PRECIOUS METALS AUSTRALIA LIMITED

WAGOO HILLS VANADIUM PROJECT
and
MINGENEW COAL PROJECT

PUBLIC ENVIRONMENTAL REVIEW

ALAN TINGAY & ASSOCIATES
ENVIRONMENTAL SCIENTISTS

&

PRECIOUS METALS AUSTRALIA LIMITED

JANUARY 1992

Report No: 91/31

WAGOO HILLS VANADIUM PROJECT AND MINGENEW COAL PROJECT PUBLIC ENVIRONMENTAL REVIEW

The Environmental Protection Authority (EPA) and Precious Metals Australia Limited (PMA) invites people to make a submission on this proposal.

The Public Environmental Review (PER) for the proposed Wagoo Hills Vanadium Project and the Mingenew Coal Project has been prepared in accordance with Western Australian Government procedures. The report will be available for comments for 8 weeks commencing January 24 1992 and finishing March 20 1992.

Following receipt of comments from Government Agencies and the public, the EPA will discuss these comments with Precious Metals Australia Limited and may ask for further information. The EPA will then prepare an Assessment Report with recommendations to Government, taking into account issues raised in public submissions.

Why Write a submission?

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

All submissions received by the EPA will be acknowledged.

Developing a submission

You may agree or disagree, 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 environmentally more acceptable.

When making comments on specific proposals in the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

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

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

Please indicate whether your submission can be quoted, in part or in full, by the EPA in its Assessment Report.

Remember to include:

- your name
- address
- the date

The closing date for submissions is: **March 20 1992**

Submissions should be addressed to:

The Chairman
Environmental Protection Authority
Westralia Square
38 Mounts Bay Road
PERTH WA 6000

Attention: Mr Colin Murray

SUMMARY

1. Introduction

This Public Environmental Review (PER) presents environmental data and information on the proposed Wagoo Hills Vanadium Project and the Mingenew Coal Project to be developed by Precious Metals Australia Limited (PMA).

2. The Wagoo Hills Vanadium Project

PMA proposes to establish Australia's only operating vanadium mine and process plant at Windimurra, 80km south-east of Mt Magnet. The proposed project comprises the mining by open cut methods of vanadium ore which will be processed in a plant to be constructed adjacent to the open pit and the transport of the final added-value vanadium product to the Port of Fremantle for export. The mining and processing will be carried out by a workforce which will be housed on site near the mining operation.

3. The Mingenew Coal Project

PMA proposes to develop a relatively small coal quarry at a site 20km north east of Mingenew in the Central Midlands District. The Mingenew coal project will supply coal to the Wagoo Hills Vanadium Project for use in the process plant as a source of energy.

4. Project Benefits

The Wagoo Hills Vanadium Project will provide significant economic and employment benefits to Western Australia and Australia over a long project life.

Benefits generated by the project will include:

- State and rural employment opportunities,
- Decentralising of industry from Perth,
- $54 million construction expenditure within WA,
- Export revenue of $900 million over the life of project,
- A new Australian mineral resource added value industry; and
- A boost to the economy of relevant local shires.

5. Objectives of the Study

The objectives of this study are to assess the environmental and social impacts of the proposed projects and management strategies to alleviate where possible minimise the environmental and social impacts of the project. In order to assess the likely impacts of the project, studies of the existing environment have been undertaken.

6. Study Guidelines

This PER Has been prepared in accordance with the guidelines provided by the Environmental Protection Authority for the projects. A copy of these guidelines is provided in Appendix 10.1. The projects have been discussed with the following Government Departments and Authorities by Precious Metals Australia Limited and its study team.

- Department of Mines, Western Australia (DOM, WA)
- Environmental Protection Authority (EPA)
- Department of State Development (DSD)
- Social Impact Unit (SIU)
- Water Authority of Western Australia (WAWA)
- Department of Conservation and Land Management (CALM)
- Department of Industry Technology and Commerce (DITAC)
- Main Roads Department (MRD)
- Agricultural Protection Board of Western Australia (APB)
- State Electricity Commission of Western Australia (SECWA)
- Western Australian Museum – Aboriginal Sites Department
- Geraldton Mid-west Regional Development Authority
- Shires of Cue, Mt Magnet, Mingenew and Morawa

7. Existing Environmental and Potential Impacts

Wagoo Hills Vanadium Project

The project area is in a semi-arid zone with a low annual rainfall of 235mm and a high evaporation rate. Wind direction is predominantly from the east.

The area is generally flat and drainage is to a series of salt pans several kilometres from the site. East of the site there is an area where a significant quantity of shallow saline groundwater has been located which will be used to supply the project requirements via a proposed borefield. Potable supplies will be obtained by treating groundwater to reduce salinity.

The vegetation and flora are typical of the Murchison River with Mulga (*Acacia aneura*) the predominant vegetation. The understorey component of the Mulga Shrublands and Woodlands have been modified by a long history of stock grazing. No declared rare flora species are known in the area. Only one species of fauna, the Black-footed Rock Wallaby is gazetted as rare in the region and does not occur in the project area.

There are no records of archaeological or ethnographic sites either in or near the project area. The project site is located on the Windimurra Pastoral Lease and the pastoral homestead is some 4km to the south of the proposed mine site. The next nearest station homestead is over 20km away. The project area covers only a total area of about 120ha over the life of the project which is less than one twentieth of 1% of the area of the Pastoral Lease.

The project comprises an open pit occupying a surface area of 1,000m by 150m wide to a depth of only 35m. The surface area affected after the initial 5 year period is approximately 15ha. A process plant will be constructed adjacent to the pit and, tailings and overburden will be disposed of at the site. The fly-in/fly-out workforce will be housed on site near the mining operations. The principal environmental impacts arising from the project will be confined to the project area.

PMA will ensure that adequate environmental management plans are established to the satisfaction of the Western Australian authorities to ensure impacts are minimised.

The transport of goods and reagents, including those of a hazardous nature, from the south-west of the State will also be managed to minimise any environmental disturbance.

Mingenew Coal Project

The 60ha site is located some 20km north-east of Mingenew and 4km from the nearest dwelling and is on a single farm paddock that has been totally cleared of native vegetation for cultivation for at least 50 years. The area is situated in a temperate Winter rainfall zone with warm to hot Summers and cool to mild Winters.

Potential environmental impacts relate to run-off, overburden dumps, rehabilitation, noise and dust control. A site drainage plan will be prepared and there will be no permanent waste dumps as overburden will be replaced into the quarry pit after the removal of coal returning the land to production farming use. Noise and dust will be minimal and controlled to Mines Department regulations.

PMA have contracted to acquire the entire farming property providing the small coal quarry operation with an immediate buffer zone so limiting the impact on neighbours.

8. Public Participation and Consultation

An active public and Government consultation programme regarding the projects has been carried out by PMA.

Issues raised by the public have been addressed in the document.

9. Environmental Management and Monitoring

PMA recognise the development of this project will to a degree impact on the environment, and the various facets of the proposed development have been planned to minimise this impact.

The management and monitoring activities that PMA proposed to undertake include:

At Windimurra

- A surface water drainage management plan.
- Overburden dumps designed and managed in accordance with guidelines laid down by the Mines Department.
- A monitoring programme to control and measure vanadium dust emissions from the plant.
- A transport management and contingency plan to ensure that the transportation of hazardous material is undertaken safely.
- A tailings dam management plan to ensure there are no adverse affects from the tailings.
- The borefield will be regularly monitored to determine the affect of off-take on salinity and the groundwater levels of the aquifer.

- The Pastoralist's fresh water supply will be monitored to ensure that good quality water is available to the Pastoral Lease.

At Mingenew

- A surface water drainage management plan will be developed in consultation with the Department of Mines and the Department of Agriculture.

- The site will be rehabilitated in accordance with guidelines laid down by the Department of Mines and monitoring to assess the success of the rehabilitation.

10. Conclusions

The proposed vanadium mine and process plant will produce vanadium products destined for world markets. The proposal complies with a number of key Government policies and will create considerable economic benefits as well as employment opportunities to the State and local communities over a long project life.

PMA believe this report demonstrates that these benefits can be achieved without unacceptable environmental or social impacts.

KEY ISSUES

Key issues raised by the Environmental Protection Authority (EPA) for PMA to address in this document are:

Wagoo Hills Vanadium Project

- Transport, handling and contingency planning for the dangerous goods and other materials (Sections 4.2.5 and 5.2.3).
- Dust control including ore handling, beneficiation and product handling (Sections 5.1.4 and 5.2.2).
- Workforce accommodation options and management (Section 2.1).
- Operational environmental management issues (Mining Plan Sections 4.1.2 and 5.1; Tailings Dam Sections 4.2.4 and 5.2.5; Waste Dumps Sections 5.1.3; and Rehabilitation Sections 5.1.3 and 5.2.7).
- Environmental monitoring for leachate and dust (Sections 4.2.4, 5.2.2 and 7.1).
- Impact on the town of Mt Magnet (Sections 2.1 and 5.2.6).

Mingenew Coal Quarry Project

- Operational environmental management issues (Mining Plan Section 4.3.2; Waste Dumps Section 5.1.3; and Rehabilitation Section 5.3.3).
- Dust control during mining and crushing (Section 5.3.4).
- Impact on the town of Mingenew (Sections 2.1 and 5.3.6).

ACKNOWLEDGEMENTS

This Public Environmental Review document has been compiled by Alan Tingay & Associates Environmental Scientists with contributions from:

Precious Metals Australia Limited	Company details, ownership, location, history, geology, the orebody.
Minproc Engineers Pty Ltd	Details of project processing operations and infrastructure.
Rockwater Proprietary Ltd	Details of surface water and groundwater, assessment of environmental impacts and management.
Quartermaine Consultants	Ethnographic and archaeological report.
Whelans Survey & Mapping Group Pty Ltd (Environmental Division)	Information on fauna, flora, rangeland management reports including impact assessment and management.
Hille Thompson and Delfos	Surveying.

In addition, discussions were held with officers of the following State Government Organisations:

- Environmental Protection Authority (EPA)
- Department of Mines

- Department of Conservation and Land Management (CALM)
- Social Impact Unit (SIU)
- Main Roads Department (MRD)
- Department of State Development (DSD)
- State Energy Commission of Western Australia (SECWA)
- Western Australian Water Authority (WAWA)
- WA Museum – Aboriginal Sites Department
- Geraldton Mid-West Regional Development Authority
- Agriculture Protection Board of Western Australia (APB)
- Explosive and Dangerous Goods Division of the Department of Mines
- Royalty and Policy Development Division of the Department of Mines

The following Shire offices were contacted with regard to the project:

- Mt Magnet
- Mingenew
- Morawa

The following industry and conservation groups have made contact with the proponent:

- Geraldton Greenough Chamber of Commerce and Industry
- Chamber of Mines and Energy of WA (Inc)
- Association of Mining and Exploration Companies (Inc)
- Sandstone Land Conservation District Committee

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1. INTRODUCTION

1.1 Background

Vanadium is a strategic metal which is of particular importance in the manufacture of tool and high strength low alloy steels and also has important applications in the chemical, ceramic and paint industries. The range of applications are illustrated in Figure 1.1.

Currently, the world vanadium output is dominated by South Africa (with over 60% of total world production) with smaller outputs from the USA, Europe and countries in the Asia Pacific Region. Demand is centred in Western Europe, the USA and Japan. There is no production of vanadium from Australia.

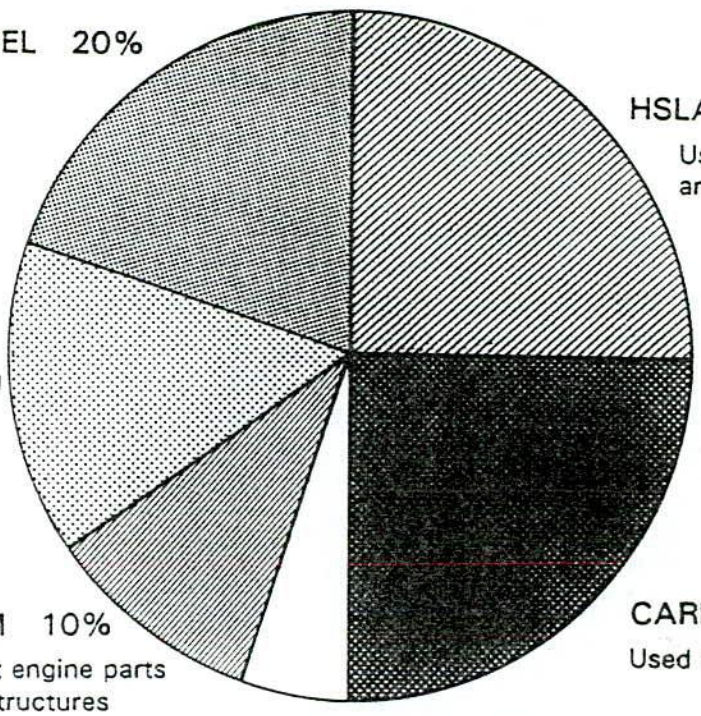
For some years, however, a large deposit of iron ore containing vanadium and titanium (vanadiferous titano–magnetite) has been known to occur in the vicinity of the Windimurra Hills to the east of Mt Magnet in Western Australia and various assessments of the ore body and of the feasibility of producing vanadium from this ore have been made. Since 1986 a mining lease and 5 exploration licences covering the known extent of this deposit were acquired by Precious Metals Australia Limited (PMA). During that time PMA has carried out detailed exploration of the deposit and has conducted metallurgical testwork to determine a process for extraction of the vanadium.

At the completion of that feasibility study, PMA decided that it was in a position to proceed with the establishment of the Wagoo Hills Vanadium Project (also known as the Windimurra Vanadium Project) and accordingly referred its proposal to produce vanadium to the Environmental Protection Authority (EPA) in August 1991, as required under the provisions of the Environmental Protection Act 1986.

On receipt of that referral, the EPA determined that the project should be formally assessed with the opportunity for public comment and established the level of assessment as a Public Environmental Review (PER). The PER has been prepared to specifically address key issues identified in Guidelines provided by the EPA and to address issues raised by the public and Government Agencies during meetings arranged by PMA as part of its consultation process.

In general, the PER provides information on the proponent, location of the project, the PER process, a detailed description of the mine site and process plant, a description of all inputs and outputs and transportation. Ancillary features such as workforce accommodation are also described. Descriptions and analyses of environmental issues relevant to each of these aspects are addressed in this PER.

END-USE VANADIUM MARKET AND APPLICATIONS



FULL ALLOY STEEL 20%
Used for Forging

HSLA STEEL 25%
Used for Construction and Pipelines

TOOL STEEL 15%
Used for High-speed tooling
Abrasion-resistant parts

TITANIUM 10%
Used for Jet engine parts & Aircraft structures

CARBON STEEL 25%
Used for Reinforcing Bar

CHEMICALS 5%
Used as a catalyst for H_2SO_4 production,
Maleic anhydride production,
Ethylene-propylene, Diene monomers.

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THE VANADIUM MARKET FIGURE 1.1

1.2 The Proponent

The proponent for the Wagoo Hills Vanadium Project is an Australian company, Precious Metals Australia Limited (PMA) of Suite 52, 2 Sherwood Court, Perth, Western Australia. All patents, leases and technology associated with the project are totally owned by PMA. The Company was incorporated in 1985 and was listed on the Australian Stock Exchange Limited in December 1988. The objectives of the Company are to research and develop resource based industrial projects which utilise proven process technology.

1.3 Project Areas

The main project area (including the mine and process plant) is located on Mining Lease 58/178, 610km north-east of Perth and 80km south-east of the mining town of Mt Magnet in the Murchison mineral field of Western Australia (see Figures 1.2 and 1.3).

The location and other tenements held by PMA are on Crown Land subject to a Pastoral Lease (No. 3114/1150) granted for grazing purposes under the provisions of the Land Act, 1933 and known as Windimurra Station. The Mining Lease has a total area of 988ha while the Pastoral Lease has an area of 260,065ha.

The project also involves the development of a small coal quarry which will be located approximately 20km north-east of the township of Mingenew. The location of the coal quarry is shown on Figure 1.2 and 1.4.

The coal project is on part of Perpetual Lease No. P/685, an established farming property, Victoria Location 9793. PMA's Exploration License E70/1105 covers the majority of Victoria Location 9793 which has a total area of approximately 1,300ha. Approximately 60ha in the north-east corner of the location will be taken up by the coal quarry.

1.4 General Overview

PMA has been carrying out research, development and demonstration of the technology for vanadium processing for the Wagoo Hills Vanadium Project over a period of 5 years and at a cost of several million dollars. During this period assistance has been provided by both the State and Federal Governments in accordance with policies which are seeking to establish "added-value" processing of mineral resources especially when these are export oriented. The objective of the Wagoo Hills Vanadium Project is to establish Australia's only operating vanadium processing plant. On the basis of the research and development programme and the recently completed feasibility study, PMA is convinced that a new and environmentally sound vanadium processing industry can be developed in Western Australia which would create benefits at the Commonwealth, State and Local level.

The Wagoo Hills Vanadium Project consists of four principal components – they are:

1. The mine at Windimurra where the vanadium bearing ore will be mined.

2. The process plant adjacent to the mine at Windimurra, in which the ore will be processed to manufacture and refine vanadium oxides for Worldwide sale.

3. A small coal quarry some 20km from the town of Mingenew (near Geraldton) to produce coal to aid in the production of vanadium oxides; and

4. Infrastructure consisting of a village, water supply, roads etc to service the integrated mine and process plant at Windimurra.

All components are necessary for the successful and viable production of vanadium oxides from the Wagoo Hills Vanadium Project.

The vanadium-bearing ore will be excavated at Windimurra by conventional earth-moving machinery in an open cut mining operation.

The great majority of the material mined will be trucked to a process plant which will be constructed adjacent to the mine. Overburden (rock) from the mining operation will be used for the construction of a tailings dam associated with the process plant. At later stages of the operation the overburden will be formed into dumps adjacent to the mine site. The design of these dumps will conform with guidelines of the Department of Mines.

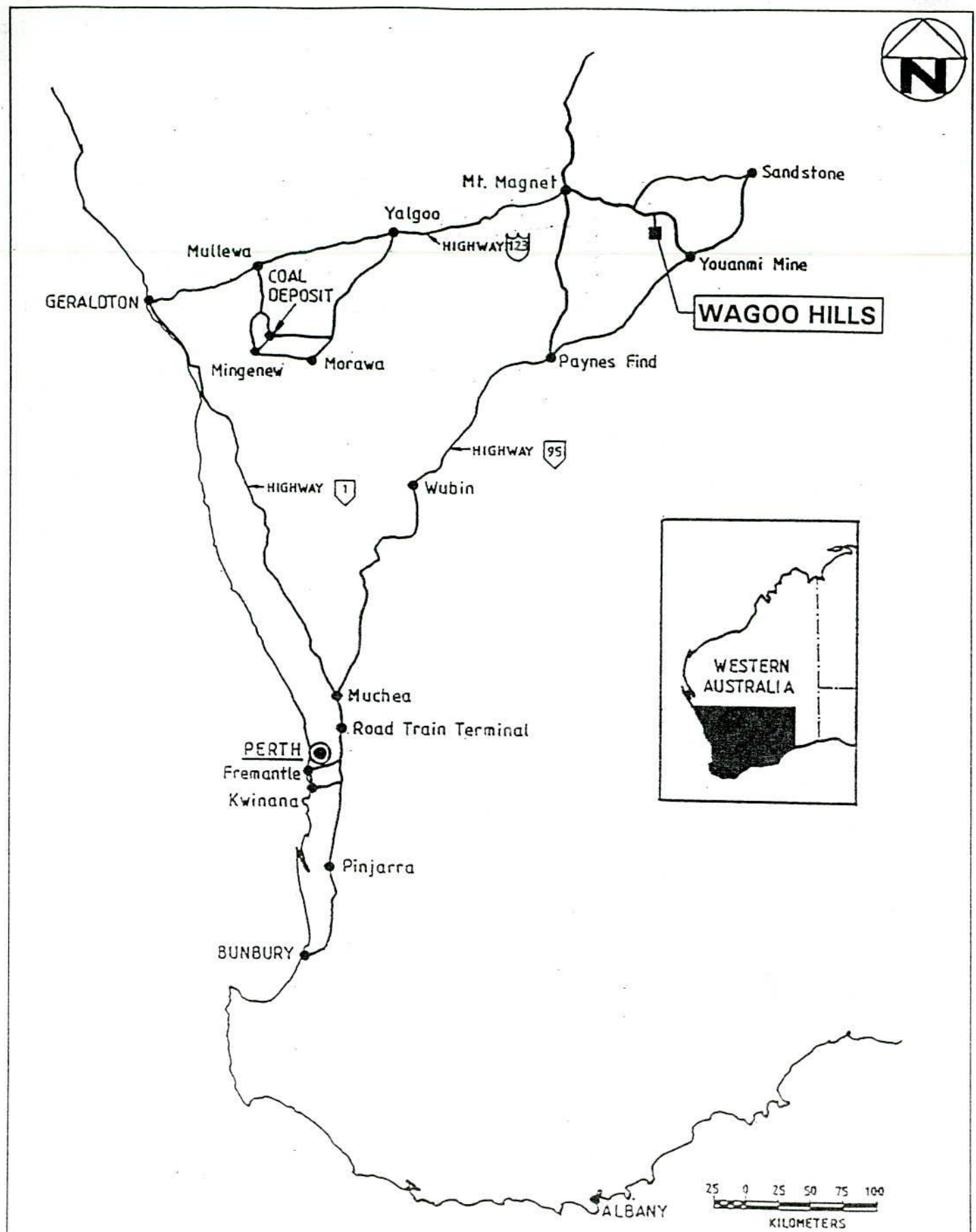
In the process plant, the ore is crushed and ground and then refined so that various oxides of vanadium are produced. These products are bagged or drummed on site and trucked to a port for shipment overseas.

