoil replacement. This application of slime material facilitates moisture retention and substantially enhances the success of rehabilitation.

After the landform surface has been shaped to the desired post-mining contours, the topsoil layer will be spread as evenly as practical across the surface. The application of the topsoil layer will be undertaken with particular care to ensure that viable seed and propagules contained within are not buried too deeply for regeneration. This will encourage the early establishment of vegetation on rehabilitated areas.

Post-mining - seeding and planting

Some native species are expected to regenerate from the transplanted, translocated and respread topsoil on rehabilitation areas. However, experience has shown that regeneration response can be quite variable and may need to be supplemented by nursery propagated seedlings and hand seeding.

The nursery propagation program will involve the production of potted seedlings from collected seed in addition to shoot and root cuttings. This will be undertaken at Cable Sands' nursery and, on a contract basis, through commercial nurseries.

At the time of planting, tree species other than Banksia species will be fertilised with a 60 g mixture of NPK with trace elements and Dynamic Lifter. Understorey species planted out in the restored area will receive either this nutrient and trace element mixture or Dynamic Lifter only.

Post-mining - maintenance of rehabilitation

The establishment of vegetation will be assessed after the first summer to determine the need for supplementary planting and seeding. Weed status will be assessed regularly and eradication will be undertaken promptly using spot spraying and/or mechanical means. Inspection for rabbit infestation will also be undertaken regularly and rabbit proof fencing will be installed where appropriate.

Ongoing maintenance requirements will be reviewed regularly in consultation with the relevant agencies.

Rehabilitation of non-mining areas (areas 1, 2, and 5)

Western area within the reserve (area 1)

The area between the tip and South West Highway in Reserve 31900 is degraded by weeds (Watsonia spp and *Cytisus proliferus* and areas of dense mixed weed species) but has some patches of bushland with significant conservation value. *Melaleuca thymoides, Jacksonia sternbergiana, Adenanthos meisneri* and *Acacia alata* were recorded in this area. As this area contains vegetation type 20b (Gibson *et al*, 1994) the area has potentially considerable value. The area will be preserved and rehabilitated to restore some of these values.

Watsonia spp. can reproduce by several methods including seed, cormlets in the flower axils as well as cormlets in the corm axils, but this species can be controlled by a total herbicide applied just before flowering. The control of this weed species is an extremely time and labour intensive process.

Cytisus proliferus is a member of the pea family and will reproduce from seeds which are viable in the soil for many years. The mature trees can be cut at ground level and a total herbicide applied to kill them, but continued weeding is required over a number of years to remove seedlings.

Rubbish tip and sand quarry area (area 2)

Large items of rubbish (eg. concrete house slabs) are currently lying on the periphery of both the tip and sand quarry sites. The entire area will be bulldozed and the larger items pushed into the base of the pits. The surrounding sand, dug out during the establishment of the pits, will be pushed in to fill quarry areas. Overburden from the mining area will also be used to fill these areas.

As the pit and quarry areas are heavily infested with weed species the whole pit area will be sprayed with a total herbicide after preparation to remove the perennial species. If the soil removed in the original establishment of the pit is to be returned as surface soil, it will be spread over the prepared area and left undisturbed. Any weeds that germinate with the onset of winter will be sprayed with a total herbicide.

Collected seed from native vegetation will be sown or the seedlings planted when this process has been completed.

Removed topsoil will only be added to the tip area after the area has been sprayed for weeds.

If a tip operation is to remain within the reserve, the working area will be reduced as far as practicable and fenced off from the rest of the reserve.

Eastern area within the reserve (area 5)

The vegetation in the eastern section of the reserve is relatively undisturbed. Some weed control measures may be undertaken with a backpack containing Fusilade to minimise the spread and intensification of the introduced grass species. The success of such a program will be monitored on a regular basis at the same time as the rehabilitation areas. In view of the seed stock of introduced species which may occur in the upper layers of the soil the herbicide treatment may be required in coming years.

No seeding should be required in this area as it is not intended to physically disturb the area and there should be sufficient native seed still in the area to invade any areas currently occupied by introduced species.

6.3.2 Plant propagation methods

Most of the species recorded within the reserve are readily propagated from seed or cuttings and a number of plants eg *Macrozamia riedlei* and *Xanthorrhoea* spp. may be transplanted into rehabilitation areas.

Propagation by cuttings requires the taking of cutting material and treatment with plant hormone before planting in soil. Regular watering (preferably misting) of cuttings will be maintained and the cutting transplanted into a large pot and grown on when they have developed roots.

Once the cuttings are well established they will be planted in rehabilitation areas, preferably, at the break of season. Where the parent plant can be divided this division is most successful after fire (B. Dixon, pers. com.). Consideration will be given to burning the areas proposed for mining prior to the commencement of work and then planting divisions of species such as sedges (*Cyperaceae*) and twine rushes (*Restionaceae*).

The smoke technique recently developed by Kings Park Board can successfully propagate some species which previously proved difficult to propagate. Research undertaken has shown that 77 species out of a total of 200 tested have shown a positive germination response (DEP, 1997a).

The methods of smoke treatment are as follows:

- Application of smoke water.

  Smoke water is made by bubbling smoke from fresh plant material through water. Smoke water can be applied to large areas of the soil surface at a rate of about one litre per square metre to stimulate the soil seed bank.

  Seeds may also be soaked in smoke water for 3-4 hours. The soaked seed is dried and then sowed immediately as it does not store after treatment.

- Application of smoke

  Smoke may be applied directly to the seeds for a period of about one hour. This is achieved by burning vegetation in an enclosed container and exposing the seed to the smoke generated.

  Smoke can be applied to punnets of sown seed for one hour in a smoke filled tent.

  In the field a tent can be used to stimulate germination in small areas by lighting a fire on a raised container and allowing the smoke to fill the area.

  All smoke treatment in the field should be done before the onset of winter rains.

Smoke treatment can reduce predation by insects as well as improving seed germination and seedling growth (Mattiske Consulting Pty Ltd, 1997).

Conventional propagation methods would require the preparation and scattering of a seed mix of species over the surface of areas to be rehabilitated. Pea and wattle seeds will be scarified prior to sowing to increase the water uptake and subsequent germination percentage.

Rehabilitation and landform commitments

7. Prepare and implement a rehabilitation plan for the Reserve 31900 in consultation with CALM. The emphasis of this plan will be to restore native vegetation values wherever practicable. This plan will be described in the Yarloop Environmental Management and Monitoring Plan.

8. Establish vegetation plots and criteria to assess the performance of rehabilitation through the rehabilitation planning process.

7. POLLUTION MANAGEMENT ENVIRONMENTAL FACTORS

7.1 NOISE

EPA objective

To ensure noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.

7.1.1 Applicable assessment standard or procedure

The levels of acceptable noise at noise sensitive premises (such as at a residence) are regulated by the *Environmental Protection (Noise) Regulations 1997*.