Inputs to the process plant are the ore, coal (from PMA's quarry near Mingenew), various reagents, water, butane and diesel fuel. Outputs are the vanadium products, tailings and possibly sodium sulphate.

An accommodation village and a borefield for water supply will be established at Windimurra to the north-east of the process plant. The village will house the workforce for the vanadium mine and process plant. The water supply system and other minor infrastructure will service the village, process plant and mining activities.

The coal for the project will be supplied from the specifically developed coal quarry located near Mingenew and will be trucked to the process plant. The coal quarry will be progressively backfilled and returned to agricultural use.

All other inputs will be transported by trucks to site.



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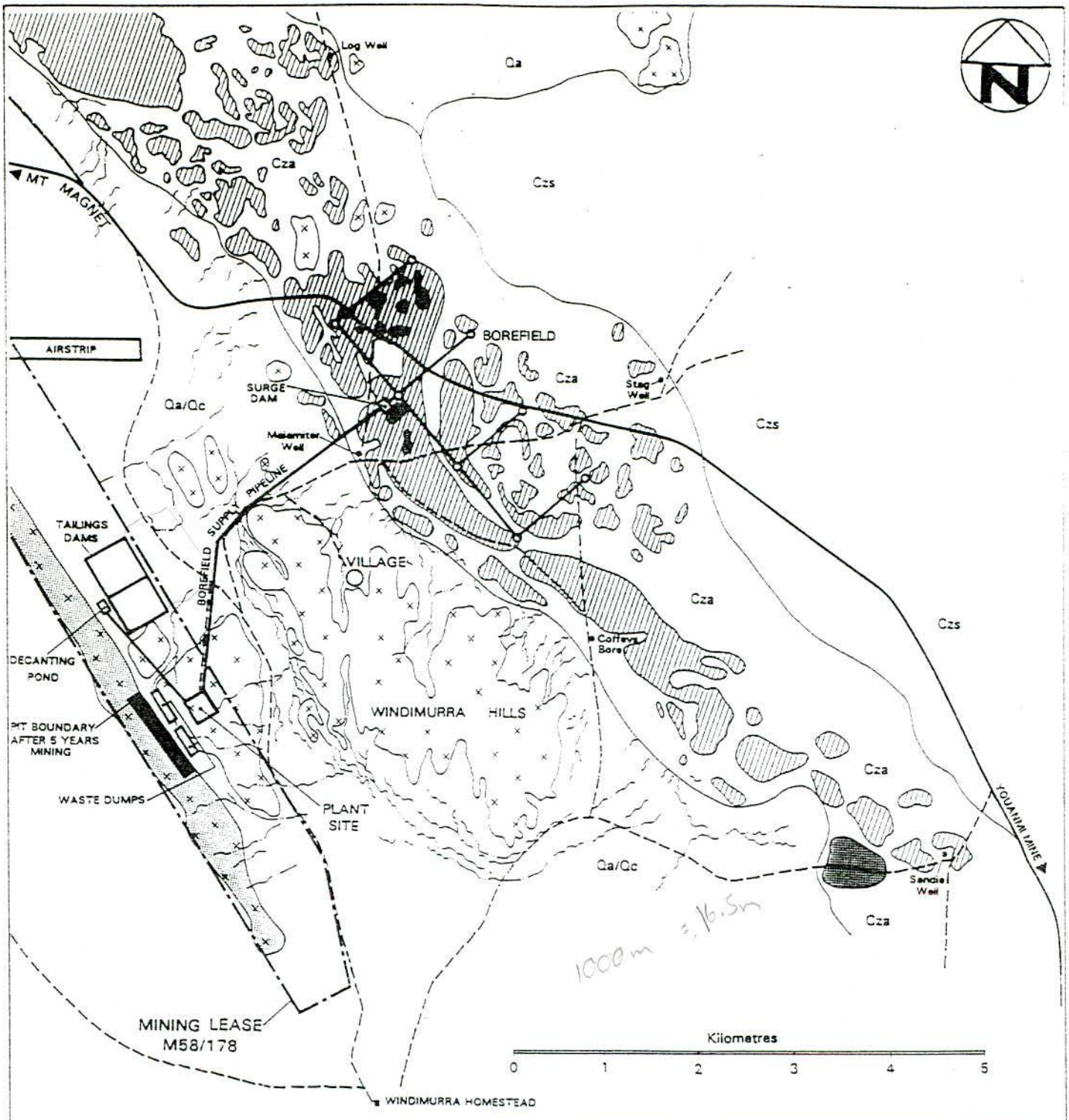
PROJECT LOCATION FIGURE 1.2



LEGEND

Qa	Alluvium
Qc	Colluvium
Cza	Alluvium (older Cainozoic)
	Calcrete & calcareous alluvium
	Claypan; clayey depression
Czs	Sandplain Deposits
	Bedrock, mainly gabbro
	Mineralised zone, magnetite scree
	Road
	Track
	Water course

8m + 1.5m

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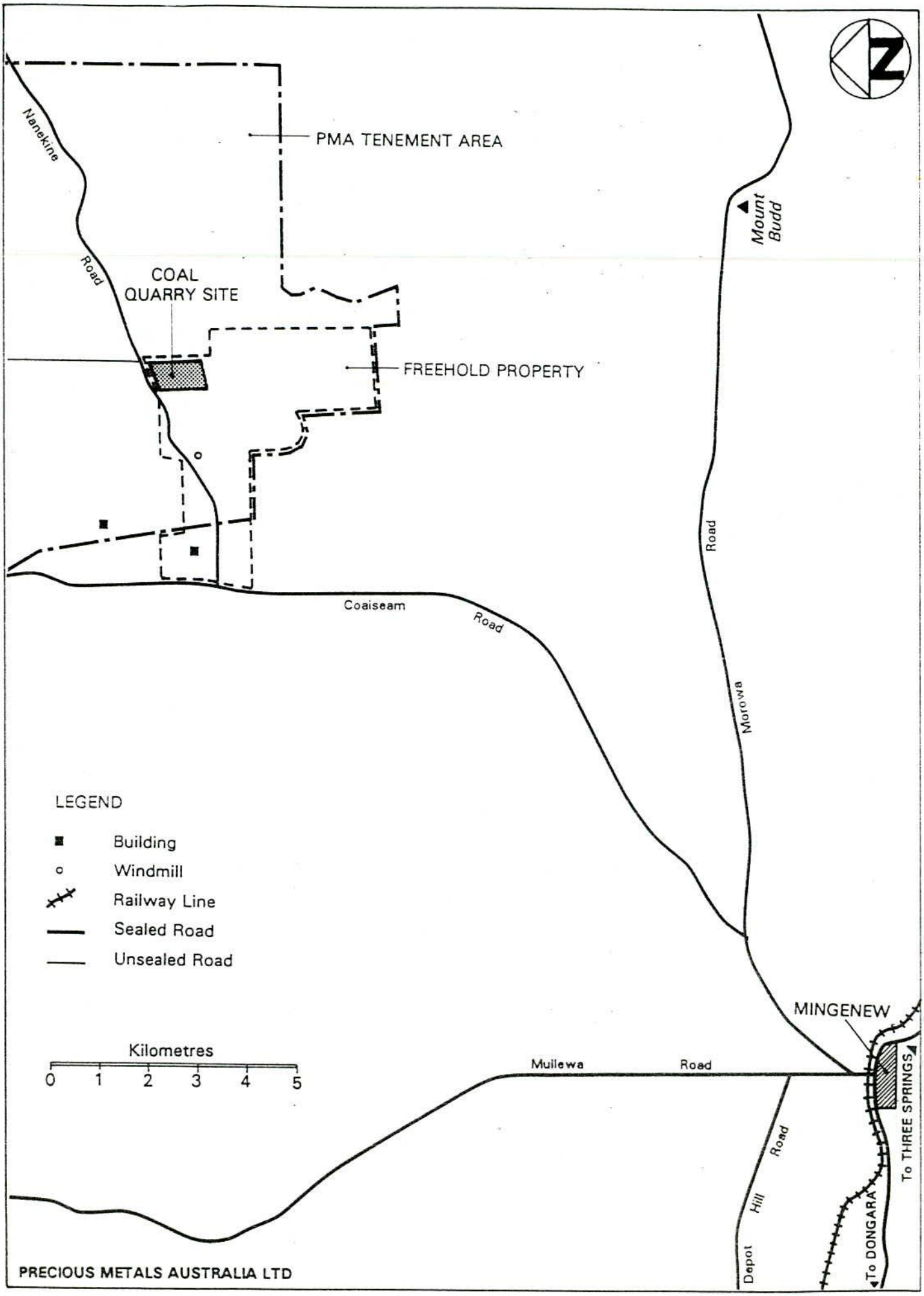
LOCATION OF VANADIUM MINE AND PROCESS PLANT

FIGURE 1.3



LOCATION OF COAL QUARRY FIGURE 1.4

The entire project is considered by PMA to involve no significant implications in terms of environmental impact. The mine, process plant site and infrastructure are located in a very small part of the remote Windimurra Pastoral Lease and in areas which have been used for stock grazing for many years. The coal mine is located in a paddock which is used for grain production. Noise, dust and atmospheric emissions from both sites will be controlled and will all comply to regulatory requirements.

1.5 Timing of the Proposal

PMA intend to proceed with the project as soon as the necessary government approvals have been obtained. Construction will take from 12 to 16 months.

1.6 Statutory Requirements and Approvals

In order to establish the Wagoo Hills Vanadium Project, PMA will have to obtain approval from the State Government and comply with the requirements of all applicable Acts and Regulations. The more important statutes and regulations in this respect will include:

- Aboriginal Heritage Act 1972–1980
- Agricultural and Related Resources Protection Act 1981
- Coal Mines Regulation Act 1946–1976
- Construction Safety Act 1972
- Dangerous Goods (Road Transport) Regulations 1983 and 1988
- Environmental Protection Act 1986
- Explosives and Dangerous Goods Act 1983
- Health Act 1911
- Mines Regulations Act 1946 and Regulations
- Mining Act 1978–1987 and Regulations
- Occupational Health Safety and Welfare Act 1984
- Poisons Act 1964
- Water Authority Act 1984

- Rights in Water and Irrigation Act 1914
- Soil and Land Conservation Act 1945–1982

1.7 The Environmental Assessment Process

The Western Australian environmental impact assessment process is illustrated in Figure 1.5. Essentially, the proponent is required to notify the EPA of the proposal. The EPA then determines the need for a more detailed document such as a Public Environmental Review (PER) and provides the proponent with a set of Guidelines to assist in the preparation of that document. The Guidelines for the present PER are provided in Appendix 10.1.

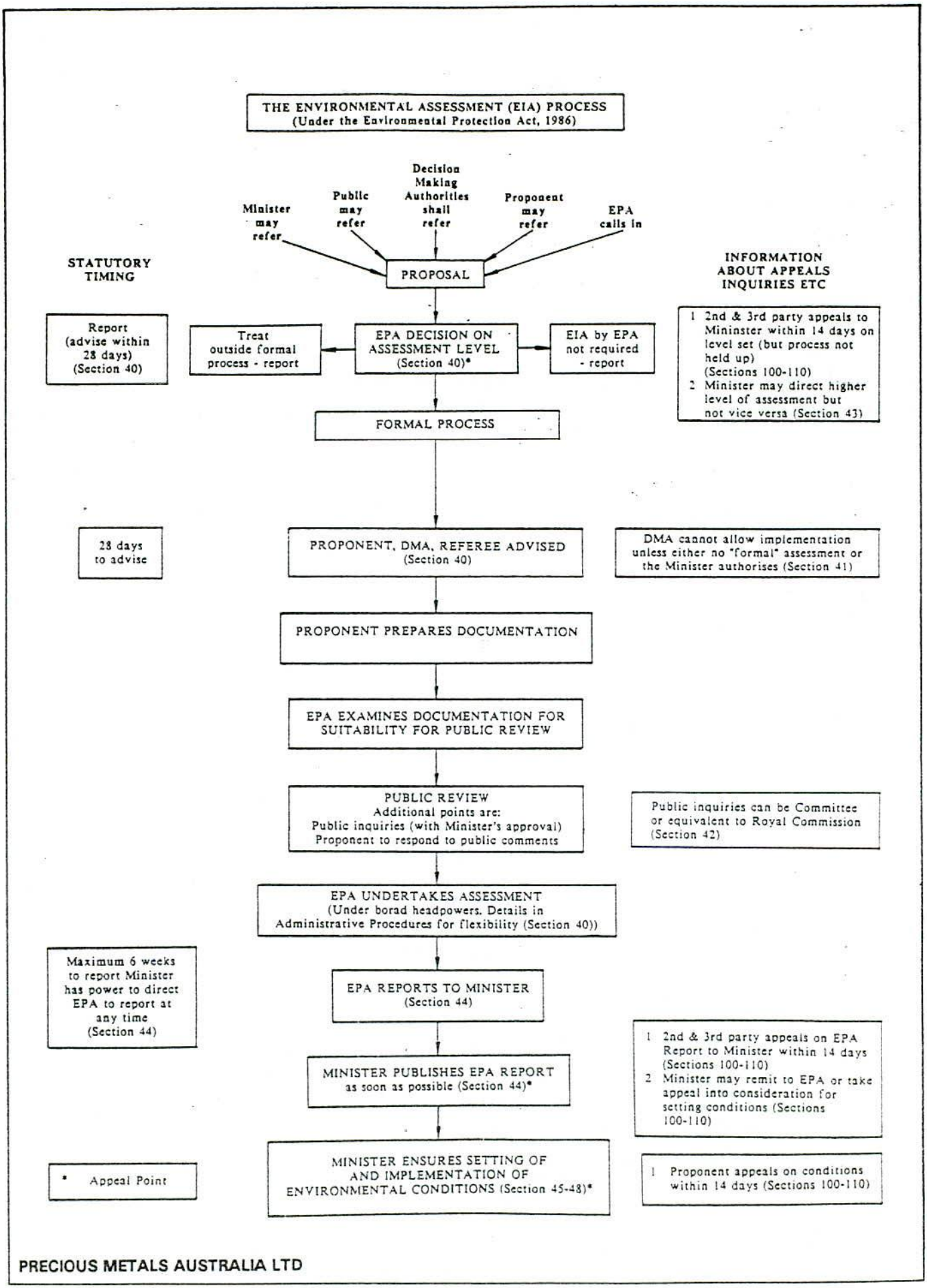
The PER is then reviewed by the EPA to ensure that it provides sufficient detail and a comprehensive coverage of issues. When this has been established, the PER is released for a public review period. At the end of this, a review of submissions is supplied to the proponent and a response is sought. The EPA then prepares an Assessment Report taking into account the public comments and the proponent's response.

The Assessment Report includes recommendations made to the Minister for the Environment who ultimately decides whether the proposal is acceptable and what conditions will be imposed upon it.

Interested parties can appeal against the level of assessment set by the EPA, and against the content of the EPA Assessment Report, or any of its recommendations. The proponent can also appeal against the Ministerial decision and any of the Ministerial Conditions.

The environmental assessment process is designed to enable State authorities to consider in detail the environmental and social implications of development proposals. These considerations are based on technical assessments of the nature and extent of changes to the existing natural and social environments, on the handling of hazardous materials and wastes (if any), on proposed management strategies to control or limit adverse changes (if any), and on monitoring programmes designed to document and analyse the effectiveness of such strategies.

The environmental assessment process also enables members of the public to obtain details of the proposal and to formally comment on any matters of interest to them. These inputs are required within specified public review periods and are considered together with the technical assessments. The public is encouraged to provide written comments to the EPA as part of the environmental review process. Details of the public review period and advice on how to make a submission are provided at the start of this PER.



THE ENVIRONMENTAL ASSESSMENT PROCESS FIGURE 1.5

2. PROJECT BENEFITS & PHILOSOPHY

2.1 The Vanadium Mine and Process Plant

PMA owns several vanadium bearing resources. The selection of the Wagoo Hills Vanadium Project site location was governed mainly by the specific ore qualities and the abundance of saline groundwater nearby. The selection of this site was further enhanced by the low environmental and social impact due to its Crown Land Pastoral Lease status and its remoteness from communities and homesteads.

The importance of the Wagoo Hills Vanadium Project can be defined in terms of the significant economic and employment benefits that it will generate over a relatively long project life. These benefits are significant in a national context in terms of the establishment of a new export industry involving a strategic and high value product; regional in terms of revenues, economic stimulation and employment generated at the State level; and local in terms of employment and revenues generated within the Shires of Mt Magnet, Mingenew and Morawa.

To date, PMA has a defined ore reserve of 44 million tonnes of vanadiferous titano–magnetite from the mineralised area within its leases. This tonnage is sufficient to ensure a mine life of 30 years. Expected initial production level for vanadium oxide from the project is 3700 tonnes per annum which is approximately 9% of current western world demand. This percentage is illustrated in Figure 2.1 relative to the proportion of the market supplied by some other mineral exports from Western Australia.

The scale of the proposed production relates to an extensive marketing review carried out by independent marketing consulting groups for PMA. Although the defined ore reserves would support a higher level of production, establishing a World market share of over 10% in the initial years would require further contractual arrangements with end users. Economic models taking into account capital expenditure and operating costs as well as the market influence, support this level of production. A lower level of production would deny the benefit of economies of scale.

It is anticipated that the total construction cost will be in the order of 54 million Australian dollars, most of which will be expended within Western Australia. Export income over the life of the project will be in the order of 900 million dollars on current vanadium prices. In addition, increased revenue will result to the state and the nation from government taxes, levies and royalties from the mining of coal and vanadium ore, and the taxation of employee income and PMA's profits. To date, PMA has spent several million dollars examining and proving the feasibility of mining and production and on pilot scale process testwork and similar matters. Research and development activities have been supported by the Federal Government through research and development financial grants.

PMA has also expended approximately $150,000 to date on planning for environmental management including design work, site investigations and the preparation of this PER.

The location of the process plant adjacent to the mine conforms with the Western Australian Government policy of encouraging industry to decentralise away from the Perth Metropolitan Region. It will also ensure that a significant component of the employment and economic stimulation occurs in the Mt Magnet area. It is the intention of Precious Metals Australia to contract the services of the local community to maintain equipment and many local businesses such as vehicle maintenance workshops, welding and machinery shops, and equipment suppliers will be used to support the project.

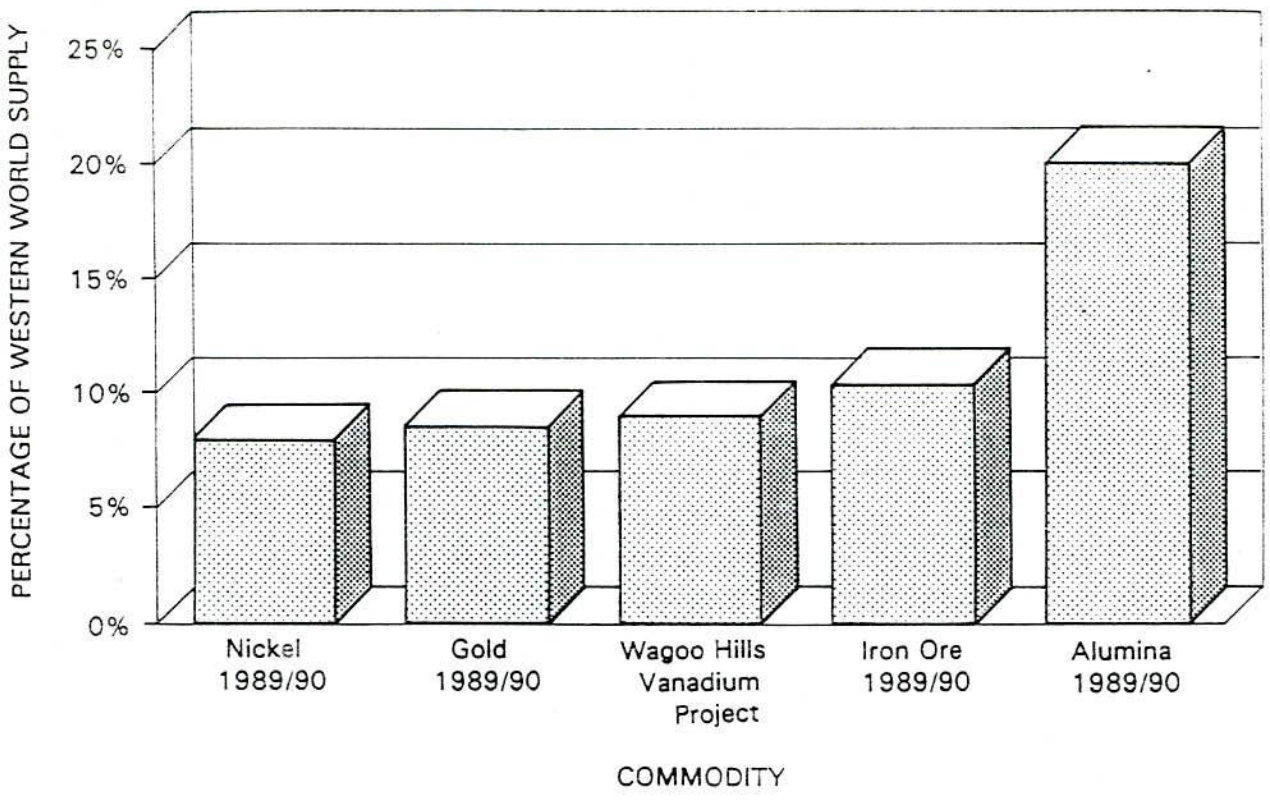
The project will also directly employ an estimated 500 people during the design and construction phase and 120 people during the operational phase. Most of the operational workforce will be employed at the main project area (Windimurra). Applying a conservative job multiplier of 1.5 to the operational workforce, the project is expected to permanently employ directly and indirectly, a total of approximately 300 people.

PMA has had several discussions with the Social Impact Unit and Department of State Development regarding the source of the operations workforce for Windimurra. As commissioning of the Wagoo Hills Project operational phase will occur some 18 to 20 months from now (January 1992) it has not been possible to determine what proportion of the skilled and non-skilled workers may originate from Perth, Geraldton, Mt Magnet and Kalgoorlie, however, the direct employment of local people will be promoted wherever possible.

At present it is planned to provide housing for the permanent workforce on site close to the plant with the workforce operating on a fly-in/fly-out basis. However, the nearest town, Mt Magnet, is some 80kms to the north-west and will provide many services to the mine site. The alternative of housing personnel in Mt Magnet therefore will be assessed as the existing infrastructure may favour this option. Land, power and water capacities at Mt Magnet will need to be considered as well as the safety of the workers who would need to travel to and from the mine site and Mt Magnet along an 80km gravel road in all weather conditions.

PMA maintains that the benefits from the Wagoo Hills Vanadium Project can be achieved with relatively minor impact on the environment at Windimurra and Mingenew. The extent and nature of environmental issues associated with the project and PMA's response in terms of design, management procedures, and commitments is described in the following sections of this PER.

Western Australia is an important producer of a range of mineral products including nickel, gold, iron ore and alumina. The proposed Wagoo Hills Project will make Western Australia one of the World's largest vanadium producers with approximately 9% of the World market.



Western Australia is an important producer of a range of mineral products including nickel, gold, iron ore and alumina. The proposed Wagoo Hills Project will make Western Australia one of the world's largest vanadium producers with approximately 9% of the world market.

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EXAMPLES OF MINERAL EXPORTS FROM WA FIGURE 2.1

2.2 The Coal Quarry at Mingenew

The Mingenew Coal Project forms an integral part of the overall project and the supply of energy is one of the project's major operating costs. The proponent has considered many alternative options in respect of its energy requirements as discussed below, this undeveloped energy resource is relatively close to the Wagoo Hills Vanadium Plant, and coupled with the ability to acquire freehold title to the land, has proven to be PMA's most attractive energy supply for the rotary kiln.

Environmental and social impacts are minimal due to the past intensive use of the land for cereal cropping and the distance of the site from the farming residence and the Mingenew township, (some 20km to the south).

At Mingenew, 12 people will be directly employed during the operational phase of the coal quarry. While this number is small, it is important at the local level. The quarry operations will also generate demand for goods and services. Similarly, the coal transport operators will require maintenance support services and the contractors are likely to use local facilities and services and labour where available. Local support for this project has been instrumental in the proponent's decision to proceed with the development of the coal resource.

There are a number of alternative fuels which could be used for the kiln in the process plant. However, PMA considers that coal from a company-owned resource relatively close to the process plant is a strategic necessity. The benefits to PMA from development of its own coal resource, include:

- Supply at a lower cost than alternative sources of energy,
- Establishment of a source of energy free from price fluctuations such as may be caused by exchange rates, and
- The security of a dedicated energy supply.

In addition the coal from Mingenew has a low sulphur content and will therefore generate low sulphur dioxide emissions. The quantity of coal required (30,000 to 70,000 tonnes each year) is very small relative to the current consumption of coal in Western Australia (over 5,000,000 tonnes per year).

Alternatives to the development of the Mingenew Coal Deposit include, approximately in order of their financial and technical attractiveness to PMA:

- Natural gas,
- Oil and distillate,

- Petroleum coke from USA or Korea,
- Coal from Indonesia,
- Coal from New Zealand,
- Coal from South Africa,
- Coal from Collie,
- Coal from other Western Australian deposits, and
- Renewable energy.

Natural gas is a viable source of fuel for the vanadium process plant. Currently, natural gas is supplied to the Geraldton region and to the south-west of Western Australia from the North-West Shelf Gas fields. PMA have discussed the possibility of connecting to this gas distribution network with SECWA but have been advised that gas could not be supplied economically. The cost of such a connection to PMA would be in the order of 30 million Australian dollars and the price for the gas delivered would then be equal to the delivered cost of coal from Collie.

Natural gas is also an internationally traded resource and local supplies can be marketed overseas as an alternative to being used for domestic purposes. The coal from Mingenew is insulated from world market price variations such as may occur with gas.

Oil and distillate are the most expensive alternatives available to PMA as energy sources. Oil is not generally favoured as a fuel for industrial purposes both because of its cost and because it is better suited for use in areas such as transport where its high energy content is beneficial. Oil products are internationally traded commodities which are subject to price variations outside the control of PMA. Australia is also a net importer of these fuels and therefore any increase in demand must adversely contribute to the current account deficit.

The refining of some crude oils gives rise to a residual product known as petroleum coke. This material is available from California and Korea as well as other sources. It is high in energy value and this partially offsets increased transport costs from such distant sources. The delivered cost to Windimurra, however, is not competitive with the supply of coal from Mingenew. Petroleum coke can also contain 5% sulphur which is substantially more than the 0.6% for Mingenew coal and would therefore generate increased levels of sulphur dioxide emissions if it were to be used.

High quality low ash coal can be imported from a range of countries including, Indonesia, New Zealand and South Africa at competitive costs. However, the cost of shipping, unloading at the port of Geraldton, and trucking to Windimurra make this alternative

significantly less attractive financially. Import of coal from overseas would also add to Australia's current account deficit.

Coal could also be supplied from established mining operations at Collie. Westrail has advised, however, that the cost of transporting coal from Collie to Windimurra would be in the order of $65/tonne. This greatly exceeds the amount that overseas vanadium producers are required to pay for coal delivered to their process plants and therefore it presents a major competitive disadvantage to PMA. In contrast, the transport cost of coal from Mingenew to the process plant is in the order of $25/tonne.

Coal deposits also occur in the mid-west region at Mt Lesueur (Hill River) and at Eneabba but it is very unlikely that supplies from these sources will be available for some years, if ever. A significant proportion of the Mt Lesueur deposits have recently been recommended for National Park status from which mining is excluded by Government Policy.

Sources of renewable energy include solar and wind power which theoretically are available at Windimurra. Significant research is being carried out in Australia and overseas aimed at developing commercial power generating capacity from these and other renewable sources of energy but there are currently no proven means of economically producing sufficient energy from such sources to meet the needs of the Wagoo Hills Vanadium Project.

On the basis of the above analysis, PMA has concluded that the Mingenew Coal Deposit offers the only commercially viable option for the supply of an energy source to the process plant at Windimurra.

3. EXISTING ENVIRONMENT

3.1 Windimurra

3.1.1 Climate

The features of the climate at Windimurra which are most relevant to this environmental assessment are rainfall, as it affects surface drainage and groundwater recharge, and wind patterns as these affect the dispersion of atmospheric emissions and dust. Run-off from rainfall is also affected by evaporation which in turn is largely determined by temperature. Rainfall, temperature and evaporation at Mt Magnet which is the nearest weather recording station, are shown in Figure 3.1

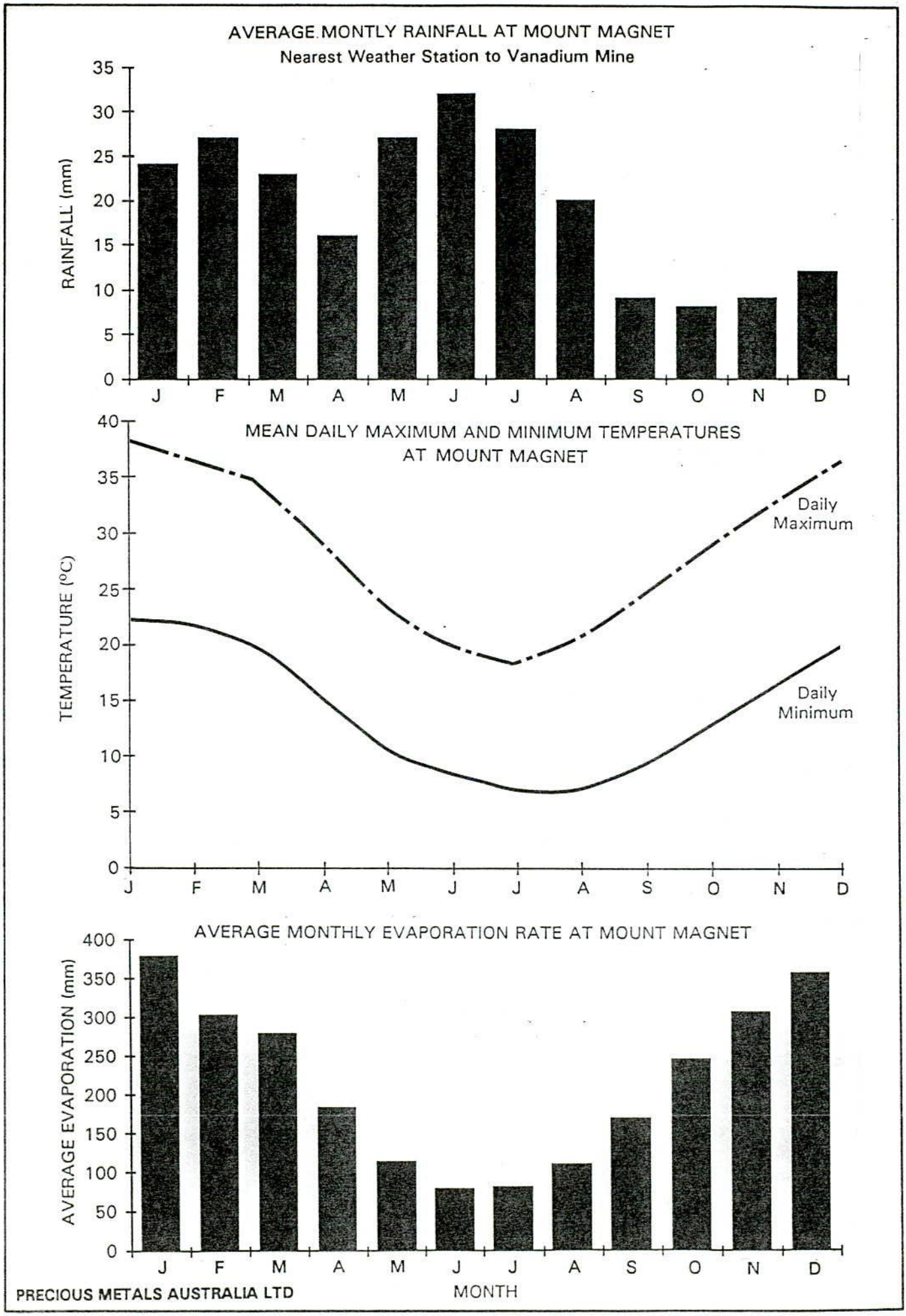
The Mt Magnet area is in the semi-arid zone of Western Australia and rainfall is typically low with an annual average of 235mm from more than 90 years of recorded data. Summer and winter are the wettest seasons with monthly averages from 16mm (April) to 32mm (June). Generally, very little rainfall occurs from September to December inclusive.

The average number of rain days in each month is also low and indicates that the overall pattern is one of occasional but locally significant falls.

A study of the maps prepared by the Institute of Engineers of Australia for rainfall and run-off for the area shows that the following storms may be expected at Mt Magnet.

Storm Duration (hrs)	Return Interval (years)	Amount (mm/hr)
1	2	16
12	2	26
72	2	0.65
1	50	35
12	50	8
72	50	2.2

The data indicate that a maximum storm of 12 hours duration producing 312mm of rain may be expected every two years.



WEATHER DATA FOR MT MAGNET FIGURE 3.1

These data are of importance in planning for water control on the waste dumps, on the walls of the tailings dam and in the control of run-off from the site. These matters are addressed in Sections 4 and 5.

In contrast to rainfall, temperatures and evaporation in the area are relatively high. Average monthly maxima exceed 30°C from November to March inclusive and daily maxima often exceed 40°C. Average evaporation in these months exceeds 270mm and generally 300mm.

In autumn and spring average monthly maxima temperatures are above 23°C and evaporation exceeds 100mm while in winter the average maxima temperatures are about 20°C and evaporation ranges from about 75mm to 100mm.

The wind patterns for Mt Magnet are illustrated in Figure 3.2 by wind roses which show morning and afternoon wind directions and speed. In the morning north-easterly winds predominate especially during summer with easterlies and south-easterlies also frequent. Winds from the west, including north and south-westerlies, are much less frequent. The easterly winds are of variable intensity but the westerlies tend to be relatively light with speeds of 1 to 20km/hr.

In the afternoon the most frequent winds are south-easterlies with easterlies and north-easterlies also common wind directions. Again, summer winds dominate the annual pattern. In general the easterly winds are light with speeds of 1 to 10km/hr. Westerlies (predominantly south-westerlies and westerlies) are more frequent than in the morning and range in speed from light to moderate (31km/hr and greater).

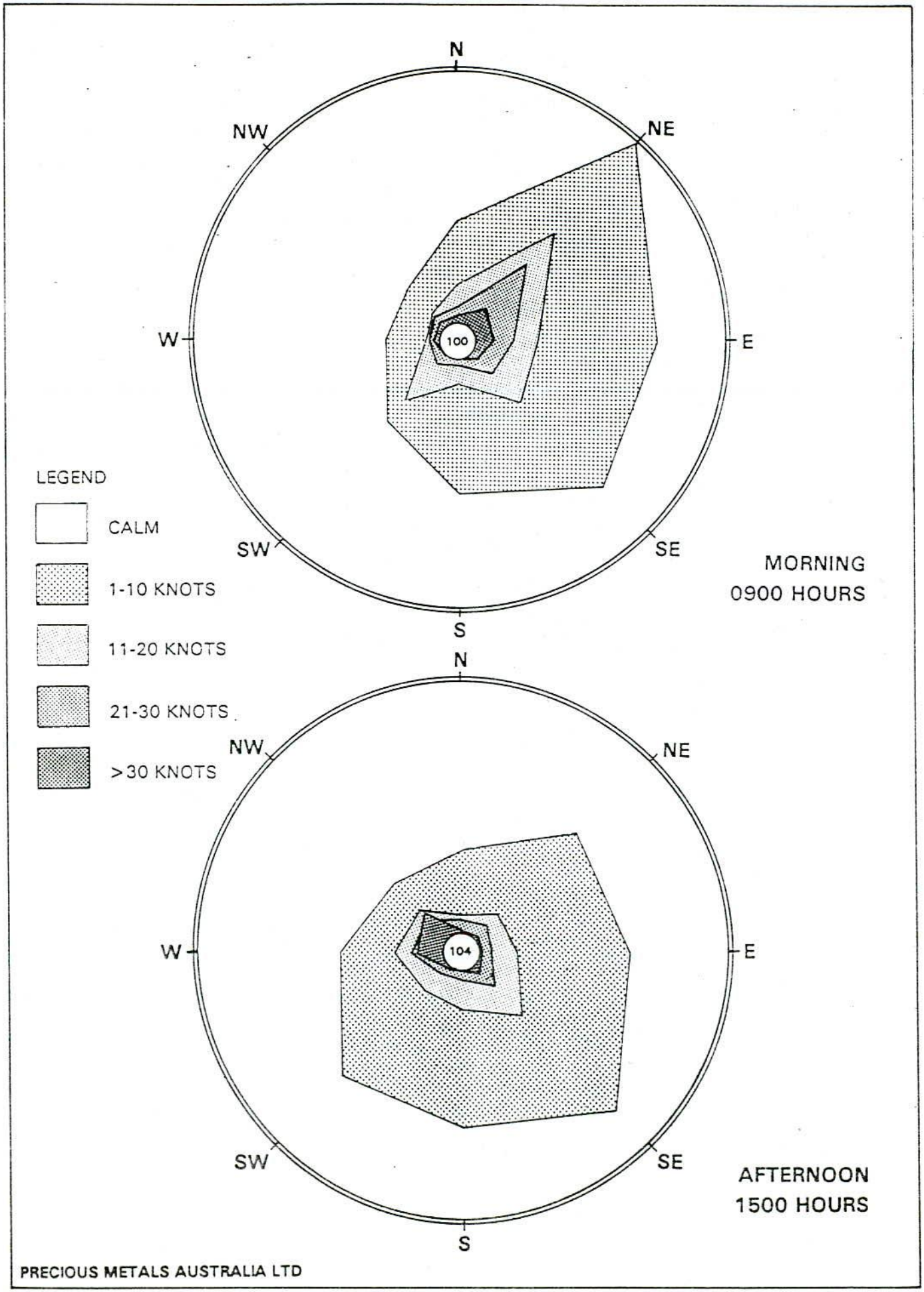
There is very little wind from the north and north-west, i.e. across the project area toward Windimurra Station.