The regulations specify general noise limits within 15 m of a noise sensitive premise (Table 5). These limits may be adjusted in accordance with influencing factors such as the proximity of industrial and commercial land and major roads.

Table 5. General noise limits at noise sensitive premises

Time of Day	Assigned Level (dB)		
	L_{A10}	L_{A1}	L_{Amax}
7 am to 7 pm Monday to Saturday	45	55	65
9 am to 10 pm Sunday, Public holidays	40	50	65
7 pm to 10 pm Monday to Saturday	40	50	55
10 pm to 7 am Monday to Saturday and 10 pm to 9 am Sundays and Public holidays.	35	45	55

7.1.2 Impact assessment and management

The area for assessment of this environmental factor is the area surrounding the proposal and includes the nearby residences (Figure 2).

Mining of Reserve 31900 will involve the use of equipment at a greater distance from noise sensitive premises than the approved operations at the Yarloop mine. The impact of noise will be limited due to the predominance of electrically driven machinery used in the separation of heavy mineral concentrate. The major potential for noise impact is through earth moving machinery. The closest residence is about 1 km away from the proposed mine area.

Noise levels arising from current Yarloop mining operations are kept below statutory levels at noise sensitive premises by employing the following procedures as required:

- As far as possible night-time earthmoving operations are restricted to within the pit.
- Substitution of flashing lights for reversing beepers at night-time.
- Fitting of acoustic exhaust mufflers to all earthmoving machinery working outside daylight hours.
- Construction of topsoil stockpiles of noise reducing bunds. This will apply particularly to the southern mining area alongside the South West Highway.

The EPA's objective for this environmental factor is likely to be achieved by the application of the above noise management measures.

Noise commitments

9. Comply with the Environmental Protection (Noise) Regulations.

10. Implement the following contingency procedure, as appropriate, to ensure that noise emissions comply with regulatory standards:

- restrict earthmoving operations at night within the mining pit to a practical minimum;
- replace reversing beepers with flashing lights at night;
- fit acoustic mufflers to earthmoving equipment, as required; and
- construct noise reducing bunding where appropriate.

7.2 DUST

EPA objectives

To ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem.

To use all practicable measures to minimise the discharge of particulate wastes.

7.2.1 Applicable assessment standard or procedure

The proposed National Environmental Protection Measure (NEPM) for particulate of a mean particle diameter of 10 μm or less is 50 $\mu g/m^3$ for an averaging period of 1 day. The Environmental Protection Policies for atmospheric contaminants for Kwinana and Kalgoorlie areas prescribes an ambient limit and standard for total suspended rural and residential areas of 150 $\mu g/m^3$ and 90 $\mu g/m^3$ for an averaging period of 24 hours.

7.2.2 Assessment and management

The area for assessment of this environmental factor is the area surrounding the proposal and includes the nearby residences.

Experience has shown that the major source of dust generation is from the transportation of heavy mineral concentrate on internal gravel roads. The impact of dust from this source will be minimised by wetting down dusty roads with a water cart during the summer months.

Dust generation from other sources will reduced by minimising the areas disturbed, restricting dust generating activities on excessively windy days and rehabilitating as soon as practical after mining has passed. Topsoil stockpiles are vegetated and slimes are used on tailings areas to reduce the amount of exposed material with dust generating potential. Vegetation screens established on site also assist in reducing dust problems.

These steps have proved effective in minimising dust at Yarloop mine and other areas. The EPA's objective for this environmental factor is likely to be achieved by the application of the above dust management procedures.

Dust commitments

11. Wet haulage roads with a water cart as required.
12. Stockpiles will be vegetated as far as practicable to prevent dust emissions.
13. Keep disturbed areas to a minimum.

7.3 GREENHOUSE GASES

EPA Objectives

To ensure that greenhouse gases, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem.

To use all practicable measures to minimise the discharge of greenhouse gases.

7.3.1 Applicable assessment standard or procedure

The EPA has adopted the following provisional policy on reducing greenhouse gas emissions to all new proposals that may potentially emit significant greenhouse gases (EPA, 1997a).

Proponents shall, upfront in the CER or PER:

a. estimate the amount of greenhouse gases that may be emitted from the proposed project during its life cycle;

b. indicate the intended measures to be adopted to minimise total greenhouse gas emissions in the proposed project;

c. compare the greenhouse gas efficiency of this proposed project (per unit of product and/or other agreed performance indicators) with the efficiency of other established projects using the same and different technologies producing a similar product; and

d. indicate whether the proposed project will be entered into the Commonwealth Government's "Greenhouse Challenge" voluntary cooperative agreement program (whether on a project specific basis, company wide arrangement or within an industrial grouping, as appropriate).

7.3.2 Assessment and management

The impact of greenhouse gases are of a global scale and are not restricted to the local or regional environment (EPA, 1997b).

The implementation the proposal would result in the emission of carbon dioxide, a greenhouse gas, either directly or indirectly as result of the following activities:

- consumption of electricity generated from the combustion of Collie coal;
- internal combustion engines in mining equipment and vehicles; and
- the clearing and subsequent decomposition of vegetation and soil organic matter.

The proposal would, in the medium to long term, result in a greater area of vegetation cover (and therefore a sink for carbon dioxide) in the reserve than would be the case if the proposal was not implemented.

The anticipated emissions of carbon dioxide from the consumption of electricity and combustion of fuels are likely to be as follows:

- about 5.5 kt/a of carbon dioxide based on electricity consumption of 5 GWh/a; and
- about 1.3 kt/a of carbon dioxide based on a diesel fuel consumption of 450 kL/a.

The proposal is not a significant source of greenhouse gases given the small amount of greenhouse gases (6.8 kt/a) that are released. The emissions are approximately 0.01% of the total emissions of these gases from Western Australia in 1990 (60,000 kt/a (DEP, 1997b)). Nonetheless, the proponent is committed, through energy efficiency measures, to reduce as far as is practicable greenhouse gas emissions.

7.4 SURFACE WATER QUALITY

EPA objective

To maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance, are protected, consistent with the draft WA Guidelines for Fresh and marine waters (EPA, 1993).

7.4.1 Applicable assessment standards or procedures

The standard that applies to the assessment of this factor is the above EPA objective.

7.4.2 Assessment and management

The assessment area for this factor includes areas downstream from the proposal. There are no significant watercourses through the reserve.

The ore body does not contain any significant amount of acid generating material that might require special management to prevent acid-mine drainage problems.

Potential sources of surface water contamination are:

- turbid water from the processing of mineral sands ore; and
- hydrocarbon spillages associated with fuel tank storage.

The proposal does not involve offsite discharge of water from the mining and processing of mineral sands. Bore water is used in the screening, concentrating and thickening plants and is subsequently discharged in the mining pit with tailings (Figure 4).

Hydrocarbons are stored in bunded areas capable of holding 110% of the largest vessel capacity.

Given that water is not discharged offsite, absence of acid bearing materials in the ore, appropriate bunding of fuel storage vessels and the proponent's commitment to prepare an Environmental Management and Monitoring Plan, the EPA objective for this environmental factor is likely to be met.

7.5 RADIATION

Present levels of surface radiation in the Yarloop area are typical of the Swan Coastal Plain. Experience with similar mining operations indicates a reduction in gamma radiation levels in the post-mining landscape. It is likely that a reduction in the order of 0.05 μGy/hr will be experienced in mined areas.

Radiation commitments

14.	Use approved procedures for handling process materials.
15.	Monitor and maintain acceptable radiation levels in rehabilitation areas

8. SOCIAL SURROUNDS ENVIRONMENTAL FACTORS

8.1 VISUAL AMENITY

EPA objective

Visual amenity of the area adjacent to the project area should not be unduly affected by the proposal

8.1.1 Assessment and management

The assessment area for this environmental factor is the viewshed from the South West Highway and neighbours.

The mining operation is located adjacent to the South West Highway and will be partially visible to passing traffic and neighbouring properties. Extensive vegetation screening has been established parallel to the highway to reduce this impact. In addition, a screen exists adjacent to the neighbouring property to the east using trees provided by Cable Sands. These screens are complemented by the vegetated topsoil bunding that will also be established along sections of the highway.

These measures have been applied at the existing Yarloop Mine and have been successful in reducing impact on visual amenity of the area.

The application of the above measures and the short term nature of the proposal should ensure that the visual amenity is not unduly affected.

Visual amenity commitment

16.	Enhance or maintain vegetation screens.

8.2 ABORIGINAL CULTURE AND HERITAGE

EPA objective

To ensure that the proposal complies with requirements of the *Aboriginal Heritage Act 1972*.

To ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.

8.2.1 Applicable assessment standard or procedure

The standard that applies to the assessment of this factor are the above EPA objectives.

8.2.2 Assessment and management

The Department of Aboriginal affairs was contacted and has advised that no recorded Aboriginal Heritage sites were listed for the area.

The Department has previously advised that the likelihood of sites occurring is usually influenced by factors such as availability of water, access to raw materials (eg. quartz or chert), the presence of dominant features and the level of disturbance or development of land. Based on these considerations it is unlikely that there are unrecorded sites in the proposal area.

In the event of unearthing of skeletal remains or discovery of Aboriginal sites the Department of Aboriginal Affairs and the Department of Minerals and Energy will be informed immediately.

Social surrounds commitment

17. Cease production in any area where Aboriginal sites are discovered and consult with DME and the Department of Aboriginal Affairs.

9. COMMITMENTS

Table 6 summarises management commitments that will apply to the proposal. The commitments are consistent with those previously made for the Yarloop mine proposal (Cable Sands (WA) Pty Ltd, 1996) and evaluated by the EPA.

TABLE 6. Summary of commitments

Commitment (Who/What)	Objective (Why)	Action (How/where)	Timing (When)	Whose Advice	Measurement Compliance Criteria
Incorporate environmental aspects of Reserve 31900 into the Yarloop Environmental Management and Monitoring Plan (EMMP)	To ensure environmental management is in accordance with EPA objectives and continually improves.	Incorporate into environmental management system	Prior to construction and throughout mine life	DEP and DME	Submission of EMMP.
Report environmental performance on an annual basis.	To inform Government on environmental performance of the proposal	Incorporate into environmental management system	Operation and decommissioning	DEP	Receipt of annual report
Locate infrastructure for mining and primary processing on cleared land outside Reserve 31900.	To minimise impact on vegetation in Reserve 31900.	Within the reserve.	Prior to and during mining	DME	Infrastructure not present on the reserve
Acquire part of Location 826 for eventual incorporation into the conservation estate.	To increase security of Forrestfield Complex	by acquire part of Location 826	Prior to decommissioning	DEP	Letter from proponent
Maintain vegetation clearing to a practical minimum.	To minimise impact on vegetation in Reserve 31900.	Within the reserve	During mining	DME	EMMP meets CALM requirements
Fence and consolidate the rubbish tip to minimum practical area (assuming tip operations are to remain on site).	To enhance conservation values of the reserve	Within the reserve	Post mining	Shire of Harvey	Letter from Shire
Prepare and implement a rehabilitation plan for Reserve 31900 in consultation with CALM. The plan will be described in the Yarloop EMMP.	To enhance conservation values of the reserve	Within the reserve	During mining	CALM, DME and Shire of Harvey	Submission in EMMP
Comply with Environmental Protection (Noise) Regulations	To ensure compliance with environmental noise regulations	Within the reserve	Throughout mine life	DEP	Advice with annual reports.
Restrict earthmoving operations at night within the mining pit to a practical minimum.	To ensure compliance with environmental noise regulations	Within the reserve	Throughout mine life	DEP	Advice with annual reports.
Replace reversing beepers with flashing lights at night.	To ensure compliance with environmental noise regulations	Within the reserve	Throughout mine life	DEP	Advice with annual reports
Fit acoustic mufflers to earthmoving equipment as required	To ensure compliance with environmental noise regulations	Within the reserve	Throughout mine life	DEP	Advice with annual reports
Construct noise reducing bunding where appropriate.	To ensure compliance with environmental noise regulations	Within and in the vicinity of the reserve	Throughout mine life	DEP	Advice with in annual reports

Commitment (Who/What)	Objective (Why)	Action (How/where)	Timing (When)	Whose Advice	Measurement Compliance Criteria
Wet haulage roads with a water cart as required	To minimise dust emissions	Within and in the vicinity of the reserve	Throughout mine life	DME, DEP	Letter from DME with annual report
Stockpiles will be vegetated as far as practicable to prevent dust emissions.	To minimise dust emissions	Within and in the vicinity of the reserve	Throughout mine life	DME, DEP	Letter from DME with annual report
Keep disturbed areas to a minimum.	To minimise dust emissions	Within and in the vicinity of the reserve	Throughout mine life	DME, DEP	Letter from DME with annual report
Use approved procedures for handling process materials.	To minimise radiation contamination by radioactive materials	Within the reserve	Throughout mine life	DME	Letter from DME with annual report
Monitor and maintain acceptable radiation levels in rehabilitation areas	To minimise radiation contamination by radioactive materials	Within the reserve	During and after mining	DME	Advice with annual report
Enhance or maintain vegetation screens	To minimise impacts on visual amenity	Around mining area	Throughout mine life	DEP	Advice with annual report
Cease production in any area where Aboriginal sites are discovered and consult with DME and Dept of Aboriginal Affairs.	To comply with the Aboriginal Heritage Act 1972	Within the mining area	Throughout mine life	DAF	Letter from DAF

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APPENDIX 1

EPA Guidelines

APPENDIX 1

Environmental Protection Authority
Guidelines

Public Environmental Review

MINING OF YARLOOP RESERVE 31900

(Assessment Number 1210)

Part A	Specific Guidelines for the preparation of the Public Environmental Review
Part B	Generic Guidelines for the preparation of an environmental review document

Attachment 1	Example of the invitation to make a submission
Attachment 2	Advertising the environmental review
Attachment 3	Project location
Attachment 4	Project area
Attachment 5	Key characteristics table

These guidelines are provided for the preparation of the proponent's environmental review document. The specific environmental factors to be addressed are identified in Part A. The generic guidelines for the format of an environmental review document are provided in Part B.