3.1.2 Physical Features

The physiography of the Windimurra region falls into the "salinaland" category of Jutson (1950). The terrain is generally flat and drainage is entirely internal with the formation of salt pans to the east of Windimurra Hills. The elevation of the mine and plant area ranges from 450m to 470m ASL while the Windimurra Hills have an elevation of 485m.

The main physiographic components of the project area are:

- The Hawkstone Ridge area, where the orebody is located,
- The Windimurra Hills, and
- The clay and calcrete flats between and surrounding these areas.



WIND ROSES FOR MT MAGNET FIGURE 3.2

The Hawkstone Ridge area consists of a low lateritic ridge which forms a breakaway over the kaolinised titano-magnetite horizon. Total relief along the orebody is approximately 20m. The orebody is characterised by a magnetite scree covered area on the eastern side of this ridge which trends in a north north-westerly direction. The surface of the orebody is generally 10m below the highest point on the ridge and mining activity will generally be to the east of this point.

The Windimurra Hills are the only significant rock outcrop in the area. These north-south trending strike ridges mostly comprise large boulders of gabbroic rock at high angles of repose. The project village will be located at approximately 450m elevation on the northern side of Windimurra Hills and will be 35m below the highest point on these hills.

The extensive flats surrounding the Windimurra Hills consist of smectite (montmorillonite) clays which, due to their shrinking and swelling properties have formed "gilgai" or "crab hole" country. The flats to the east of Windimurra Hills are largely covered by a layer of rubbly calcrete.

The soils on the Hawkstone Ridge and flat areas have been significantly eroded in many places and the exposed roots of dead mulga trees indicate a 3 to 5cm soil loss.

The main physiographic components of the project area can be further subdivided into 7 distinct landforms as follows:

- Hills and rocky outcrops - with a prominent mantle of heavily weathered cobbles and pebbles, lateritic platforms and steep grades towards the summit. Soils are skeletal though sandy belts occur with depths to 25cm.

- Less highly weathered hills with gabbro - hills with lower internal relief than above and with quartz ridges and outcrops and with substantially less weathering, grades are lower and footslopes trend to the drainage plain. Soils are skeletal.

- Abrupt ridge-like hills (Windimurra Hills).

- Gravel covered slopes.

- Drainage plains marginal to hills - footslopes and gently sloping plains broken with insize drainage. Soils are sandy loams with gravel and stone inclusions to 20cm.

- Central drainage flats - broad usually unincised zones of surface water flows with drainage flats. Soils are shallow sandy loams over hardpan with cracking clay soils in the drainage areas.

- Sloping plains flanking the Hawkstone Ridge on the east.

The distribution of these landforms in the project area is illustrated in Figure 3.3.

3.1.3 Hydrology

Surface Water

The project area is located on slightly elevated ground which means that run-off from rainfall will be conveyed away from the site in local drainage channels. Most of the drainage runs in an easterly direction into depressions and clay pans along the south-western margin of an alluviated paleodrainage. Here it apparently evaporates or infiltrates as no major drainage channel or other means of water transport from the claypans is evident.

The proposed project site will not involve the disruption of natural drainage due to the absence of defined channels, creeks or tributaries in the area.

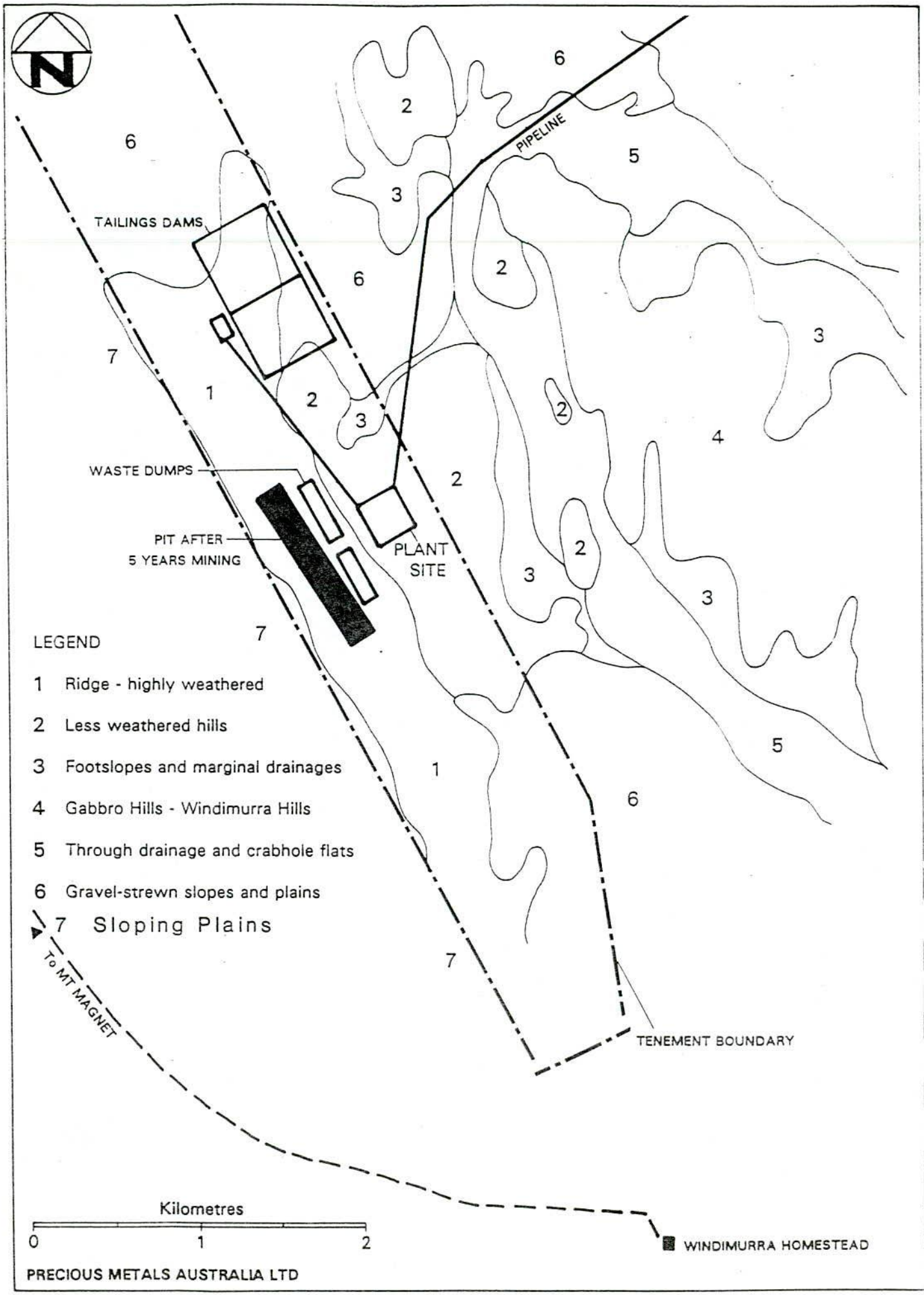
Regionally, the project area is adjacent to a surface water sink which is part of a paleodrainage that used to run north-westwards then west and south-westwards towards an elongate lake system south of Challa Homestead.

Groundwater

The main body of groundwater near the project area is contained in the alluvium of a paleodrainage located to the east of the mine and process site. Minor amounts of groundwater have also been encountered in bedrock.

The alluvium of the paleodrainage is calcreted sand and silt at the surface, underlain by clay and sand to depths of about 80m. A test hole drilled in the alluvium determined that the water table is 3m below ground surface and that the upper aquifer (of ferricrete-calcrete and basal quartz grit) extends from the water table to 8m depth. This aquifer is underlain by plastic clays from 8m to 57m depth which are considered to be impermeable. A lower alluvial aquifer of sand with clay lies between 57m and 76m depth. Weathered and fractured gabbro bedrock, which was drilled to depths of 87m also contains groundwater.

Test bores indicate that groundwater salinity increases with depth with salt content ranging from 2,000-2,500mg/l TDS in the upper aquifer, to 14,000mg/l TDS in the lower bedrock aquifer. Sampling of stock bores/wells in the paleo-channel has yielded groundwater salinities of between 1700-8600mg/l TDS all from the upper aquifer. This is not fit for human consumption. Stock such as sheep may consume water up to 14,000mg/l TDS.



LANDFORMS IN THE PROJECT AREA FIGURE 3.3

The area of the aquifers has not been precisely determined at this stage but it is considered that they are at least 12km in length and 2km in width.

Yields from the test bores range from 200–480m^3/day depending on depth but yields from production bores are expected to be higher than this. It is considered that there is a large margin of safety in the capability of the paleo–channel aquifer to yield the required water supply for the process plant and other project needs.

The gabbro bedrock contains small quantities of groundwater with salinity 900–1,300mg/l TDS and it is considered that shear zones and quartz reef cutting the bedrock in the area might yield useful quantities of groundwater for human use.

3.1.4 Vegetation and Flora

The principal project area at Windimurra lies within the Eremaean Botanical Province. This botanical Province is divided into 'regions' and 'sub–regions' and Windimurra lies within the Barlee Sub–region which is part of the Murchison Region (Beard, 1976). Mulga (*Acacia aneura*) is the predominant vegetation of the Eremaean Botanical Province and the basic vegetation type occurring on the lease area is Mulga Shrubland and Mulga Low Woodland.

The understorey component of these Mulga Shrublands and Woodlands has been modified due to a long history of stock grazing and the Department of Conservation and Land Management has advised that no declared Rare Flora populations are known in the area (Appendix 10.2). Four plant species are on the Priority Flora List prepared by CALM for the general region but none of these are expected to occur at the site since they grow on sandplains and waterlogged flats which do not occur there. During the botanical inspection a possibly rare plant species *Grevillia inconspicua* was discovered and CALM has been notified of the find. The Grevillia was found on the gneissic slopes immediately above the tributary drainage plains and will not be affected by the proposed mining operations.

The dominant vegetation types in terms of the landforms described in Section 3.2 and illustrated in Figure 3.3 are as follows:

- Hills and rocky outcrops, less weathered hills with gabbro, and abrupt ridge–like hills – stunted mulga (*Acacia aneura*) with *A. ramulosa* and *A. grasbyi* in the tree layer and *Ptilous obovatus, Thryptomene inconspicua, Grevillia inconspicua, Solanum lasiophyllum* and Eremophila species in the shrub layer. The ground flora consists of sparse annual herbs and grasses in season.

- Drainage plains marginal to hills – open mulga with Casuarina and other Acacia species over *Eremophila forrestiana* and other Eremophila species with Blue Bush (*Maireana rhagodia*) and Sida species with annuals.

- Central Drainage Flats – mulga with other Acacia species including *A. tetragonophylla* and *Pittosporum phylliraeoides* and Eremophila species, *Ptilotus obovatus* and *Solanum lasiophyllum* on shallow hardpan soils, and Maireana pyramidata (*Halosarcia*) on the cracking clays.

- Gravel covered slopes – groves of mulga and other shrubs and trees.

3.1.5 Vertebrate Fauna

Lists of amphibian, reptile and mammal species which could be found in the general area of the mine and process plant have been compiled by reference to the literature and are provided in Appendix 10.3. Bird lists were compiled using data from the Western Australian branch of the Royal Australasian Ornithologists Union's (RAOU) database from the Shires of Mt Magnet and Sandstone.

The lists indicate that 2 species of amphibians, 42 species of reptiles, 51 species of birds and 19 indigenous mammals may occur in the general area. The only animal in the lists which is gazetted rare under the Wildlife Conservation Act 1950 is the Black-footed Rock Wallaby (*Petrogale lateralis*) but it is considered unlikely that this species actually occurs in the area (Appendix 10.2).

3.1.6 Heritage Sites

The Western Australian Museum has informed PMA that it has no records of either archaeological or ethnographic sites in the Windimurra area (Appendix 10.2). However, PMA has instructed Quartermaine Consultants to discuss the possibility of ethnographic and/or archaeological sites with Aboriginal people with traditional links to the area. A site survey will be carried out to assist the Aboriginal custodians of the land and with respect to any sites which may be located, PMA will comply with the provisions of the Aboriginal Heritage Act 1972-80.

There are no known sites of significance in the area in terms of European heritage.

3.1.7 Adjacent Land Use

The lessees of the Windimurra Pastoral Lease live at Windimurra Homestead 4km to the south of the proposed mine site. The location of the project and the homestead are shown in Figure 1.3. The next nearest dwelling is some 20km away and the nearest town (Mt Magnet) is 80km north-west of the project area.

The pastoral range consultant engaged to advise PMA, considers that the project will have little impact on the carrying capacity of the pastoral lease and will cause only minor disruption to pastoral activities. The project area covers some 120ha which represents less than one twentieth of 1% of the total area of the pastoral lease. A study of rangeland conditions made in 1975 indicated that the Salt Bush and Blue Bush communities were in fair to good condition with some depletion of the perennial Salt Bush vegetation. Observations made by the pastoral consultant in 1992 suggest that the situation has not changed significantly in the past 17 years, though the shrub layer has been depleted. The area of the mine and process plant is mostly covered by surface scree and only a small part of this could be considered as potential grazing land.

The carrying capacity of the various landforms in and around the project area as identified in Section 3.2 and illustrated in Figure 3.3 are as follows:

- Hills and rocky outcrops, less weathered hills, and abrupt ridge-like hills - 1SSU (Small Stock Unit) to 18ha.

- Drainage plains marginal to hills, and gravel covered slopes - 1SSU to 19ha, and

- Central drainage flats - 1SSU to 10ha.

Using the carrying capacities listed above, the Mining Lease (988ha) is estimated to have a carrying capacity of about 50SSU. The actual project area will affect less than a third of this area.

As there is no permanent water in the project area, most stock water is produced from bores. Two small dams, one well to the north of the pit area and the other in the central drainage flats do not depend for their total replenishment from the run-off from the hills, but gather water from the run-off closer to their location. PMA will ensure that all supplies are maintained. The hydrological assessment by Rockwater Pty Ltd also indicates that run-off from the project area is not likely to be significant or cause any environmental problems and therefore will not affect the pastoral activities.

Ongoing discussions are continuing to be held with the pastoralist to help minimise any impact mining may have on his operation. The Mining Act 1978-87 provides a mechanism for pastoralists to seek compensation from a mining company for defined losses caused by mining activities. By successful application to the Warden's Court the pastoralist may be compensated for damage to improvements, loss of earnings, social disruption and reasonable expenses.

3.2 Mingenew

3.2.1 Climate

Weather data for Carnamah, the nearest weather station to Mingenew are shown in Figure 3.4 and wind roses for Carnamah in Figure 3.5. The area has annual rainfall and temperature patterns typical for the south-west of Western Australia with most of the rain occurring between May and August inclusive and hot summers with mean daily maxima exceeding 35° in December to February, and relatively mild winters.

As the area is inland from the coast, the usual patterns of sea breezes or south-westerlies which occur at Geraldton, for example, are not pronounced. The wind roses indicate that calm (virtually no wind) conditions are a prominent feature of the Mingenew district particularly in the afternoon. Winds with speeds of 1-10 knots are the next most frequent. In the morning, winds are liable to originate from any direction but there is a small predominance of north-easterlies. Winds from the easterly sector in the morning may also exceed speeds of 30 knots. Similarly in the afternoon the occurrence of winds is virtually equivalent from all directions although westerlies are slightly more frequent.

3.2.2 Physical Features

The proposed site for the coal quarry is located on elevated but flat land which has no defined surface drainage.

3.2.3 Hydrology

Exploration drilling of the coal deposits has indicated that the highest water table is below the proposed depth of excavation. There is also no surface drainage system close to the quarry site. The proposed project will not involve the disruption of known surface water channels or tributaries.

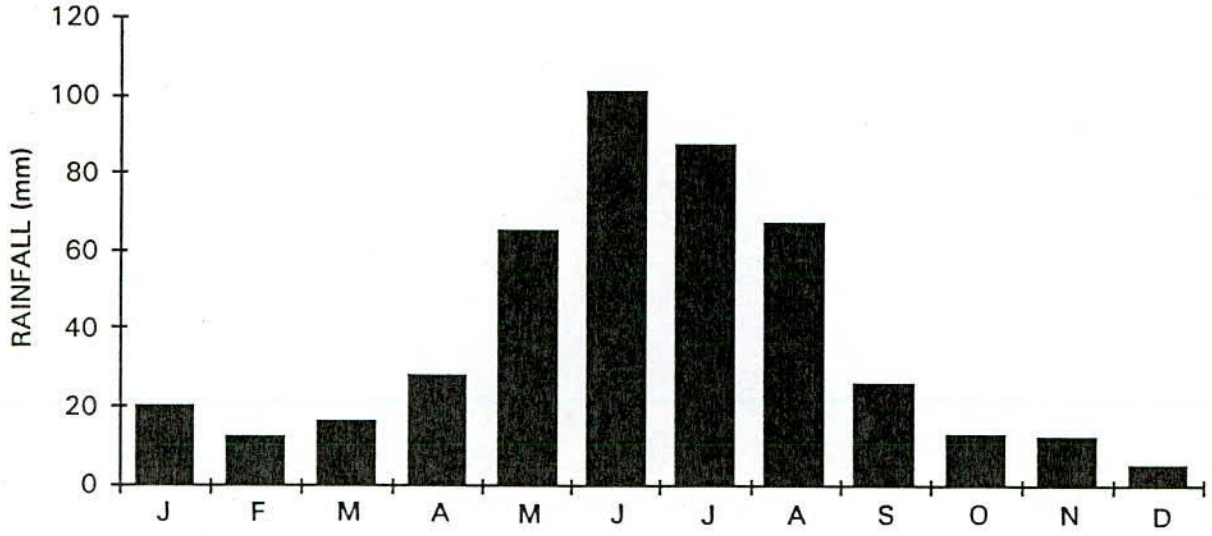
3.2.4 Flora and Fauna

The proposed coal quarry is located on a farming property which was cleared and developed for intensive agriculture about 50 years ago. The quarry itself is within a large paddock currently used for grain crops and there is no indigenous vegetation or vertebrate fauna.