The environmental review document must address all elements of Part 'A' and Part 'B' of these guidelines prior to approval being given to commence the public review.

Part A: Specific Guidelines for the preparation of the Public Environmental Review

1. The proposal

Cable Sands WA (the proponent) proposes to mine an area of Reserve 31900, two kilometres south of Yarloop. The reserve has an area of approximately 20 hectares and is vested with the Shire of Harvey for rubbish disposal and sand extraction. The proposal location is indicated on the attached plan (Attachment 3).

Cable Sands currently operates a titanium minerals mine on privately owned land to the south and east of Reserve 31900. This mine commenced operation in 1997 under environmental conditions set by the Minister for the Environment, following a formal assessment by the Environmental Protection Authority (EPA).

The original proposal included clearing and mining of a section of Reserve 31900. The EPA concluded in Bulletin 838 that mining in Reserve 31900 would compromise its objective to ensure that the abundance, diversity, geographic distribution and productivity of the vegetation community types 3b and 20b were protected. The EPA recommended to the Minister for the Environment that mining and further clearing of vegetation be excluded from Reserve 31900 and that existing activities in the reserve cease immediately and the reserve be vested in the National Parks and Nature Conservation Authority for conservation purposes. The Minister for the Environment did not approve Cable Sands to mine in Reserve 31900.

The referral document indicates that this proposal differs from the original proposal in the following ways:

- this proposal includes rehabilitation and management of a larger area than originally considered, including the entire Reserve 31900;
- Cable Sands may be able to obtain an area of land with comparable vegetation values to those in Reserve 31900. This land is adjacent to the Yarloop reserves and would be made available by the proponent for inclusion in the conservation estate if mining were to proceed in the reserve; and
- this proposal includes an additional 30,000 tonnes of heavy mineral concentrate.

This proposal involves clearing and mining of approximately 9.1 hectares of Reserve 31900, shown as areas 3 and 4 on Attachment 4. The proposal includes rehabilitation to native vegetation of these areas following mining, and also rehabilitation of area 2 (Attachment 4). Areas 1 and 5 would not be cleared (Attachment 4).

The key characteristics of this proposal are presented in Attachment 5.

2. Environmental factors relevant to this proposal

The review document should give an assessment of each of the environmental factors identified for this proposal. In addition, the project is located in a dynamic ecosystem and therefore the proponent should also give a detailed assessment of the likely environmental impacts in terms of ecosystem processes, recognising the links within and between separate environmental factors.

Western Australia is part of an ancient continent, leading to a weathered landscape with nutrient poor soils. Western Australia is also dry and flat, and part of the world's most fire prone continent. The environmental implications of this are a highly fragile environment with an extremely rich species diversity. The concept of biodiversity should be discussed as it pertains to this proposal.

The importance of rehabilitation in the proposed management strategy for this proposal is recognised by the proponent. Specifically, the referral document states that, "the impact of mining in Reserve 31900 will be minimised by re-establishing native vegetation on all mined areas in the reserve". Rehabilitation is regarded as a key aspect of the management of the environmental impacts of the current mining proposal and will require detailed discussion.

At this preliminary stage, the Environmental Protection Authority (EPA) believes the relevant environmental factors, objectives and work required is as detailed in the table below:

INTEGRATING PROCESS			
Biodiversity		Maintain biological diversity where that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity. Through studies carried out for the following environmental factors, demonstrate that biodiversity will not be compromised by this proposal.	
Nature Conservation Values		Ensure that nature conservation values are adequately protected at the local, regional, national and international level, through the CAR[1] system of reserves. Assess the nature conservation values of this area. Assess those values against the local, regional, national and international representation.	
CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
BIOPHYSICAL			
Flora	Vegetation communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	Detailed studies to identify and map existing vegetation communities within the project area and to identify the occurrence of 3b and 20b plant communities in other areas. Baseline studies of the abundance, diversity and structure of the stands of vegetation in the areas proposed to be mined, at a level sufficient to enable auditing of post mining rehabilitation. Complete flora inventory to show the diversity of the flora. Assessment of potential impacts (direct and indirect) on vegetation communities (local and regional) as a result of mining and associated activities. Proposed measures to mitigate impacts.
	Declared Rare and Priority Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950.*	Targeted search by appropriately trained persons for rare flora likely to occur on the subject land. Analysis of likelihood of occurrence of taxa not flowering at time of survey. Proposed measures to manage impacts.

[1] Comprehensive, adequate and representative reserve system.

CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
Fauna	Fauna	Maintain the abundance, species diversity and geographical distribution of fauna.	Baseline studies to identify existing fauna in the project area. Assessment of potential impacts (direct and indirect) on fauna (local and regional) as a result of mining and associated activities. Proposed measures to manage impacts.
	Specially Protected (Threatened) and Priority Fauna	Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950*.	Targeted search by appropriately trained persons for rare and priority listed fauna which may occur in the project area. Analysis of the values of affected land as habitat for endangered fauna. Proposed measures to manage impacts.
Land	Landform	Establish stable, sustainable landform consistent with surroundings.	Assessment of potential impacts of the proposal on existing landforms.
	Rehabilitation	Ensure proposal area, and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long term land use.	Detail of measures proposed to rehabilitate the impacted area, including removal of infrastructure, clean-up of any contaminated areas, and establishment and monitoring of rehabilitation performance criteria.
POLLUTION MANAGEMENT			
Air	Particulates / Dust	(i) Ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of particulate wastes.	Baseline studies to identify existing sources of dust. Assessment of potential increases in dust resulting from the construction and operation of the mine and associated activities. Assessment of potential impacts of increased dust on the surrounding environment and the amenity of surrounding land users from the construction and operation of the mine and associated activities. Proposed measures to manage impacts.
	Greenhouse gases	(i) Ensure that greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of greenhouse gases.	Detail source(s) and amounts of greenhouse gases released or absorbed as a result of mining or rehabilitation activities.

CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
Water	Surface water quality	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993).	Detail of water requirements for any on-site processing and mine operations. Detail of drainage and fate of water used in any on-site processing and mine operations. Assessment of impact from any change in surface water quality, on surrounding environment. Proposed measures to manage impacts.
Non-chemical Emissions	Noise	Ensuring that noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.	Baseline studies to identify existing sources of noise. Assessment of potential increases in noise resulting from the construction and operation of the mine and associated activities. Assessment of potential impacts of any increased noise on the amenity of surrounding land users. Proposed measures to manage impacts.
SOCIAL SURROUNDINGS			
Aesthetic	Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal.	Assessment of potential impacts on visual amenity of the project area and surrounds from the proposal. Proposed measures to manage impacts.
Culture and Heritage	Aboriginal culture and heritage	(i) Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Identify any Aboriginal cultural and heritage sites of significance through archaeological and ethnographical surveys of the project area and through consultation with local Aboriginal groups and the Department of Aboriginal Affairs. Identify potential impacts on any identified sites. Proposed measures to manage impacts.

These factors should be addressed within the Public Environmental Review for the public to consider and make comment to the EPA. The EPA anticipates addressing these factors in its report to the Minister for the Environment.

The EPA expects the proponent to take due care in ensuring all other relevant environmental impacts which may be of interest to the public are addressed and that management is covered in the environmental review.

Figures required to be provided for this PER, in addition to those specified in Part B of these guidelines are:

- project layout;
- distribution of vegetation communities; and
- all vegetation data should be in a GIS format, compatible with DEP GIS data.

3. Availability of the environmental review

3.1 All copies for distribution free of charge

Supplied to DEP:

- Library/Information Centre 9
- EPA members 6
- Officers of the DEP (Perth & Bunbury) 8

Distributed by the proponent to:

Government departments	•	Department of Minerals and Energy 2
	•	Water and Rivers Commission 2
	•	Department of Conservation and Land Management 2
	•	Aboriginal Affairs Department 1
	•	Department of Resources Development 1
Local government authorities	•	Shire of Harvey 1
Libraries	•	J S Battye Library 3
	•	The Environment Centre 2
	•	Shire of Harvey Library 2
Others	•	Conservation Council of WA 1
	•	D'Entrecasteaux Coalition 1

3.2 Available for public viewing

- Department of Environmental Protection Library, Perth;
- Department of Environmental Protection Library, Bunbury;
- Shire of Harvey Library;
- J S Battye Library, Perth; and
- The Environment Centre, Perth.

Part B: Generic Guidelines for the preparation of an environmental review document

1. Overview

All environmental reviews have the objective of protecting the environment. Environmental impact assessment is deliberately a public process in order to obtain broad ranging advice. The review requires the proponent to describe:

- the proposal;
- receiving environment;
- potential impacts of the proposal on factors of the environment; and
- proposed management strategies to ensure those environmental factors are appropriately protected.

Throughout the assessment process it is the objective of the Environmental Protection Authority (EPA) to help the proponent to improve the proposal so the environment is protected. The DEP will co-ordinate, on behalf of the EPA, relevant government agencies and the public in providing advice about environmental matters during the assessment of the environmental review for this proposal.

The primary purpose of the environmental review is to provide information on the proposal within the local and regional framework to the EPA, with the aim of emphasising how the proposal may impact the relevant environmental factors and how those impacts may be mitigated and managed.

The language used in the body of the environmental review should be kept simple and concise, considering the audience includes non-technical people, and any extensive, technical detail should either be referenced or appended to the environmental review. It should be noted that the environmental review will form the legal basis of the Minister for the Environment's approval of the proposal and therefore the environmental review should include a description of all the main and ancillary components of the proposal, including options where relevant.

Information used to reach conclusions should be properly referenced, including personal communications. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinion, and each assessment should lead to a discussion of the management of the environmental factor.

2. Objectives of the environmental review

The objectives of the environmental review are to:

- place this proposal in the context of the local and regional environment;
- adequately describe all components of the proposal, so that the Minister for the Environment can consider approval of a well-defined project;
- provide the basis of the proponent's environmental management programme, which shows that the environmental impacts resulting from the proposal, including cumulative impact, can be acceptably managed; and
- communicate clearly with the public (including government agencies), so that the EPA can obtain informed public comment to assist in providing advice to government.

3. Environmental management

The EPA expects the proponent to develop and implement an Environmental Management System appropriate to the proposal consistent with the principles outlined in the AS/NZS ISO 14000 series, including provisions for accountability review and a commitment to continuous improvement.

The key components which should be included in environmental review documentation, depending on the scale of the proposal, are environmental management:

- policy;
- resources budget;
- programme;
- plan(s);
- training programme;
- monitoring programme;
- contingency plan(s); and
- improvement plan(s).

Documentation on the relevant components should be proportional with the scale of the proposal and the potential environmental impacts. If appropriate, the documentation can be incorporated into a formal environmental management system and provision made for periodic performance review. Public accountability is a principle that should be incorporated into the approach on environmental management.

The environmental management programme is the key document that should be appropriately defined in an environmental review. The environmental management programme should provide plans to manage the relevant environmental factors, define the performance objectives, outline the operational procedures and outline the monitoring and reporting procedures which would demonstrate the achievement of the objectives.

4. Format of the environmental review document

The environmental review should be provided to the DEP officer for comment. At this stage the document should have all figures produced in the final format and colours.

Following approval to release the review for public comment, the final document should also be provided to the DEP in an electronic format.

The proponent is requested to supply the project officer with an electronic copy of the environmental review document for use on Macintosh, Microsoft Word Version 6, and any scanned figures. Where possible, figures should be reproducible in a black and white format.

5. Contents of the environmental review document

The contents of the environmental review should include an executive summary, introduction and at least the following:

5.1 The proposal

Justification and alternatives

- justification and objectives for the proposed development;
- the legal framework, including existing zoning and environmental approvals, and decision making authorities and involved agencies; and
- consideration of alternative options.

Key characteristics

The Minister's statement will bind the proponent to implementing the proposal in accordance with any technical specifications and key characteristics[2] in the environmental review document. It is important therefore, that the level of technical detail in the environmental review, while sufficient for environmental assessment, does not bind the proponent in areas where the project is likely to change in ways that have no environmental significance.

Include a description of the components of the proposal, including the nature and extent of works proposed. This information could be presented in the form of a table as follows:

Table 1: Key characteristics (example only)

Element	Description
Life of project (mine production)	55 months
Size of ore body	682 000 tonnes
Area of disturbance	100 hectares
Ore mining rate • maximum • average	 • 200 000 tonnes per year • 160 000 tonnes per year
Background gamma radiation levels • maximum • average	 • 0.52 µGrey per hour • 0.16 m 0.08 µGrey per hour
Water supply • source • maximum hourly requirement • maximum annual requirement	 • Yarloop borefield, shallow aquifer • 180 cubic metres • 1 000 000 cubic metres
Heavy mineral concentrate transport • truck movements (maximum)	 • 75 return truck loads per week

The key characteristics table should be supplemented with figures to ensure that the proposal is clearly explained. Figures that should always be included are:

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;

[2] Changes to the key characteristics of the proposal following final approval, would require assessment of the change and can be treated as non-substantial and approved by the Minister, if the environmental impacts are not significant. If the change is significant, it would require assessment under section 38 or section 46. Changes to other aspects of the proposal are generally inconsequential and can be implemented without further assessment. It is prudent to consult with the Department of Environmental Protection about changes to the proposal.

- a map showing the proposal in the regional context;

and, if appropriate:

- a process chart / mass balance diagram showing inputs, outputs and waste streams.

All figures should include a north arrow, a scale bar, a legend, grid co-ordinates, the source of the data, a title and (where applicable) the date of aerial photo.

Other logistics

- timing and staging of project; and
- ownership and liability for waste during transport, disposal operations and long-term disposal (where appropriate to the proposal).

5.2 Environmental factors

The environmental review should focus on the relevant environmental factors for the proposal, and these should be agreed in consultation with the EPA and DEP and relevant public and government agencies. Preliminary environmental factors identified for the proposal are shown in Part A of these guidelines.

Further environmental factors may be identified during the preparation of the environmental review, therefore on-going consultation with the EPA, DEP and other relevant agencies is recommended. The DEP can advise the proponent on the recommended EPA objective for any new environmental factors raised. Minor matters which can be readily managed as part of normal operations for the existing operations or similar projects may be briefly described.

Items that should be discussed under each environmental factor are:

- a clear definition of the area of assessment for this factor;
- the EPA objective for this factor;
- a description of what is being affected - why this factor is relevant to the proposal;
- a description of how this factor is being affected by the proposal - the predicted extent of impact;
- a description of where this factor fits into the broader environmental / ecological context (only if relevant - this may not be applicable to all factors);
- a straightforward description or explanation of any relevant standards / regulations / policy;
- environmental evaluation - does the proposal meet the EPA's objective as defined above;
- if not, environmental management proposed to ensure the EPA's objective is met;
- predicted outcome.

The proponent should provide a summary table of the above information for all environmental factors, under the three categories of biophysical, pollution management and social surroundings:

Table 2: Environmental factors and management (example only)

Environ-mental Factor	EPA Objective	Existing environment	Potential impact	Environ-mental management	Predicted outcome
BIOPHYSICAL					
vegetation community types 3b and 20b	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation community types 3b and 20b	Reserve 34587 contains 45 ha of community type 20b and 34 ha of community type 3b	Proposal avoids all areas of community types 20b and 3b	Surrounding area will be fully rehabilitated following construction	Community types 20b and 3b will remain untouched Area surrounding will be revegetated with seed stock of 20b and 3b community types
POLLUTION MANAGEMENT					
Dust	Ensure that the dust levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards	Light industrial area - three other dust producing industries in close vicinity Nearest residential area is 800 metres	Proposal may generate dust on two days of each working week.	Dust Control Plan will be implemented	Dust can be managed to meet EPA's objective
SOCIAL SURROUNDINGS					
Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal	Area already built-up	This proposal will contribute negligibly to the overall visual amenity of the area	Main building will be in 'forest colours' and screening trees will be planted on road	Proposal will blend well with existing visual amenity and the EPA's objective can be met

5.3 Environmental management commitments

The implementation of the proposal and all commitments made by the proponent become legally enforceable under the conditions of environmental approval issued in the statement by the Minister for the Environment. All the key environmental management commitments should be consolidated in the public review document in a list (usually in an Appendix). This list is attached to the Minister's statement and becomes part of the conditions of approval.

The proponent's compliance with the key environmental management commitments will be audited by the DEP, so they must be expressed in a way which enables them to be audited.

A commitment needs to contain most of the following elements to be auditable:

- who (eg. the proponent)
- will do what (eg. prepare a plan, take action)
- why (to meet an environmental objective)
- where/how (detail the action and where it applies)
- when (in which phase, eg. before construction starts)
- to what standard (recognised standard or agency to be satisfied)
- on advice from (agency to be consulted).

The proponent may make other commitments, which address less significant or non-environmental matters, to show a commitment to good general management of the project. Such commitments would not normally be included in the list appended to the statement. The EPA expects that the proponent will audit these commitments by internal processes. Though the DEP would not subject the less significant environmental commitments to routine audit, it may periodically request that compliance with these commitments be demonstrated, so as to verify satisfactory environmental performance in the proponent's implementation of the proposal.

With the implementation of continuous improvement, the procedures to implement the commitments may need to be changed. These changes can be made in updates to the environmental management plan, whilst ensuring the objective is still achieved.

Once the proposal is approved, changes to the commitments constitute a change to the proposal and should be referred to the DEP.

Examples of the preferred format for typical commitments are shown in the following table:

Table 3: Summary of proponent's commitments (example only)

Commitment (Who/What)	Objective (Why)	Action (How/Where)	Timing (When)	Whose advice	Measurement/ Compliance criteria
1. XYZ Mining will develop a rehabilitation plan	to protect the abundance, species diversity, geographic distribution and productivity of the vegetation community types 3b and 20b	by limiting construction to a small area (10 ha) of Reserve 34587 and rehabilitating the area	before construction	CALM, NPNCA	fences built; species distribution and density consistent with vegetation community types 3b and 20b
2. XYZ Mining will minimise dust generation	to maintain the amenity of nearby land owners	by preparing and implementing a Dust Control Plan which meets EPA Dust Control criteria	before the start of construction phase	preparation: DEP; implementation: Shire	Letter from Shire submitted with Performance and Compliance Report.

Commitments should be written in tabular form, preferably with some specification of ways in which the commitment can be measured, or how compliance can be demonstrated.

Draft commitments which are not in a format that can be audited will not be accepted by project officers for public review documentation. Proponents will be assisted to revise inadequate commitments.

5.4 public consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the environmental review. It should describe the activities undertaken, the dates, the groups/individuals involved and the objectives of the activities. Cross reference should be made with the description of environmental management of the factors which should clearly indicate how community concerns have been addressed. Those concerns which are dealt with outside the EPA process can be noted and referenced.

APPENDIX 2

Ministerial Statement 442 – Mining of titanium minerals 2 km south of Yarloop

Statement No.

MINISTER FOR THE ENVIRONMENT;
EMPLOYMENT AND TRAINING

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

MINING OF TITANIUM MINERALS, 2 KM SOUTH OF YARLOOP (1032)

CABLE SANDS (W.A.) PTY. LTD.

That part of the proposal relating to mining of titanium minerals within "C" Class Reserve No. 31900 may not be implemented.

That part of the proposal located on private land and within Mining Leases Nos 70/49, 70/937 and 70/938 (pending) may be implemented subject to the following conditions:

1 Proponent Commitments

The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposal, the proponent shall fulfil the commitments made in the Consultative Environmental Review and subsequently during the environmental assessment process by the Environmental Protection Authority; provided that the commitments and environmental management measures are not inconsistent with the conditions or procedures contained in this statement. In the event of any inconsistency, the conditions and procedures shall prevail to the extent of the inconsistency.