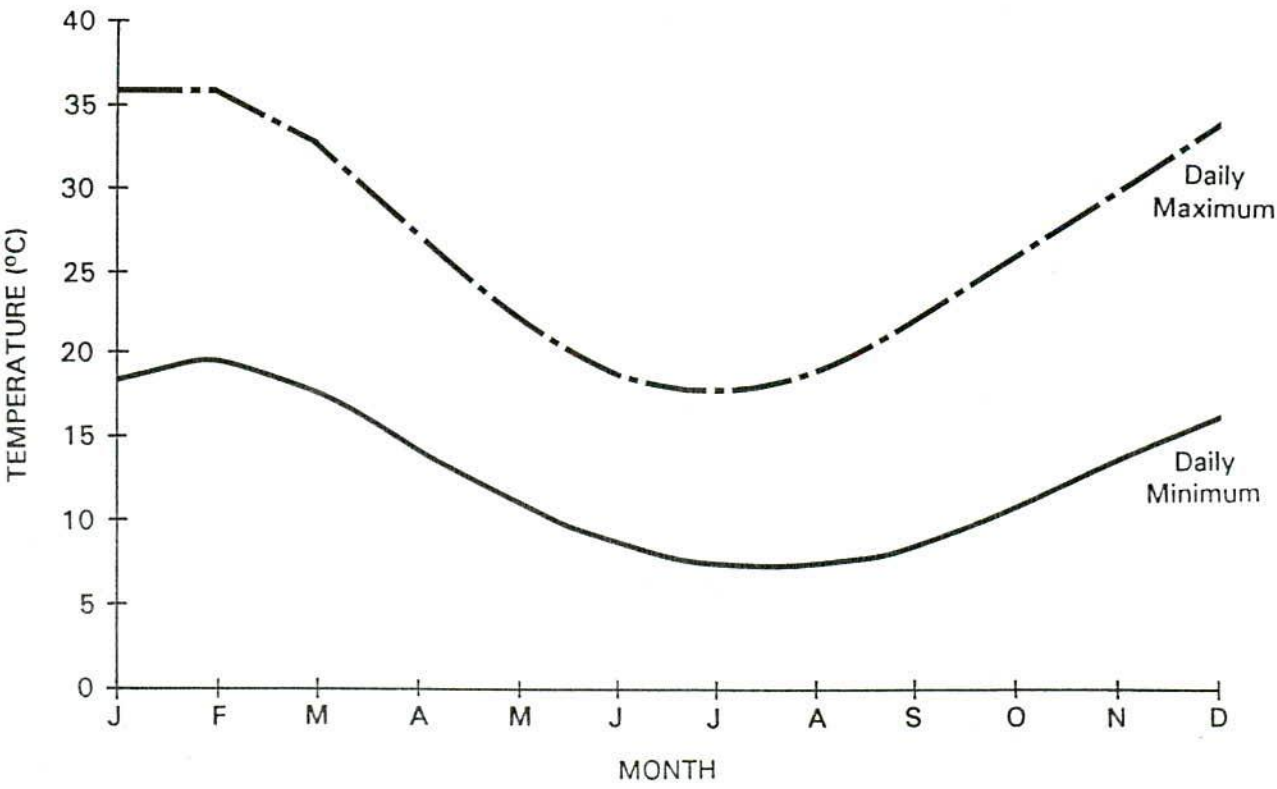
3.2.5 Heritage Sites

There are no known sites of Aboriginal or European heritage in the area and in view of the extensive disturbance as a result of initial clearing and subsequent agricultural use it is unlikely that any sites of significance exist.

AVERAGE MONTHLY RAINFALL AT CARNAMAH
Nearest Weather Station to Coal Quarry

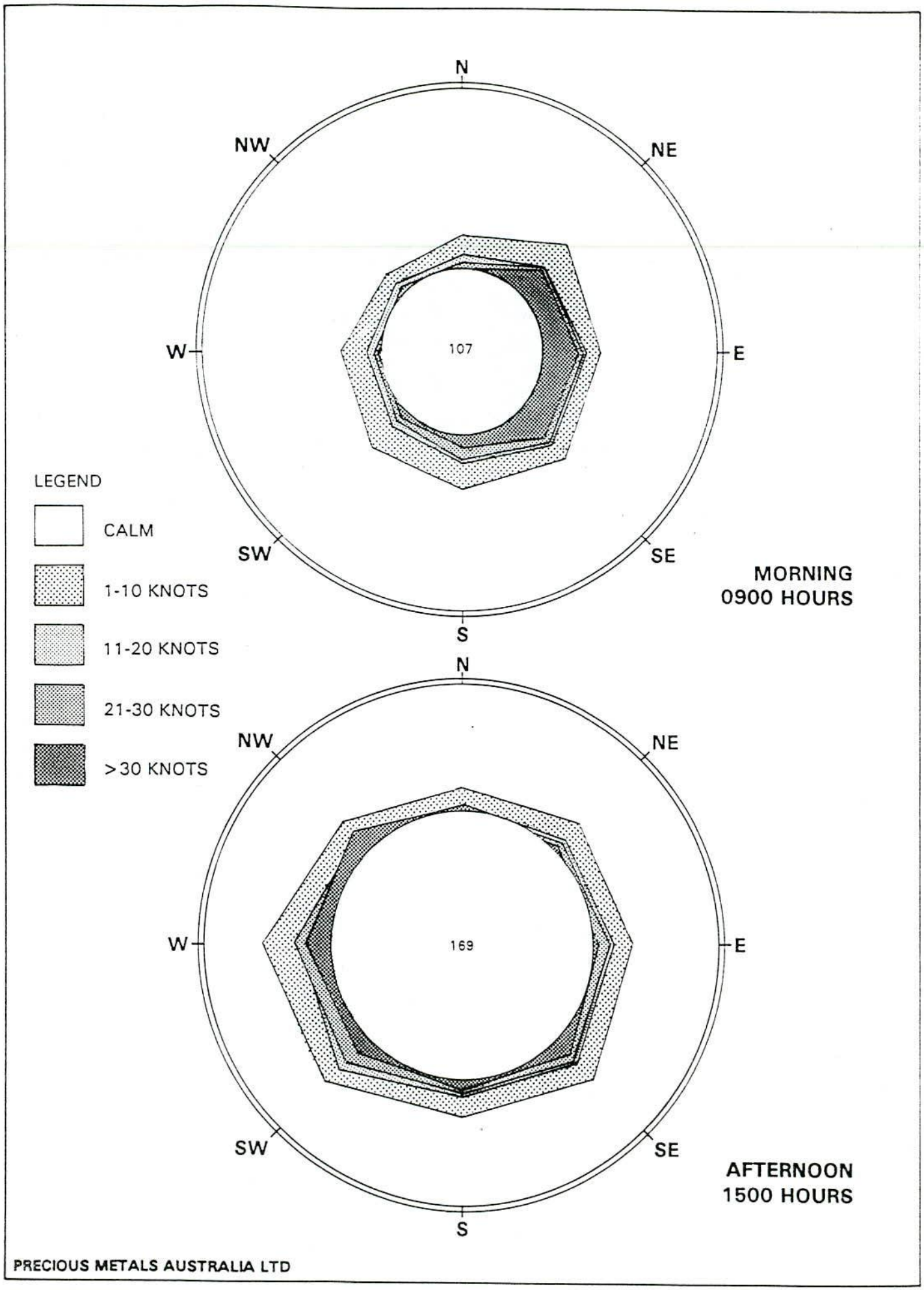


MEAN DAILY MAXIMUM AND MINIMUM TEMPERATURES
AT CARNAMAH



PRECIOUS METALS AUSTRALIA LTD

WEATHER DATA FOR CARNAMAH FIGURE 3.4



WIND ROSES FOR CARNAMAH

FIGURE 3.5

3.2.6 Adjacent Land Use

The quarry site is located approximately 20km north–east of Mingenew which is the closest town. It is in a farming district and properties surrounding the proposed quarry site are used for agricultural purposes with most areas having been cleared of natural vegetation. Principal activities include sheep grazing and grain crop production. The nearest occupied residence is more than 4km away to the west.

The resident current owner of the farming property has permitted exploration drilling and has entered into an Agreement with PMA where PMA has an option to acquire the whole of Victoria Location 9793 which contains the coal quarry site.

The land is currently zoned for rural purposes and it is anticipated that rezoning may be necessary for this proposal to proceed. PMA will apply to the Shire of Mingenew for rezoning of the land if necessary and will also apply to the Department of Mines to convert a portion of their Exploration License to a Mining Lease.

4. THE PROPOSED WAGOO HILLS PROJECT

4.1 The Vanadium Mine at Windimurra

4.1.1 The Orebody

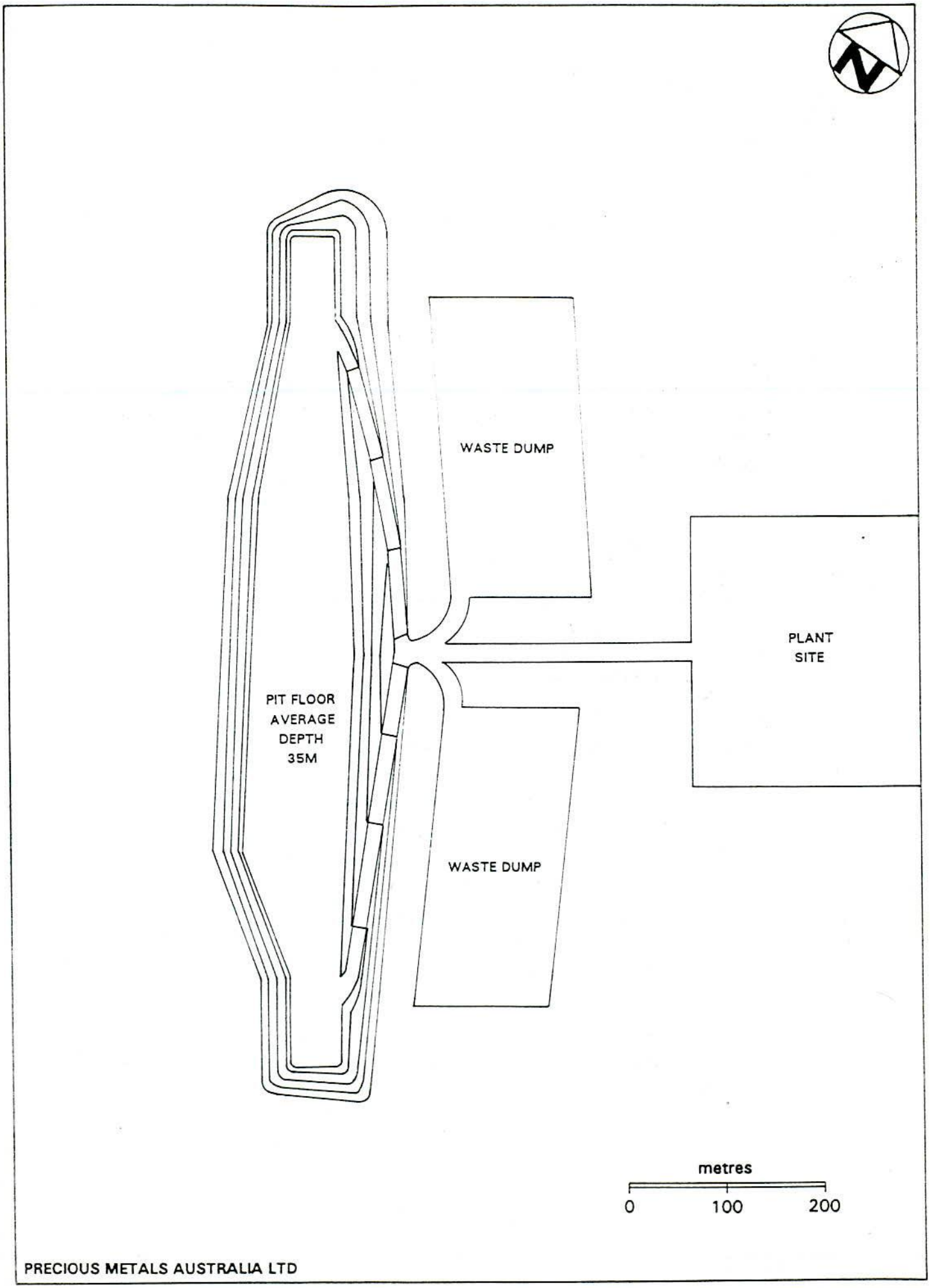
An ore reserve has been determined at Windimurra in accordance with the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves (1989). A resource of 44 million tonnes of free diggable oxidised ore averaging 0.57% vanadium pentoxide (V_2O_5) has been delineated to date. Geophysical, geochemical and geological data indicate that the ore body is continuous and that further drilling has a high probability of substantially increasing the size of the reserve.

4.1.2 Mining Plan

A conceptual mining plan has been developed for the excavation of 1,450,000 tonnes per year of ore for extraction of vanadium pentoxide. Mining methods have been determined after a series of geotechnical, hydrological and engineering studies. It is considered that it will be possible to extract the ore by simple excavation with digging equipment and that drilling and blasting requirements will be minimal. Mining equipment is expected to consist of only 1 excavator and three to five 50 tonne trucks plus a bulldozer, grader and water cart for incidental use and dust control. Mining will be carried out continuously. As the ore is excavated it will be trucked the short distance (approximately 1km) to the process plant and delivered to a coarse ore bin. All excavation operations will be carried out by a contractor.

At this stage, the optimal design for the mining pit has not been determined but a schematic plan for the initial phase of mining is shown in Figure 4.1. It is considered that the general dimensions will be approximately 150m wide by up to 35m deep and will extend approximately 200m in length each year. The surface area affected after the initial 5 years of mining is expected to be in the order of 15ha.

Drilling of the orebody and modelling studies have indicated that the groundwater table is located about 35m below surface. As the maximum depth of the mine is 35m it is anticipated that there will be no hydrological problems and no requirement for dewatering. A bund wall will be constructed around the mined-out areas of the pit to minimise entry of surface water. Inpit water control requirements will thus be minimal.



VANADIUM MINE PLAN **FIGURE 4.1**

4.2 The Process Plant

4.2.1 Construction and Workforce Requirements

Construction of the process plant will take a total of 12 to 16 months from the time of ordering the major process equipment. The construction workforce is expected to peak at about 200.

The construction work will be undertaken by a main contractor and its selected subcontractors. It is expected that these will be Western Australian companies as the construction will not involve any technology or techniques that are not commonly undertaken in the State.

The proponent will endeavour to employ people from the local region wherever possible.

4.2.2 Ore Processing

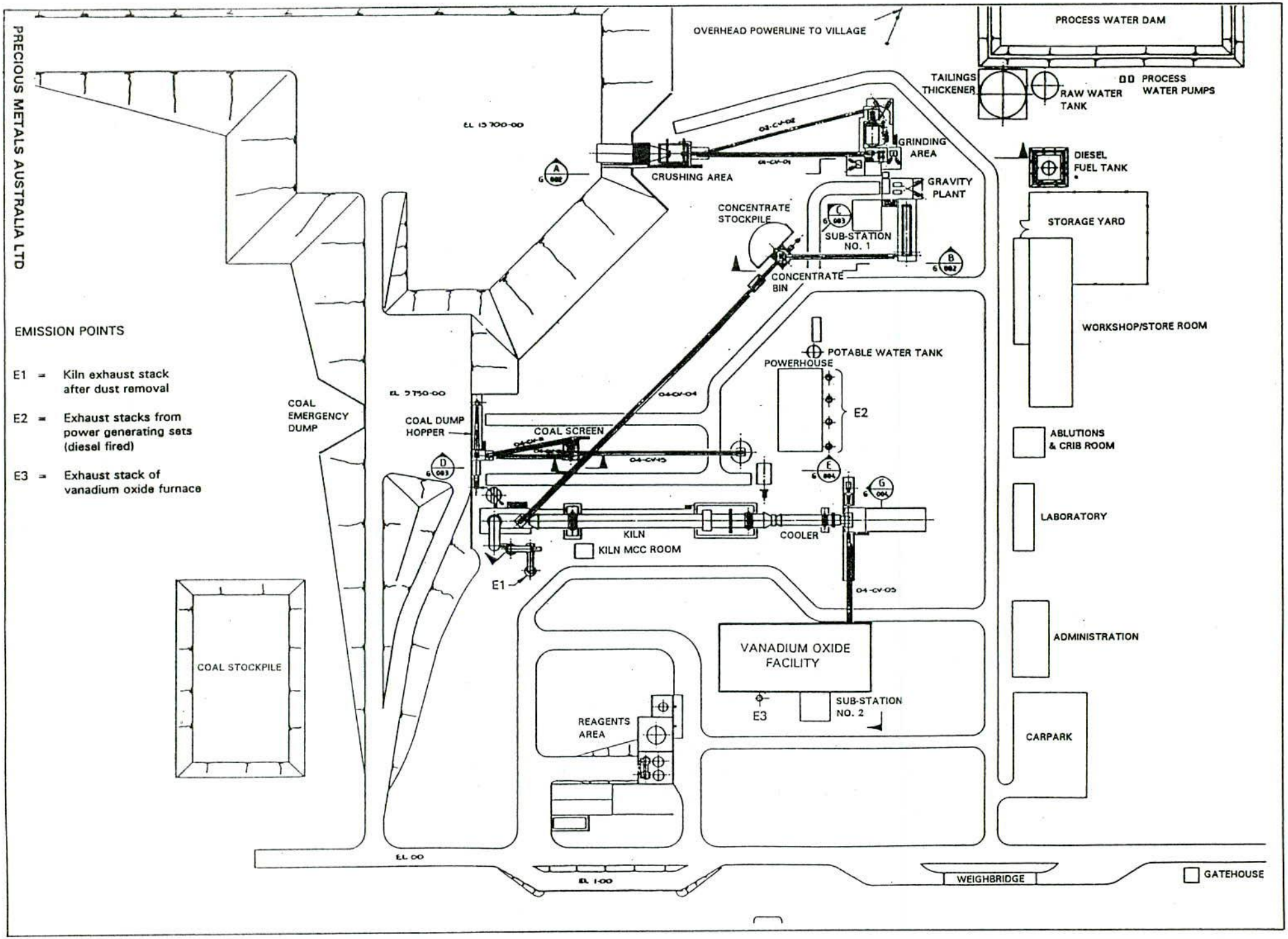
The description of ore processing in this Section should be read in conjunction with the conceptual plant layout and flow chart presented in Figures 4.2 and 4.3 respectively.

At the process plant, ore from the mine is fed into the Primary Jaw Crusher and the crushed material is conveyed into a Grinding Mill where further size reduction of the ore takes place. A small stockpile of uncrushed material will be maintained adjacent to the crusher hopper to ensure continuous feed to the plant.

The finely ground ore is pumped to gravity separation cyclones. The underflow from the cyclones containing the coarser particles is fed into a separation plant where borewater and recycled water are added to the ground slurry.

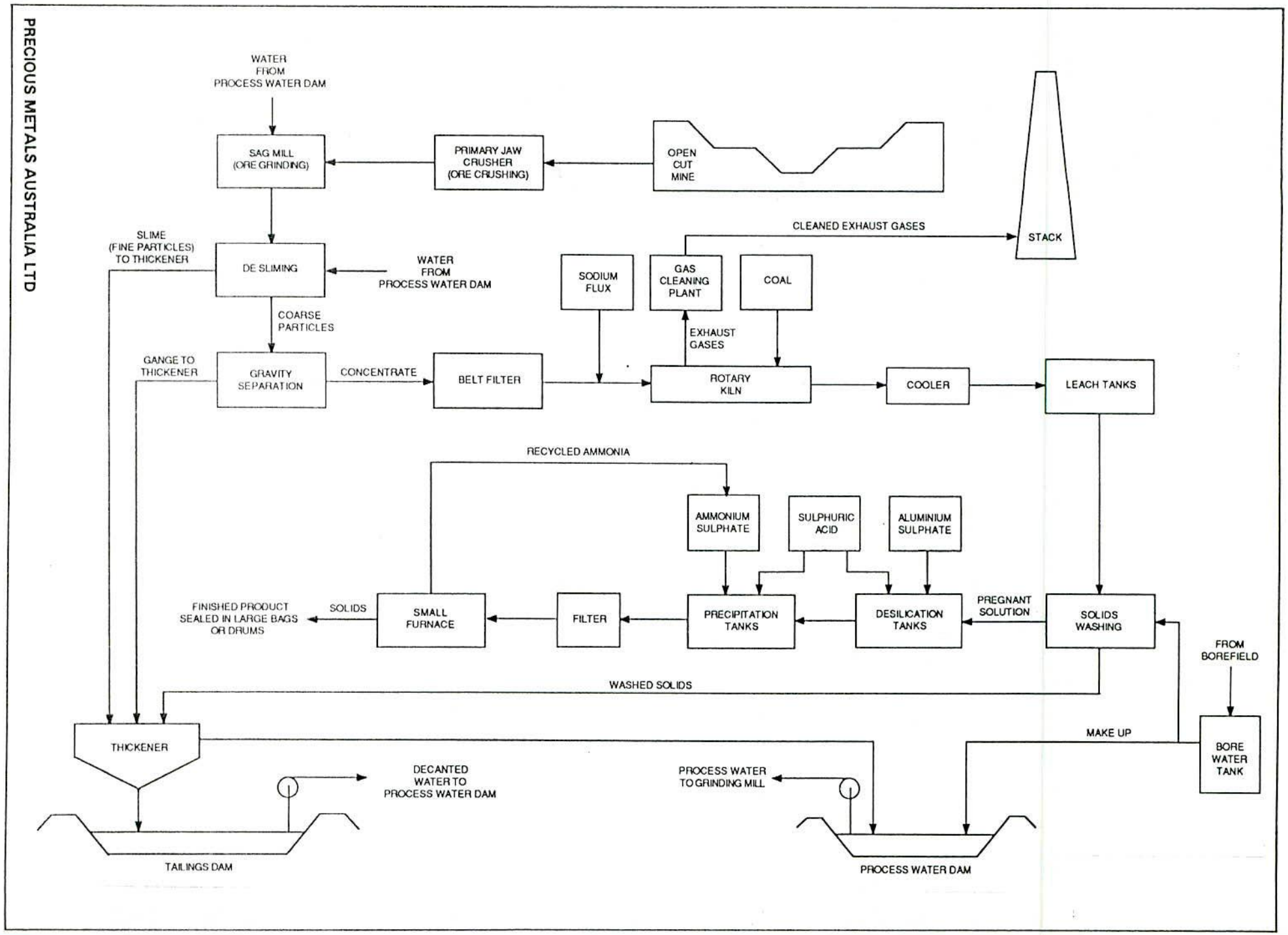
The overflow from the cyclones containing the fine particles, and fine particles from the separation plant, are pumped to the tailings thickener. In the tailings thickener solids are separated from the process water and the thickened slurry is pumped to a Tailings Dam while the recovered process water is piped to the process water dam for re-use in the plant.