The consolidated and revised environmental management commitments of 2 January 1997 are attached.

2 Implementation

Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal.

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2-2 Where, in the course of the detailed implementation referred to in condition 2-1, the proponent seeks to change the designs, specifications, plans or other technical material submitted to the Environmental Protection Authority in any way that the Minister for the Environment determines, on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

3 Proponent

These conditions legally apply to the nominated proponent.

3-1 No transfer of ownership, control or management of the project which would give rise to a need for the replacement of the proponent shall take place until the Minister for the Environment has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the project in accordance with the conditions and procedures set out in the statement.

4 Mine Dewatering

4-1 Prior to dewatering the mine, the proponent shall develop a dewatering management plan to the requirements of the Environmental Protection Authority on advice of the Water and Rivers Commission and the Department of Environmental Protection. This plan shall include specific reference to maintaining an adequate water supply to the remnant vegetation of the area.

4-2 The proponent shall implement the dewatering management plan required by condition 4-1.

5 Environmental Management

5-1 The proponent shall exercise all care and diligence in managing the proposal to ensure the protection of the environment.

5-2 The proponent shall prepare and implement an environmental management plan and environmental management procedures in order to implement the proposal, and shall manage the relevant environmental factors to ensure that the environmental objectives (Section 3, Environmental Protection Authority Bulletin 838) are met.

5-3 In preparation of the plan referred to in condition 5-2, the proponent shall adopt quality assurance principles (such as those adopted in Australian Standards ISO 9000 series) and environmental management principles (such as those adopted in the voluntary Australian Standards ISO 14000 (Int):1995 series), with appropriate monitoring, auditing and reporting to ensure compliance with these conditions and the on-going protection of the environment.

5-4 If, through the implementation of the environmental management procedures referred to in condition 5-2, the proponent identifies a relevant environmental factor not reported on in Environmental Protection Authority Bulletin 838, the proponent shall immediately report to the Minister for the Environment on that factor, providing a proposed objective and the suggested means for managing the factor to achieve the objective.

6 Time Limit on Approval

The environmental approval for the proposal is limited.

6-1 If the proponent has not substantially commenced the project within five years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the project has been substantially commenced.

Any application to extend the period of five years referred to in this condition shall be made before the expiration of that period to the Minister for the Environment.

Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Department of Environmental Protection that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years.

7 Compliance Auditing

To help determine environmental performance and compliance with the conditions, periodic reports on the implementation of the proposal are required.

7-1 The proponent shall submit periodic Performance and Compliance Reports, in accordance with an audit programme prepared by the Department of Environmental Protection in consultation with the proponent.

Procedure

1 Unless otherwise specified, the Department of Environmental Protection is responsible for assessing compliance with the conditions contained in this statement and for issuing formal clearance of conditions.

2 Where compliance with any condition is in dispute, the matter will be determined by the Minister for the Environment.

Note

1 The proponent is required to apply for a Works Approval and Licence for this project under the provisions of Part V of the Environmental Protection Act 1986.

2 The Environmental Protection Authority reported on the proposal in Environmental Protection Authority Bulletin 838 (December 1996).

3 To achieve the principles of maintaining abundance, diversity, geographic distribution, productivity, protection and secure management of Reserves Nos 31900, 31901 and A22307, the Department of Conservation and Land Management will be responsible for ensuring that the status of Reserve No. 31900 is upgraded to "A" class, and that the three reserves Nos 31900, 31901 and A22307 are all vested in the National Parks and Nature Conservation Authority for conservation purposes.

CHERYL EDWARDES (Mrs) MLA
MINISTER FOR THE ENVIRONMENT

17 APR 1997

APPENDIX 3

List of flora species in Reserve 31900 and adjoining reserves

APPENDIX 3

LIST OF FLORA SPECIES IN RESERVE 31900 AND ADJOINING RESERVES

Species	1	2	3
Acacia alata	+		
Acacia lateriticola		+	
Acacia pulchella	+		
Acacia pulchella var. pulchella	+		
Acacia sessilis	+		+
Acacia stenoptera	+		+
Acacia willdenowiana		+	
Adenanthos meisneri	+		+
Allocasuarina fraseriana	+	+	+
Anigozanthos manglesii	+	+	+
Astroloma pallidum	+		+
Austrodanthonia occidentalis			+
Austrostipa elegantissima			+
Banksia attenuata	+		+
Banksia grandis	+	+	+
Bossiaea eriocarpa	+	+	
Bossiaea ornata	+	+	+
Briza maxima	+		
Burchardia congesta	+	+	+
Caladenia flava			+
Caladenia sp.	+	+	
Calytrix flavescens			+
Chamaescilla corymbosa	+	+	
Comesperma virgatum	+		
Conospermum aff. canaliculatum	+	+	+
Conospermum incurvum			+
Conospermum stoechadis			+
Conostephium pendulum	+	+	
Conostylis ?juncea		+	
Conostylis juncea	+	+	
Conostylis serrulata	+		
Conostylis setosa	+		
Corymbia calophylla	+		
Craspedia variabilis	+		
Cyathochaeta avenacea	+		+
Dampiera linearis	+	+	+
Dasypogon bromeliifolius	+	+	+
Daviesia costata		+	
Daviesia decurrens			+
Daviesia divaricata	+	+	+
Daviesia incrassata	+		
Daviesia physodes	+	+	
Daviesia preissii	+	+	+
Desmocladus fasciculatus	+	+	+
Desmocladus flexuosus	+		+
Dianella revoluta	+		+
Drosera erythrorhiza	+	+	
Drosera huegelii		+	
Drosera sp.		+	
Drosera sp. climbing	+		
Dryandra bipinnatifida		+	