The concentrate from the separation plant is fed to a filter to recover as much water as possible and then the filtered concentrate is mixed with a sodium salt flux and fed into a horizontal rotary kiln for heating. The kiln is coal fired.



VANADIUM PROCESS PLANT LAYOUT FIGURE 4.2

PRECIOUS METALS AUSTRALIA LTD



VANADIUM PROCESS FLOW CHART

FIGURE 4.3

The hot material discharged from the rotary kiln passes through a cooler so that heat is recovered and the fuel (coal) requirement is minimised. Cooled material is then fed into leach tanks where the vanadium is dissolved in water. Discharge from the last leach tank is pumped to a thickener. The solids underflow from the thickener are then washed countercurrently with process water to remove all soluble vanadium from the roasted material.

The "pregnant liquor" overflowing the thickener is fed to the desilication tanks. Sulphuric acid is added to control the tank pH and alum is added to remove any traces of silica via the precipitation of inert sodium–alumina silicate. The sodium–alumina–silicates are then filtered from the vanadium–rich solution (pregnant liquor).

The pregnant liquor is then fed to the precipitation tanks where ammonium sulphate is added. Caustic soda and/or sulphuric acid is also added to control the pH. Addition of ammonium sulphate causes an ammonium vanadate (AV) solid to precipitate and this is filtered and fed to small furnaces. The furnaces are heated by LPG or diesel or butane gas. Ammonia gas is driven off during the heating process and is forced through an ammonia scrubber. The ammonia is brought into solution and recycled to the AV precipitation process. The gases drawn through the column are stripped of the ammonia and exhausted via a stack.

Product from the furnaces is discharged in either a granular form (vanadium trioxide V_2O_3) or as a fused flake (vanadium pentoxide V_2O_5). The flake V_2O_5 or V_2O_3 granules are metered into bulkabags or drums, sealed, and removed by forklift to storage.

4.2.3 Inputs To The Process Plant

A number of inputs to the process other than the ore are mentioned in Section 4.2.2. These are described in more detail below.

Coal

Coal from the proponents quarry near Mingenew will be delivered to the process plant at a rate of around 30,000 to 70,000 tonnes per year for use as fuel for the rotary kiln. The coal quarry is described in detail in Section 4.3.

Normally the coal will be fed directly into a storage bin prior to crushing and use but periodically some will be used to build a small stockpile of about 4,000 tonnes to allow for any unplanned interruptions of delivery.

Sodium Salt – Reagent

Sodium salt reagents will be transported to the plant at a rate of approximately 15,000 to 25,000 tonnes per annum. A description of the material is contained in Appendix 10.4.

The reagent will be unloaded into a hopper and transferred to a storage vessel. Periodically the reagent will be directed to a contained long term storage facility of 3,000 tonnes capacity to provide for unplanned interruptions of delivery.

Other Reagents

Other chemical reagents which will be used in the processing operations are listed in Table 4.1 and are described in Section 10.4.

TABLE 4.1
Wagoo Hills Vanadium Project Reagents

Reagent	Form	Usage (t/day)
Flocculant to aid filtering and settling of solids (polyacrylamide)	Liquid or Solid	0.06 to 0.12
Alumina ($Al_2O_3 - 3H_2O$)	Dry Solid	0 to 3.0
Sulphuric Acid (H_2SO_4)	98% Solution	12 to 18
Ammonium Sulphate [$(NH_4)_2SO_4$]	Dry Solid	8 to 12
Sodium Hydroxide (NaOH)	50% Solution	0 to 1.0

Other Fuels

Liquid fuels will be employed at the process plant, principally for the generation of electrical power. The fuel usages are predicted to be:

Fuel	Usage
Butane	1 to 2 tonnes/day
Diesel/Fuel Oil	15 to 25 m^3/day

4.2.4 Outputs From The Process Plant

Product

The process plant will produce a total of 3,700tpa of product in fused flake (V_2O_5) and granule form (V_2O_3).

The products will be packaged on site into sealed 200 litre drums or 1 tonne bulkabags. These bags are currently used in a wide range of industries for transporting bulk products and will be rated appropriately, where applicable, to hazardous goods standards.

Sodium Sulphate

Sodium sulphate (Na_2SO_4) may be produced as a by-product from the process in quantities of up to 20,000 tonnes per annum. This material will be trucked to the Kwinana industrial area in the same trucks that have transported raw bulk commodities from that area to the process plant.

Tailings

The tailings will consist of 1.3 to 1.5mtpa residue from the mineral process plant. This represents the bulk of the material mined. That is, of the 1,450,000 tonnes of material mined, around 3,700 tonnes is extracted as vanadium oxides, the remaining 1,446,000 tonnes is discharged to the tailings dam principally in the same chemical form as mined. This dam will be located approximately 1km north north-east of the process plant (Figure 1.3).

All of the tailings material will be ground to below 500 microns in size and will be pumped to the dam as a slurry with borewater. As much of the water as practical will be recycled to the process plant.

The following properties of the tailings are known at present and further testing is being undertaken:

- Salinity of Process Water 4000–14000ppm TDS, and
- pH of Slurry ex plant 5.0 to 7.0.

Testwork undertaken demonstrates that many of the non–vanadium bearing minerals that comprise a large proportion of the mined material (and directed to the tailings dam during the initial stages of processing), have a strong neutralising capability and the ability to remove solubilised vanadium that may escape from the vanadium leaching facilities.

In addition the ability of the barren or waste material to neutralise the tailings, the waste material exhibits a very low permeability. As a result the dam itself will have low permeability as it is made from this material and the tailings material deposited in the dam will continue to seal the dam during operation.

Final detail of the dam design will be in accordance with the "Guidelines for the Preparation of a Notice of Intent (NOI) and Works Approval Application for New Tailings Dams or Extensions to Existing Dams" prepared by the Mining Engineering Division of the Department of Mines, Western Australia.

A starter embankment will be constructed from waste rock from the mining operations and excavation from the centre of the dam. As the tailings rises within the dam the embankment will be raised by upstream construction methods using waste rock.

The dam itself will comprise two bays to provide flexibility for tailings management and maximise efficiency of beaching of the tailings. Each bay will be approximately 500m x 500m with an initial embankment height of 3m.

The initial embankment will provide 1 years storage. Each year the embankment height will be increased by about 2m to the maximum allowable height as set by Mines regulations. After year 5 a third bay will be constructed. Adequate free board will be maintained to accommodate storm events in excess of the 1 in 100 year event.

The objectives of the tailings dam design are to:

- Minimise environmental impact of the tailings disposal,
- Maximise water return from the deposited tailings,
- Maximise storage capacity of the tailings dam by depositing tailings in a manner to achieve high density tailings, and

- Allow staged embankment construction utilising mine waste.

The tailings dam system incorporates the following features to achieve objectives listed above:

- Decant arrangements to collect supernatant water to return to the plant for use in ore processing. To maximise water recovery the ponds around the decants will be kept as small as possible.

- A spillage trench will be provided either side of the distribution pipe to collect sediment and spillage.

- PMA anticipate that the large fraction of fine material present in the tailings from the process plant will also seal the dam during operation as described above. Therefore it is most unlikely that there will be any leakage, however further work will be undertaken to finalise the dam design and determine a management program to ensure the protection of groundwater quality. This program will be developed in consultation with the Department of Mines.

The tailings dam will be operated in accordance with Mines Department Guidelines. It should be noted that maximum water return is required from the tailings dam as an integral part of ore processing requirements. It is therefore not in the interest of the project to neglect the proper management of this structure.

Tailings will be deposited from numerous spigots around the embankment of the dam, with discharge being controlled to ensure uniform velocity from adjacent spigots. To maximise the storage capacity of the dam, the drying time of the tailings will be maximised between successive depositions.

Daily inspections of all tailings lines and water return lines and embankments will be undertaken.

The tailings dam embankments will be progressively rehabilitated along with the waste dumps as described in Section 5.1.3.

Stack Emissions from the Kiln

The kiln employed for heating the ore will be fired with the coal mined from the proponents quarry at Mingenew. The coal has a very low sulphur content of 0.6%. Off-gas from the Rotary Kiln is drawn through de-dusting equipment which allows heavy dust particles to be collected and recycled into the process. The gases, then drawn through a wet venturi scrubber (the second stage of off-gas cleaning) where finer dust particles are wetted, reslurried, and also returned to the process. The scrubbed (cleaned) gases are then blown to a tall stack for venting to atmosphere. The

vented gas will contain sulphur dioxide, nitrogen oxides, and low concentrations of residual particulate matter.

Emissions from the Power Plant

Exhaust gases from the power plant will be equivalent to similar scale generating plants throughout the State operating on diesel or medium fuel oil.

The installed capacity of the powerhouse will be around 6 to 7 MW, however the average running load is anticipated to be between 3.7 and 4.7 MW.

Emission from the Vanadium Oxide Furnace(s)

The small furnace(s) processing around 0.5tph of vanadium oxide will emit a waste gas containing 0.03 to 0.06 tonnes of ammonia (NH_3) per hour. The waste gas will be scrubbed to remove dust and the ammonia to below the levels determined by the Department of Mines. The ammonia will be recycled within the plant.

4.2.5 Transportation

Total Transport Requirements

The Wagoo Hills Vanadium Project will require transport of a range of raw materials, the principal of which are listed in Table 4.2.

TABLE 4.2
Wagoo Hills Vanadium Project Raw Materials

Raw Material	Annual Requirement	Source	Distance to Windimurra	Form of Material	Trucks per Year
Coal	30,000–70,000t	Mingenew	360km	Bulk	430–1,000
Diesel Fuel	6–10 million litres	Geraldton	425km	Bulk, Liquid	90–155
Sodium Salt	15,000–25,000t	South–West WA	700–800km	Bulk, Wet, Filter Cake	270–460
Sulphuric Acid	4,400–6,500t	Kwinana	690km	Bulk, Liquid	175–260
Ammonium Sulphate	3,000–5,000t	Kwinana	690km	Bulk, Granular	55–90
Alumina Trihydrate	0–1,000t	Kwinana	690km	Bulk, Powder	0–18
Butane or LPG	360–550t	Kwinana	690km	Bulk, Liquid	20–30
Sodium Hydroxide	0–400t	Kwinana	690km	Bulk, Liquid	0–16
Flocculant	20–40t	Kwinana	690km	Powder x 1t containers	N/A*

* Note: The small shipments of flocculant will be transported on trucks bringing other materials (such as spares) to site.

Vanadium oxides and sodium sulphate cake will be produced from Wagoo Hills and backloaded to Fremantle. Details of these products are provided in Table 4.3.

TABLE 4.3
Wagoo Hills Vanadium Project Products

Product	Annual Production	Port of Export	Distance from Windimurra	Form of Material	Trucks per Year
Vanadium Oxides	3,700t	Fremantle	676km	1 tonne bulkabags	Backload
Sodium Sulphate (Optional)	6,000t to maximum 20,000t	Perth	660km	Bulk powder	Backload

Coal

The coal will be transported from the proponent's coal quarry near Mingenew to Wagoo Hills by a trucking contractor. There are no other transport options.

It is envisaged that the truck configuration will be either:

- "B–Double", or
- Road Train (double trailer combination), or
- Road Train (rigid prime mover & 2 trailers).

The trailers will be either "sidetipping", "belly dumpers" or "back tippers". The trucking operation will be continuous with an average of 2 to 3 trucks per day undertaking the journey from Mingenew to the process plant.

The trucking contractor will comply with all trucking regulations laid down by the Mains Road Department, the WA Department of Mines, and the Local Shires through which the transport route passes.

Sodium Salt

The sodium salt reagent will be transported from production sites south of Perth in single trailers via main roads to the Apple Street Roadtrain Assembly Yard at Middle Swan, where they will be assembled into roadtrains (double configuration) for haulage to the process plant. Most of this transport will be on the Great Northern Highway.

This reagent is classified as hazardous and therefore will be safely transported in purpose-built trailers as discussed in Section 5.2.3. Each trailer will be capable of containing 20t to 27t of material.

Other Reagents - Hazardous Goods

Other hazardous goods that will be transported to site will be butane, sulphuric acid and caustic soda. These are fuels and chemicals that are currently transported in bulk tankers throughout Western Australia in very large tonnages and transport to the process plant will be in accordance with the well established current safe practices. (See Section 5.2.3.).

Non-Hazardous Goods

The non-hazardous goods, viz; diesel fuel, flocculant (liquid or solid); alumina (bulk solid) and ammonium sulphate (bulk solid) will be transported in either bulk transport trailers or liquid containers in accordance with current safe practice for goods of this nature in Western Australia.

Transport Routes (See Figure 4.4)

Reagents & Consumables from Kwinana/Perth

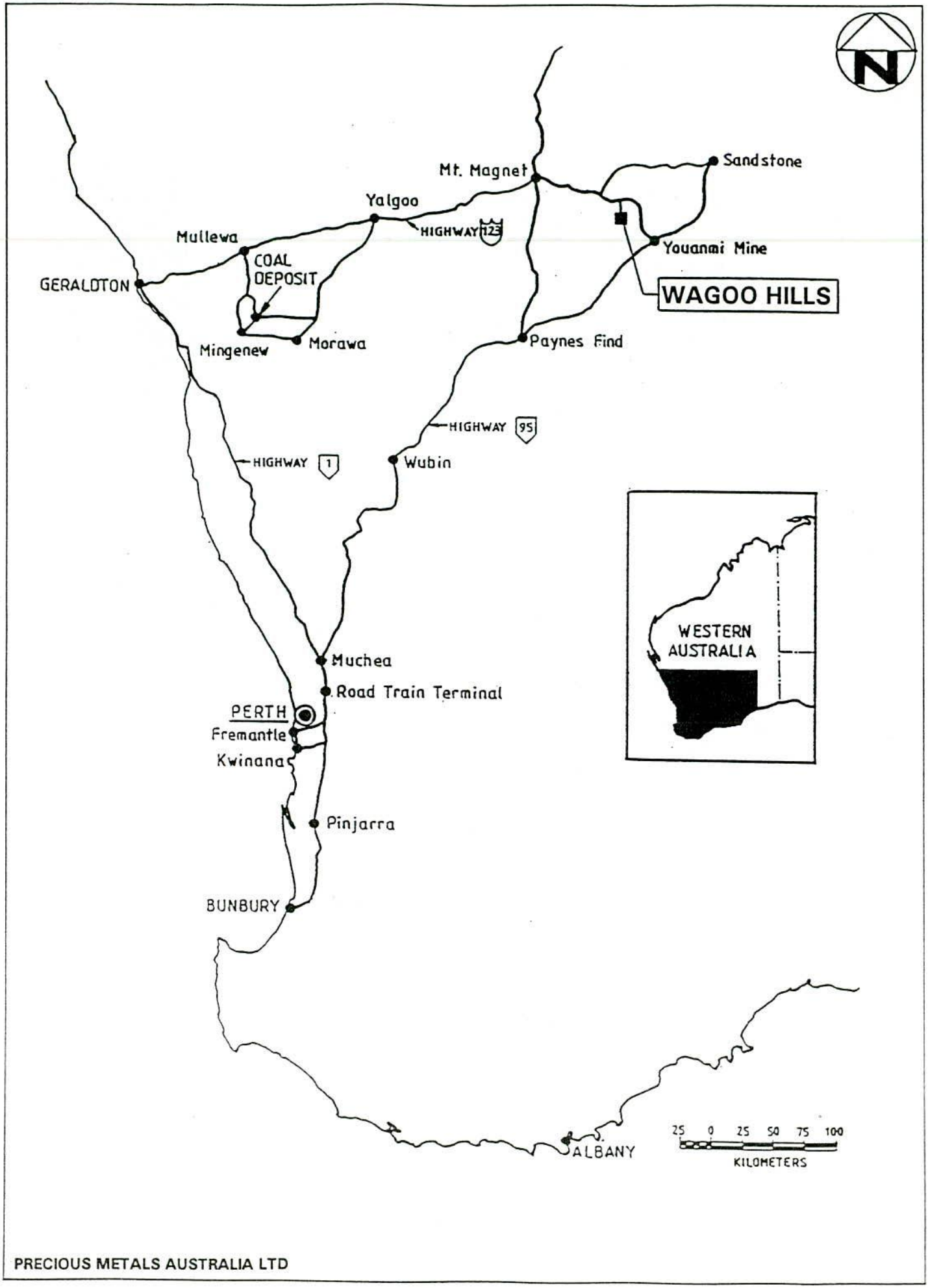
Sodium reagent, aluminium trihydrate, ammonium sulphate and all other raw materials and consumables purchased in the Kwinana and Perth industrial areas will be transported via the Leach and Roe Highways and then via the Great Northern Highway to Mt. Magnet. From Mt Magnet the rigs will travel on route S80 towards Sandstone for approximately 50km before turning E-SE onto the road leading to the Youanmi Mine. The rigs will then turn off the Youanmi Mine Access Road and head south on the Wagoo Hills access road. This route has been discussed with the Main Roads Department, Water Authority and Local Shires and has been selected by PMA as that route that minimises disturbances to communities and limits the risk of pollution of water resources.

Coal from Mingenew

Coal from Mingenew will be transported to Wagoo Hills via Yalgoo and then via Highway No.123 to Mt. Magnet before heading to Wagoo Hills.

Diesel from Geraldton

Diesel will be trucked from Geraldton via Highway No.123 to Mt. Magnet and then to Wagoo Hills.



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VANADIUM PROJECT TRANSPORTATION ROUTES FIGURE 4.4

Product from Wagoo Hills

Vanadium products and sodium sulphate will be transported to Fremantle and Perth respectively, following the route described for reagents above. The bulkabags of vanadium products will be stored in shipping containers at the Port of Fremantle prior to export.

Section 5.2 discusses the environmental issues and proposed management strategies relating to these commodities.

4.3 The Mingenew Coal Quarry

4.3.1 Geology

The coal quarry will be developed on part of the Permian Irwin River Coal Measures.

The coal measures are dominated by finely laminated carbonaceous and micaceous siltstones with interbeds of fine to coarse sandstone. Five extensive coal seams have been defined by PMA and two of these are considered to be economic. These seams strike at approximately 350° to 355° and dip at about 7° to the east. Drill hole data suggest that the strike of the seam is consistent and that no major structural discontinuities or flexures exit. The characteristics of the coal are provided in Table 4.4.

The Irwin River Coal Measures have been known to contain well developed coal seams since 1836. Coal from this area was used on a trial basis to fuel a steam engine that ran from Perth to the mid-west in the early 1900's and small open cut coal excavations from this era can still be seen at a location known as Coalseam Park (Irwin River and Reservation of Natural Features Reserve A900) some 10km north of the PMA coal quarry area.

TABLE 4.4
Mingenew Coal Analysis

Rank	Sub-Bituminous
Inherent Moisture	20.2%
Ash	16.1%
Volatile Matter	33.4%
Fixed Carbon	30.3%
Specific Energy (Air Dried)	18.5 MJ/kg
Total Sulphur	0.6%
Relative Density	1.45

4.3.2 The Quarry Operation

The site of the proposed coal quarry is on a Perpetual Lease which is currently used for growing grain crops. In the quarrying operation the topsoil will be removed over the area of the mine to a depth of 1-2m and stockpiled separately for later replacement. Excavation will be by conventional open cut techniques and the overburden will be replaced into the quarried area (backfilling). The stockpiled topsoil will be respread onto the backfilled section of the quarry and the area will be progressively returned to grain growing.

Excavation will be conducted on a day shift only basis from Monday to Saturday and will be carried out by one small excavator. Haulage will involve up to three 25 or 35 tonne trucks. Approximately 50% of the overburden material will require blasting for excavation and 100% of the coal will be drilled and blasted before excavation. Excavation will progress from the east to the west. The average overall pit slope angle will be 45° and the haul road will have a 1-9 gradient.

The annual production of 30,000 to 70,000 tonnes of coal will require the removal of approximately 300,000 to 650,000m^3 of overburden material.

To begin the excavation sequence, a box-cut will be excavated in the north-west corner of the deposit where the stripping ratio is the lowest. Approximately six months of coal supply will be exposed in the box-cut. The exposed coal area extends 100m east and 300m south. This excavation will require the removal of approximately 470,000m^3 of overburden including a haul ramp to the surface. A conceptual quarry plan is illustrated in Figures 4.5 and 4.6.

All the initial overburden material will be deposited adjacent to the excavation. At a later stage of the operation, this overburden material will be dumped back into the worked out area of the pit. Deeper material will also be hauled to the outside dump but will be re-deposited onto the pit floor once the bottom coal seam has been removed.

After the first cut has been completed to the eastern boundary limit, the next 20m strip will be excavated.

An area of approximately 350m x 350m will be allocated for the overburden dump and the dump will also be 20m high comprising two 10m lifts with 5m berms between the lifts.

The coal will be hauled from the pit to a stockpile located adjacent to the ramp exit. If required, it will then be crushed in a single jaw crusher to -150mm and then deposited on the final production stockpile.

In addition to the excavation equipment, auxiliary equipment comprising 1 front-end loader or equivalent, 1 bulldozer, 1 grader and 1 water truck will be required. The front-end loader will mainly be used in the coal stockpile/crusher area while the bulldozer will be used in the pit floor for clearing and cutting ramps. A water truck will also be used to wet haul roads in order to control dust.

A small site office store will be established on site for company personnel use and a workshop and fuel storage will be provided for the earthmoving contractor.

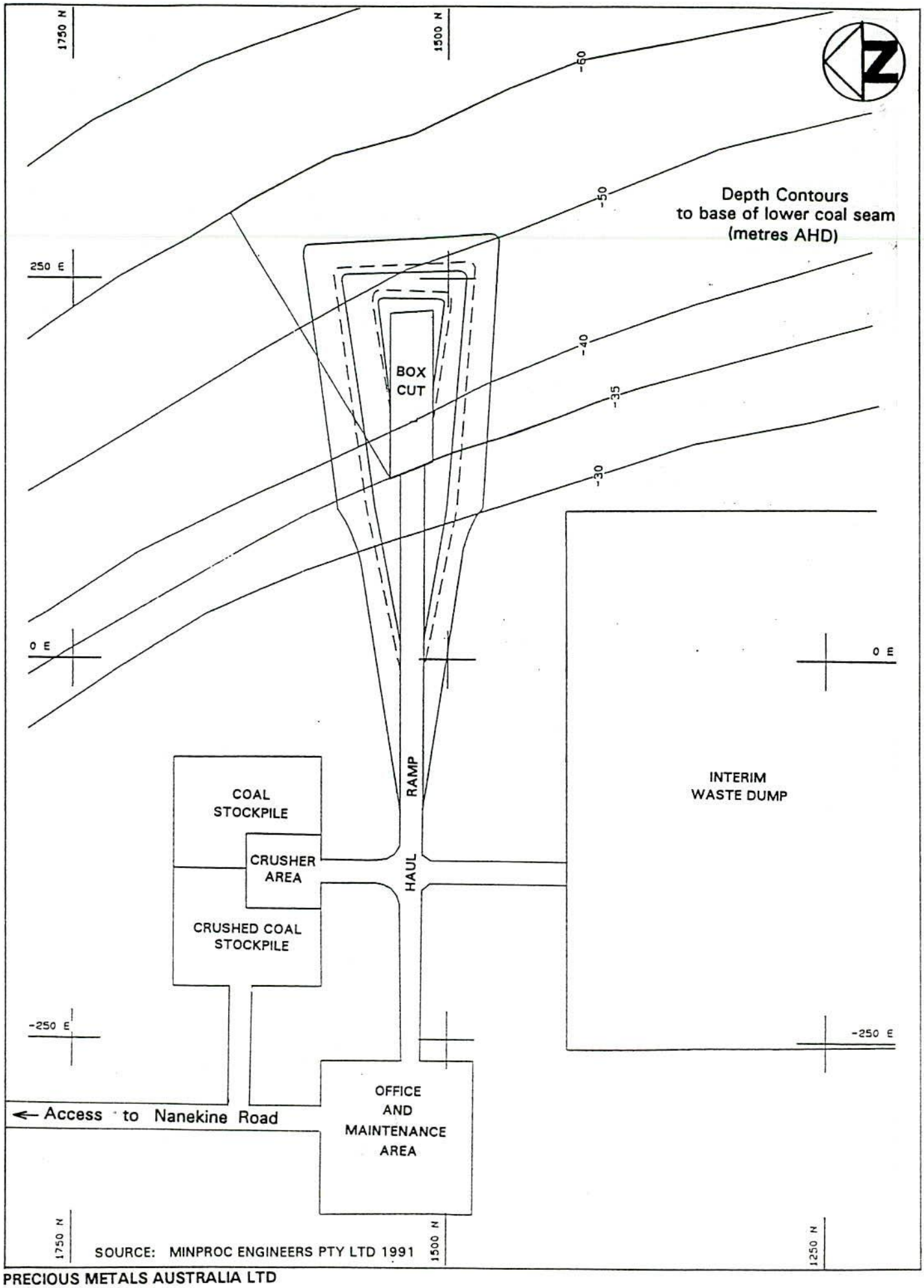
4.4 Infrastructure at Windimurra

4.4.1 Workforce Accommodation and Other Infrastructure

The location of the village facilities are shown in Figure 1.3. The proposed site was selected after considering access, wind direction, distance from the mine and plant, and topographical features. The construction camp will also be located at this site.

The location is in the north-west corner of a rocky outcrop known as the Windimurra Hills, over 2km in distance from the vanadium process plant and mine. These low hills provide a degree of screening from the mine and process plant operations.

The accommodation facilities will be based on pre-fabricated and site assembled houses for senior staff living permanently on site and nearby single persons accommodation comprising 12 x 6 bedroom houses. Central to this accommodation are recreation and messing facilities. Each house will be connected to a septic tank facility.



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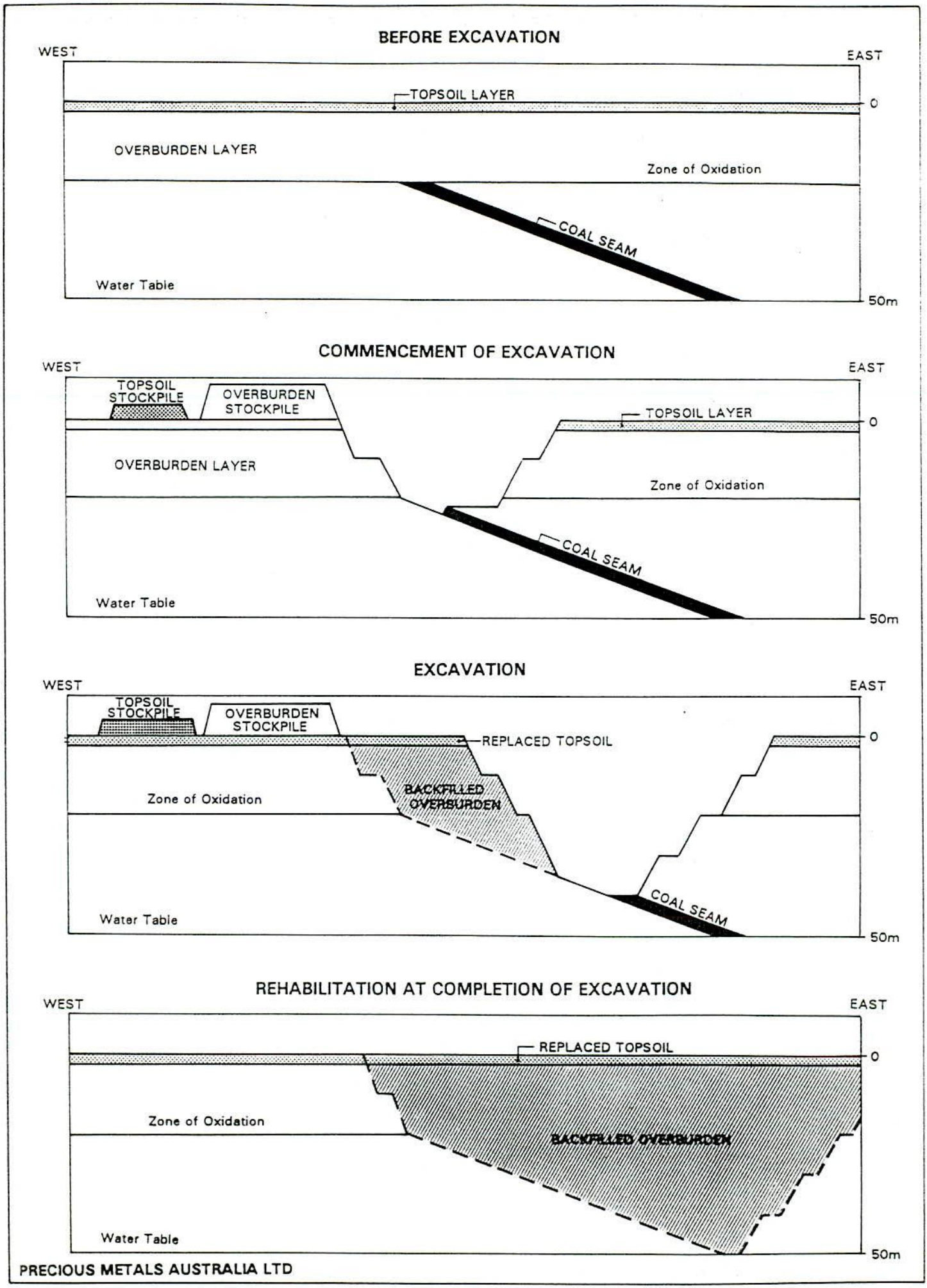
COAL QUARRY PLAN FIGURE 4.5



SCHEMATIC CROSS-SECTION OF COAL QUARRY DEVELOPMENT AND REHABILITATION

FIGURE 4.6

The village will be capable of accommodating the entire workforce of approximately 100 persons. (The average number of persons on-site will be less at around 65 with the remainder on rostered days off.)

Shift workers will work two weeks on then will have one weeks leave. Recreation facilities will include a wet bar, BBQ facilities, tennis courts, swimming pool, retransmitted satellite TV/radio services and exercise facilities. Telephone service will be provided by satellite link.

4.4.2 Water

The processing plant is expected to require around 3,000m^3/day of water.

Water will be supplied from a borefield extracting local saline groundwater located in a large alluvial paleodrainage system lying about 4 km north east of the mine site (see Figure 1.3 and Section 3.1.3). The borefield will comprise 5 bores each producing 600 to 700m^3/day and water will be delivered to the plant via a collector pipeline, dam and transfer pipeline. The 200mm Nominal Bore collector pipeline will be buried in certain places to prevent alterations to the surface hydrology in the drainage flats and in order that stock movements through the paddock will not be obstructed.

Two to three additional bores may be required to supply the total water demand at start-up until recycling of water is fully established. These additional bores would also be used as stand-by's in case of shut down of any of the main production bores.

Measures will be taken within the plant to conserve water as much as possible. These measures will include:

- recycling of water from thickeners and filters;
- thickening of tailings prior to disposal;
- recovery of water from the tailings dam; and
- inspections and monitoring all pipelines for leakage.

The potable water requirement for the workforce is predicted to be about 132m^3/day. This will be obtained by treating process water using the reverse osmosis method or by construction of bores into bedrock aquifers that contain fresh water.

4.4.3 Power Supply

A diesel fired powerstation will be installed to provide power for the process plant and village. The powerstation will consist of 5 or 6 internal combustion diesel engines driving alternators. The powerstation shall be of similar scale to existing powerstations throughout Western Australia with an installed capacity of around 6 to 7 MW, however the average running load is anticipated to be between 3.7 and 4.7 MW.

4.4.4 Airstrip

The mine site will be serviced by a registered 1,400m all weather airstrip located some 4km from the plant and the project's access roads will be upgraded to a 6m wide all weather lateritic gravel road. If need be, construction gravel will be sourced as close as possible to these areas as described in Section 5.2.1.

5.0 ENVIRONMENTAL ISSUES AND MANAGEMENT

5.1 The Vanadium Mine at Windimurra

5.1.1 Site Disturbance

The vanadium mine site has been used for grazing sheep for many years although it mostly consists of hills and slopes of low pastoral value. As a result of past intensive grazing, the vegetation in the area is disturbed and is significantly different from the original vegetation in terms of species composition. The vegetation is also typical of that which occurs over very large areas in the Mt Magnet region and no declared rare flora populations are known from the general area of the pastoral lease.

The actual area disturbed by the project will be small in both absolute terms and relative to the total area of the Pastoral Lease. In the first 5 years after commencement the surface area directly affected by all site works is expected to be less than 20ha including roads. If the mine operates for 30 years the total area affected will be in the order of 120ha. Removal of vegetation will be kept to the minimum required for safe mining practices and the shallow surface soils will be removed and stored separately for use in rehabilitation.

Therefore, the impact of the proposal in terms of site disturbance, including removal of indigenous vegetation and reduction in the area available for pastoral activities is not considered to be significant.

The impact of the fauna also will not be significant. There will be local impacts initially due to destruction of habitat and relocation of mobile species into adjacent habitats but these impacts will be minimised by the staging of clearing and by limiting new road and track development.

5.1.2 Run-off

The rainfall data for Mt Magnet when extrapolated indicates that run-off from the minesite is only likely to occur after significant rainfall events (Sections 3.1.1 and 3.1.3). These events have a relatively low frequency of occurrence. Run-off and sediment transport into natural drainage channels will occur on the area surrounding the minesite. Run-off management will ensure that there will be no significant additional sediment transport from the mining operations.

Prior to the commencement of mining a surface water drainage management plan will be developed in consultation with the Department of Mines and the Department of Agriculture in order to prevent soil erosion. The need for sediment traps will be determined at that time. The pit will be adequately bunded prior to the commencement of the mining in order to prevent run-off entering it.

5.1.3 Overburden Dumps and Rehabilitation

The mining plan is aimed at achieving a maximum overburden to ore ratio of 1 tonne overburden to every 12 tonnes of ore mined. This ratio is very low for an open cut mining operation and means that a total of only about 120,000 tonnes of overburden will be generated each year. The overburden material will be used to upgrade roads and to progressively construct cells for the tailings dam until that dam reaches the size necessary for maximum production levels from the process plant. After this the overburden will be formed into one or two waste dumps adjacent to the road connecting the mine and process plant (Figure 4.1).

The overburden (waste) dumps will be designed and rehabilitated to the requirements of Government Agencies. The present requirements are specified by the "Guidelines for Waste Dump Design and Rehabilitation" of the Department of Mines. These Guidelines may be considered the minimum requirements for waste dumps in the future. Basic design criteria specify that:

- the height, area and shape of the waste dump should be designed having regard to the area of land available, the general topography of the area and the vegetation in that area.
- all completed surfaces of the dump should be stable and able to resist long term erosion,
- stockpiled subsoil and topsoil, should be spread on all completed surfaces and revegetated with suitable vegetation,
- the completed external slope should not exceed 20 degrees from the horizontal, and
- drainage should be constructed to handle heavy rainfall events based on at least a 20 year return period and should be directed away from nearby mines.

The Guidelines relating to the rehabilitation of overburden (waste) dumps include a requirement to consult with relevant Government Agencies including the Department of Agriculture and to carry out ongoing assessments of the success of rehabilitation so that an optimal strategy can be developed. Apart from the design criteria specified above it is expected that the waste dump will include the following measures to assist rehabilitation:

- Early covering by any available topsoil to prevent decay of seeds and micro-organisms in stockpiled material.
- Initiation of rehabilitation at an early stage of waste dump formation.

- Terracing of the dump as an erosion control measure with terraces sloped back into the dump.

- Spreading of any vegetation removed from the mine site onto the dump both to promote revegetation and as an erosion control measure.

- Deep ripping along the contour at 1m intervals after placing of any topsoil to increase penetration of rainfall.

- Use of seeds collected from local plants.

In order to implement the above measures, PMA will develop a specific waste dump rehabilitation plan which will involve the systematic stripping and stockpiling of vegetation and topsoil from the mine site and its progressive re-spreading on the waste dumps taking account of seasonal factors which are likely to favour seed germination and plant development.

5.1.4 Noise and Dust

The limited nature of the equipment required for mining, the lack of blasting, the position of the mine with respect to the village and the existing Windimurra homestead, and the generally unpopulated area in which the mine is located, all indicate that there are not likely to be any significant noise and dust issues associated with the mining operation. The control of noise and dust abatement will conform to statutory requirements of the Mines Regulations Act 1946 and Regulations and to the directions of the Department of Mines.

The only operational noise associated with the mine will be that generated by the earthmoving/ mining equipment. All operators and other personnel near this equipment will be required to wear hearing protection devices unless they are in cabins with acceptable noise levels.

The buffer distance between the mine site and the nearest station homestead is some 4km. The accommodation site is located approximately 2.5kms to the north-west of the mining activities. This site is also separated by a range of hills which are up to 50 metres above the general ground level at the accommodation site. Given the location of the site, and the prevailing wind directions, the volume of noise generated by the project is unlikely to be significant outside the immediate vicinity of the mining operations, and particularly at the station homestead and accommodation site.

There may be a temporary localised impact on faunal populations and distribution, as shown from studies of other mining sites, however the only fauna which respond to noise are large mobile species such as kangaroos and birds which will avoid the area. It is considered that no significant impact will occur to the biota through noise.

Dust may be generated by the mining and haulage of ore and also by the movement of vehicles on unsealed roads. As the vanadium in the ore is in an insoluble state and is intrinsically mixed with magnetite, dust particles from the mining operations are not toxic. Normal dust suppression procedures will be adopted in order to reduce the emissions of excessive dust. These include the use of water sprays on stockpiled material, watering of roads in dry conditions, and the minimisation of exposed areas of soil by early implementation of rehabilitation as required by the Department of Mines.

5.1.5 Weed Control

The Project site lies within a Saffron Thistle quarantine area (Appendix 10.2). Saffron Thistle (*Carthamus lanatus*) is a declared noxious weed of both crops and pastures in Western Australia as it discourages grazing, contaminates wool and leads to dockage of wheat containing the seed. The thistle reproduces from seed contained in the topsoil where it may remain dormant for several years. Movement of topsoil containing the seed may spread the weed to other uninfected areas.

Saffron Thistle is reported to occur on the Pastoral Lease, plants were observed on the drainage plains where water relations favour its presence. There are no Saffron Thistle plants on the mining area. Nevertheless, no topsoil will be removed from the general location of the mine and overburden dumps. If Saffron Thistle is encountered during the mining operation, vehicle movements will be restricted to uninfected areas and specific management advice will be sought from the Department of Agriculture.