Dryandra lindleyana	+	+	+
Eriostemon spicatus	+	+	+
Eucalyptus marginata	+	+	+
Gompholobium knightianum			+
Gompholobium marginatum		+	+
Gompholobium polymorphum	+	+	
Gompholobium preissii	+		
Gompholobium tomentosum			+
Grevillea bipinnatifida		+	
Grevillea quercifolia	+	+	+
Grevillea wilsonii	+	+	+
Haemodorum laxum	+	+	+
Haemodorum spicatum		+	
Haemodorum sp.	+	+	
Hakea ruscifolia	+		+
Hakea stenocarpa		+	
Hemiandra pungens	+	+	+
Hibbertia acerosa	+	+	+
Hibbertia amplexicaulis	+	+	
Hibbertia commutata	+	+	+
Hibbertia cunninghamii	+	+	
Hibbertia huegelii	+	+	
Hibbertia hypericoides	+	+	+
Hibbertia pachyrrhiza	+		+
Hibbertia racemosa	+		
Hibbertia vaginata			+
Hovea chorizemifolia	+	+	+
Hovea trisperma		+	+
Hybanthus floribundus	+	+	+
Hypocalymma robusta			+
Hypochaeris glabra	+	+	
Hypolaena exsulca	+	+	
Isopogon formosus			+
Jacksonia sternbergiana	+		
Kennedia coccinea	+	+	+
Kennedia prostrata	+	+	
Labichea punctata	+	+	+
Lagenifera huegelii	+	+	+
Lepidosperma squamatum	+	+	+
Lepidosperma squamatum (narrow)	+	+	
Lepidosperma tenue	+	+	
Leucopogon australis		+	+
Lomandra brittanii	+	+	
Lomandra hermaphrodita	+	+	
Lomandra nigricans	+	+	
Lomandra preissii	+		+
Lomandra purpurea			+
Lomandra sericea	+	+	
Lomandra sp.	+		
Loxocarya cinerea	+		
Lyginia barbata		+	+
Macarthuria apetala	+		
Macrozamia riedlei	+		+
Melaleuca thymoides	+		
Melaleuca thyoides			+
Mesomelaena gracilipes	+		
Mesomelaena tetragona	+	+	+
Muehlenbeckia adpressa			+

Nemcia capitata			+
Olearia paucidentata	+	+	+
Opercularia apiciflora	+	+	+
Opercularia hispidula	+	+	+
Orchidaceae sp. (leaf only)		+	
Patersonia aff. juncea		+	
Patersonia occidentalis	+		+
Patersonia pygmaea		+	
Patersonia umbrosa		+	
Pentapeltis peltigera	+	+	+
Persoonia elliptica	+		+
Persoonia saccata	+	+	+
Petrophile linearis	+	+	+
Phlebocarya ciliata	+	+	+
Phyllanthus calycinus	+	+	+
Pimelea lehmanniana	+	+	
Pimelea rosea			+
Platytheca verticillata		+	
Poaceae sp.	+		
Poaceae sp. (seedlings)	+		
Pronaya fraseri	+	+	
Pterostylis recurva		+	
Pterostylis sanguinea	+	+	
Pyrorchis nigricans	+	+	
Scaevola calliptera	+	+	+
Scaevola paludosa			+
Schoenus cruentus		+	
Schoenus sp.			+
Senecio quadridentatus			+
Sonchus oleraceus		+	
Sowerbaea laxiflora	+	+	+
Stachystemon vermicularis	+	+	
Stirlingia latifolia	+	+	+
Stylidium piliferum	+	+	
Stylidium sp.			+
Stypandra glauca	+		
Styphelia tenuiflora		+	+
Tetraria capillaris	+	+	+
Tetraria octandra	+	+	+
Tetrarrhena laevis	+	+	
Tetratheca hirsuta	+	+	
Thelymitra crinita			+
Thysanotus sp.			+
Trachymene pilosa	+		
Trichocline spathulata	+	+	
Tricoryne elatior			+
Watsonia ? bulbillifera	+		
Watsonia bulbillifera	+		
Watsonia sp.	+	+	
Xanthorrhoea gracilis	+	+	+
Xanthorrhoea preissii	+	+	+
Xanthosia candida			+
Xanthosia huegelii	+	+	
Xylomelum occidentale	+	+	+

1 = Reserve 31900 (Mattiske Consulting Pty Ltd, 1997)

2 = Adjoining reserves including rifle range (Mattiske Consulting Pty Ltd, 1997)

3 = Reserve 31900 (Environmental Survey & Management, 1996)

APPENDIX 4

Distribution of plant species on transect from west to east

APPENDIX 4

DISTRIBUTION OF PLANT SPECIES ON TRANSECT FROM WEST TO EAST

(Mattiske Consulting Pty Ltd, 1997)

Species	Sampling Site			
	1a	2a	3a	4a
Hypolaena exsulca	+	+	+	+
Eucalyptus marginata	+	+	+	+
Labichea punctata	+	+	+	+
Lepidosperma squamatum	+	+	+	+
Dryandra lindleyana	+	+	+	+
Grevillea wilsonii	+	+	+	+
Gompholobium polymorphum	+	+	+	+
Drosera erythrorhiza	+	+	+	+
Pentapeltis peltigera	+	+	+	+
Xanthorrhoea preissii	+	+	+	+
Tetraria octandra	+	+	+	+
Xylomelum occidentale	+	+	+	+
Dasypogon bromeliifolius	+	+	+	+
Burchardia congesta	+		+	+
Dampiera linearis	+		+	+
Bossiaea ornata		+	+	+
Kennedia prostrata		+	+	+
Allocasuarina fraseriana		+	+	+
Stirlingia latifolia	+	+	+	+
Loxocarya fasciculata	+	+	+	+
Hibbertia hypericoides	+	+	+	+
Daviesia divaricata	+	+	+	+
Lomandra sericea	+	+	+	+
Drosera sp. climbing	+			+
Hybanthus floribundus	+			+
Kennedia coccinea	+			+
Scaevola calliptera		+		+
Mesomelaena tetragona	+	+		+
Phlebocarya ciliata	+	+		+
Xanthorrhoea gracilis	+	+		+
Tetraria capillaris	+	+		
Conospermum aff. canaliculatum	+	+		
Pyrorchis nigricans	+	+		
Banksia grandis	+			
Cyathochaeta avenacea	+			
Caladenia sp.	+			
Acacia sessilis	+			
Hibbertia amplexicaulis	+			
Astroloma pallidum	+			
Persoonia saccata	+			
Hibbertia huegelii	+			
Opercularia apiciflora	+	+	+	
Lagenifera huegelii	+		+	

Stylidium piliferum	+		+	
Acacia stenoptera	+		+	
Hibbertia acerosa	+		+	
Olearia paucidentata		+		
Sowerbaea laxiflora		+		
Trichocline spathulata		+		
Lomandra brittanii		+		
Lepidosperma tenue		+		
Dianella revoluta		+		
Chamaescilla corymbosa		+	+	
Haemodorum sp.		+	+	
Tetrarrhena laevis		+	+	
Hypochaeris glabra			+	
Hibbertia cunninghamii			+	
Haemodorum laxum			+	
Daviesia preissii			+	
Pimelea lehmanniana			+	
Mesomelaena gracilipes			+	
Hemiandra pungens			+	
Xanthosia huegelii			+	
Bossiaea eriocarpa			+	
Trachymene pilosa			+	
Petrophile linearis			+	+
Comesperma virgatum			+	+
Daviesia physodes			+	+
Eriostemon spicatus			+	+
Conostephium pendulum			+	+
Stachystemon vermicularis			+	+
Pronaya fraseri				+
Opercularia hispidula				+
Pterostylis sanguinea				+
Conostylis serrulata				+
Adenanthos meisneri				+