5.2 The Process Plant

5.2.1 Construction

The process plant will be located adjacent to the mine site and in similar vegetation as described for the pit. It will occupy a small area of approximately 6ha including stockpiles. The environmental impact associated with site disturbance for construction of the plant is therefore not considered to be significant.

The construction camp will be situated at the permanent village location. The Company employment policy will prohibit firearms and pets on the site during both the construction and operational phases of the project.

Construction gravel for building foundations and concrete works will be sourced as close as possible to the process plant area. However, PMA will ensure that any small pits developed to obtain this material will be in areas acceptable to all interested parties, including the pastoralist, the Shire of Mt. Magnet, and all relevant government departments.

During construction, contractors will be controlled to that ensure dust is minimised and dust suppression measures will be undertaken, including restrictions on site travel to ensure minimal disturbance to areas which will not form part of the project.

5.2.2 Occupational Health

General

The process plant will be designed and operated to ensure very high occupational health standards are achieved with respect to noise, dust and the handling of reagents and compounds. The project involves the use of many chemicals commonly employed in mining and industrial projects throughout Western Australia. The only chemicals that are not already handled in significant quantities in Western Australia are vanadium compounds.

This section includes a comprehensive review of the planned methods to prevent occupational health concerns relating to vanadium compounds, the other hazardous materials and noise.

Standards for Vanadium Compounds

The Mines Regulation Act 1946 and Regulations stipulate that the vanadium content in respirable dust per cubic metre of air shall be not more than 0.05 milligrams. The regulations also stipulate that the total dust per cubic metre of air shall be no more than 10 milligrams.

Control of General Dust

The initial phase of ore processing is the crushing, grinding and beneficiation circuit. These facilities are common in many mineral processing plants and in the present project do not present any unusual occupational health problems. Dust generated at the crushing plant will have a low percentage of vanadium and the vanadium is in a form which is harmless. Excessive total dust will be avoided by the use of:

- Water sprays in the crusher loading area,
- Covered and skirted conveyors at ore transfer points, and
- The installation of a positive suction (fan driven) dust collector at the crusher station.

These features are illustrated in Figure 5.1.

There will be minimal dust generated in the grinding and beneficiation facilities as these facilities operate with slurries (i.e. ore mixed with water).

Also no harmful reagents will be added in these stages of processing. The only reagent consumed is a synthetic flocculant used to promote settling and filtering of the solids. This material is harmless and consumed at very low dose rates of around 20 to 40ppm (parts per million).

Control of Vanadium Dust and Fume

Stringent occupational health precautions are employed in the processing areas after the beneficiation circuit from roasting of the concentrate through to production of vanadium oxide. In particular there exists the potential for vanadium sickness or "Green Tongue" in the final step of the process where vanadium oxide is formed and packaged. This final step is identified as the V_2O_5 Dust Containment Area on Figure 5.2 around the "Small Furnace".

Exposure to vanadium pentoxide dust and fume in excessive levels can cause mild to moderate respiratory distress and mucosal irritation. These effects including chest pains, sore throats and eye irritation and colouring of mucous areas such as the tongue can last for several days after exposure. Severe effects, however, have not been reported and the symptoms are reversible. (Source: October 1990 Draft – Toxicological Profile for Vanadium and Compounds by Clement Associates for U.S. Public Health Service Agency for Toxic Substances and Disease Registry.)

The commonly known symptom called "green tongue" is caused by the vanadium pentoxide dust settling on the tongue and discolouring the tongue and other mucosal areas.

PMA has designed the kiln feed, off-gas, and discharge systems to ensure the working environment around this area will contain less than 10mg/m3 total dust, and less than 0.05mgV/m^3. Dust control measures include:

- A two stage gas cleaning and scrubbing system,
- Sealing of all joints and the installation of dust hoods and dust suppression devices,
- Operation of the kiln at "negative" pressure so that air is drawn into the kiln rather than the kiln atmosphere blowing out of the kiln, and
- Intensive operator training in all aspects of kiln operation so that the working environment is maintained at a high standard and any potential problems are

quickly identified by monitoring and appropriate actions taken to remedy the situation.

In the final stage of processing and packaging the potential hazards presented by vanadium oxides will be managed with no effects on workers by:

- correct equipment design,
- correct operational procedures, and
- adequate operator training.

PMA will ensure that vanadium dust is controlled by incorporating dust extraction and collection equipment, and enclosing this section of the plant in a building so that the area can be well maintained and outside influences such as wind do not affect good operation. PMA will also develop an effective operation training and awareness programme to ensure that the plant is well operated and maintained and any potential problems are quickly identified and rectified.

The final product of fused vanadium flakes (being around 2.5cm by 2.5cm in size) is not a hazardous substance as it is no longer in a respirable form.

PMA's staff and engineers have visited most of the World's vanadium mines and plants and viewed the safety precautions employed there. Vanadium is routinely produced in these plants often close to residential areas without any health problems occurring. Dust extraction and other precautions proposed by PMA are similar to those employed successfully in plants, for example in West Germany and Austria, where environmental standards are high.

Ammonia Emissions

The final stage of vanadium oxide production involves the heating of an ammonium vanadate salt to "drive-off" ammonia. PMA will ensure that workers are not exposed to excessive ammonia fumes by the installation of adequate ammonia extraction equipment and ammonia scrubbing equipment.

Handling of Sulphuric Acid

The project will consume in the order of 4500 to 6500 tpa of 98% Sulphuric Acid. PMA will ensure that the sulphuric acid handling, pumping, dosing systems and operational procedures meet the current well-established guidelines for the handling of this widely used chemical.

Coal Dust

The principal sources of coal dust are the coal stockpile, coal crushing and coal conveying facilities. Dust generation from the stockpile will be minimised by water spraying and dust from crushing and conveying equipment will be minimised through design measures such as;

- enclosure of conveyors at transfer points, and
- the installation of dust suppression devices.

Sodium Salt Reagent Handling

The sodium salt reagent shall be principally handled as a slurry and there will be little possibility of airborne dust. Dust will only occur as a result of two circumstances:

- Spillages being left to dry out – this will be avoided by good housekeeping with immediate removal and washdown of any areas of spillage, and
- During the kiln operation when the salt dries out during heating, upon reaching temperatures of over 300°C the sodium salt becomes harmless sodium carbonate.

Any dust generated in the kiln that is extracted through the exhaust system will be removed by the water scrubber. The design and proposed operating techniques therefore will prevent the salt from causing any occupational health problems.

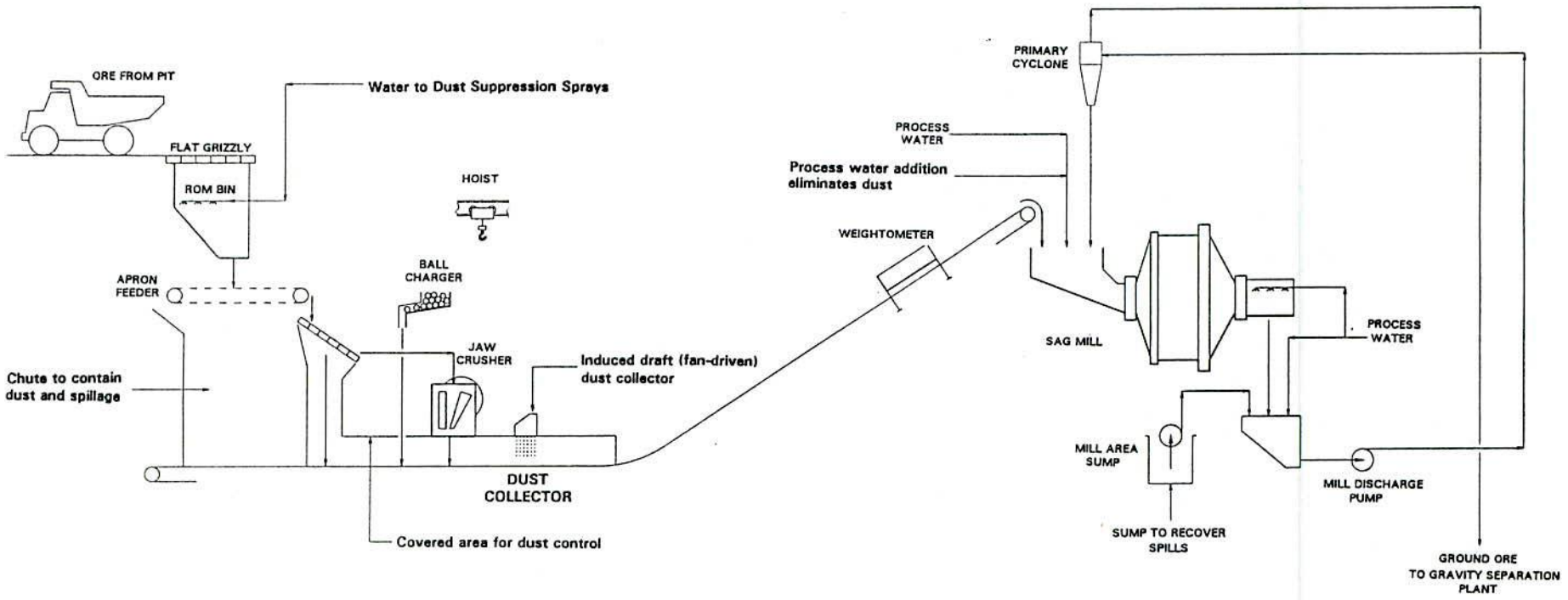
5.2.3 Transport, Storage and Handling of Reagents, Fuels and Products

General

The transport of all hazardous materials will be carried out in accordance with the provisions of the Explosives and Dangerous Goods Act 1983 and the Australian Code for the Transport of Dangerous Goods by Road and Rail. All transport will be by contractors with proven experience in the handling and transport of hazardous goods by road in Western Australia.

In addition, PMA will establish a contingency plan for all hazardous reagents and products in the event of an accident resulting in spillage of any hazardous material. This contingency plan will be established in accordance with WAHMEMS, the Western Australian Hazardous Materials Emergency Management Scheme. The Police Department of WA is responsible for the planning, training and functioning of this scheme.

PRECIOUS METALS AUSTRALIA LTD



DUST CONTROL - ORE CRUSHING AND GRINDING FIGURE 5.

PRECIOUS METALS AUSTRALIA LTD

VANADIUM OXIDE FLOW CHART
SHOWING DUST CONTAINMENT AREA

FIGURE 5.2

Coal

Coal transportation, storage and handling is well established throughout Western Australia and Australia, with Australia being the World's largest exporter of this commodity. The Wagoo Hills Vanadium Project will be a very small consumer of coal in comparison to other industries in Western Australia such as SECWA, Worsley Alumina and the Mineral Sands Industry. The winning of the coal and the environmental issues associated with the Mingenew coal quarry are discussed in Sections 4.3 and 5.3.

As discussed in Section 4.2.5 of this PER, there will be an average of 2 to 3 road trains or B-doubles completing the round trip from Mingenew to Wagoo Hills each day. The proposed route experiences a large number of truck movements per day, and there will be no additional disruption to communities that are on or close to it.

PMA will implement a Driver Training Programme to ensure that the coal roadtrains are operated to a high safety standard and are operated to minimise noise and dust, particularly when passing through communities, by adhering to specified speed levels.

The only road that will experience a significant increase in trucking movements is the Wagoo Hills access road. PMA has elected to locate the plant well north (over 4km) from the Windimurra Pastoral Lease homestead so that there will be minimal disturbance to activities at the homestead. The mine access road will not pass the homestead but will enter from the north.

The coal will be dumped from the road trains into a receival hopper at the Wagoo Hills plant. The material will be withdrawn from the hopper, crushed and stored in a bin ready for feeding to the kiln. The crushing and materials handling equipment will be designed to minimise dust emissions, will incorporate dust suppression devices and will be operated in accordance with the Mines Regulation Act 1946 and Regulations.

A strategic stockpile of 4000t of coal will be maintained in a stable condition to provide 4 weeks' supply of coal to cover unplanned interruption of delivery, such as when access roads are impassable. This stockpile will be compacted and sprayed with water to maintain its condition and prevent dust. Run-off from the stockpile will be controlled by specific drainage design measures which will be developed in consultation with the Department of Mines as part of the process plant drainage management plan. The permeability of soils within the plant area will be considered in selecting the location for the stockpile.

Sodium Salt Reagent

The nature of the sodium salt reagent is described in Appendix 10.4. According to the categories set out in the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG code), the material is listed as harmful Class 6.1(b). The sodium salt reagent will be received from its point of manufacture as a wet damp filtercake. The liquid component of the filtercake comprises principally water and caustic soda (sodium hydroxide).

PMA has discussed the transportation and storage of this sodium salt reagent with all relevant government departments (viz: Department of Mines, EPA, Main Roads Department and the Water Authority of WA). The sodium salt reagent will be transported in purpose-built trailers incorporating safety features such as tank design which have been approved by the Explosives and Dangerous Goods Division of the Department of Mines. The Department will also approve transport routes and emergency procedures. PMA believes that the transport route described in Section 4.2.5 is the optimum route to minimise disturbance to communities. The vehicles will be operated to minimise disturbances when passing through towns, by adhering to specified speed levels. The proponent will provide training for drivers of the sodium reagent tankers and will produce a handbook that outlines the procedures involved in accordance with current practice for the transportation of hazardous goods.

The sodium salt reagent will be transferred and stored in the plant as a slurry and there will be little likelihood of spillage as the material will be contained in pipes and agitated tanks. Any spillage that may occur will be contained and returned to the storage tank via sump pumps as is the case at the reagent manufacturing facilities.

The reagent decomposes to the harmless (non-toxic) salt of sodium carbonate at around 300 to 400°C. However, the proponent will feed the reagent to a roasting kiln operating at 900 to 1200°C with a residence time of at least 1 hour. Under these conditions, the reagent will totally decompose.

A strategic stockpile of 3000 tonnes of the sodium salt reagent will be maintained to provide 4 weeks supply to cover unplanned interruptions of delivery, such as when access roads are impassable. The final design of this long-term and bunded storage facility will provide secure containment and will be submitted to the Department of Mines and the EPA for approval as part of an Environmental Management Program prior to the construction of the process plant.

Fuels

Fuel requirements for the process plant are typical of small to medium size gold mining operations throughout Western Australia and so do not present any unusual logistic or operational problems. The proposed routes for the transport of fuel (diesel

and butane) currently experience a large number of truck movements per day (including bulk fuel carriers), hence there will be no disruption to communities that are close to the transport route. PMA will ensure that fuel transportation and off-loading is carried out according to the regulations stipulated by the various Government departments.

The fuel storage facilities will be constructed and operated in accordance with the regulations of the Department of Mines.

Other Reagents

All other reagents including sulphuric acid, sodium hydroxide, alumina trihydrate, ammonium sulphate and flocculants are currently transported and consumed in large quantities throughout Western Australia. Of these, only sulphuric acid and sodium hydroxide are listed as Dangerous Goods (due to their corrosive nature). The other reagents are harmless.

5.2.4 Atmospheric Emissions

The process plant will generate atmospheric emissions from the rotary kiln, the power plant and the small vanadium oxide furnaces. The rotary kiln will be coal-fired and the main emissions will be sulphur oxides, nitrogen oxides, particulate matter (dust) and carbon dioxide. The power plant will be oil-fired and will be a conventional generating plant typical for small communities. Emissions from the power plant are therefore not considered to have any significant health or environmental implications. The small vanadium furnaces will emit a low volume of ammonia.

The dispersion of emissions from the kiln and the ground level concentration of the various constituents of the stack gas around the site of the process plant, will be determined by a range of factors including the height of the stack, temperature of the gas and weather conditions. The environmental and health implications of the various constituents of the stack gas are assessed in terms of their ground level concentrations and in terms of the nature and location of the plant with respect to the type of nearby human activity (beneficial use). For example, the EPA has recently adopted a policy that the ground level concentrations of sulphur dioxide within the Kwinana Industrial Zone should not exceed 700 micrograms/m^3 and in nearby residential areas outside the buffer zone to the industrial area 350 micrograms/m^3 for more than 1% of the time.

The Wagoo Hills plant will conform to the generally accepted air quality criteria for sulphur dioxide, nitrogen oxides and particulates both in the immediate area surrounding the plant and at the workforce village as advised by the EPA.

Ground level concentrations of sulphur dioxide, which is the principal environmental concern, are expected to be low because of the low sulphur content in the coal from

the Mingenew Quarry and the absence of sulphur in the ore being treated. It is predicted that SO_2 concentrations in the kiln stack will only be about 2.0g/Nm^3 or 20g/sec. These levels are extremely low and can be compared with other operational plants such as the AGIP nickel smelter at Karratha (1,100g/sec) and the Stage 1 Fimiston roaster at Kalgoorlie (6,700g/sec).

The low volume of ammonia from the vanadium oxide furnaces will be scrubbed to remove the ammonia and any remaining dust.

The accommodation village has also been deliberately sited to the east of the process plant as the most common winds in the area are easterlies (that is they blow towards the west). This means that for the majority of the time emissions from the process plant will be blown away from the accommodation village.

Although the available data suggests that atmospheric emissions from the process plant will have not significant health or environmental implications, PMA recognises that this will need to be established during detailed design for the plant when such matters as the stack height will be finalised. PMA therefore makes a commitment to supply the necessary data to the EPA at that time as part of an Environmental Management Program.

5.2.5 Tailings Management

Design details aimed at achieving high integrity for the tailings dam and protection of the surrounding environment and groundwater are specified in Section 4.2.4.

5.2.6 Social and Environmental Impacts

The process plant is not expected to generate any environmental impact beyond the plant area during operations as it will be designed to minimise dust and noise emissions for occupational health reasons. The only areas of habitation in the vicinity of the plant site will be the PMA accommodation village 2.5km to the east and located behind the ridge of the Windimurra Hills and the Homestead which is approximately 4.5km to the south. The next nearest dwelling is some 20km away. PMA believe these buffer zones are adequate to ensure that there will be no adverse social impact from the plant operations.

Pastoral Activities

Feed for sheep within the area of the proposed pit, plant site, waste dumps and tailings dam area is limited by the nature of the ground which is covered by outcrops of rock and a surface mantle of gravels and cobbles. There is also no permanent surface water for stock at the site. The proposed airstrip site and accommodation sites have some feed, but this is sparse, and dependent on regular rainfall for its maintenance.

The mine will have a minor impact on the pastoral productivity as only a small part of the area of the station lease will be lost to grazing. A maximum estimate of the stock grazing area lost is about 16 sheep assuming that 300ha are affected including the area of disturbance associated with the pipeline from the borefield. The annual monetary value of this will be assessed in conjunction with the station lessee.

Merino sheep are adaptable in their behaviour and it is expected, after a short introductory period, that they will not be affected by the activities at the mine or by vehicle traffic associated with the project.

The mine and its associated facilities will have an impact on the traditional mustering activities as it is reasonably close to the drainage tract which divides the Hawkstone Ridge from the Windimurra Hills. Sheep may need to be moved from the north along this flat area to the shearing shed once a year. Should it prove difficult to drive sheep through this area, the company will erect fencing to facilitate the movement of the stock.

The company, through consultation with a pastoral management expert, has more detailed proposals for dealing with these possible impacts which may influence the income potential of the Lessee and will move positively to ensure that joint use of the land can be achieved.

Ongoing discussions with the pastoralist will be held to minimise the impact of the mining activities. Additional stock watering points will be provided where wells are affected by project dewatering and by the drawdown from the borefield. It is noted that the existing stock wells only tap the top of the aquifer In the event of drawdown below existing pump levels the company guarantees it will maintain stock water by deepening the wells or by providing storage capacity.

PMA appreciates that some activities during the construction and operational phase will have an impact on the normal pastoral operations. Pastoral management activity may need to be reviewed due to the site activities in association with the Lessee so that conflict need not arise. There will also be a range of social and economic benefits to the Pastoralist including:

- Improved road systems to and from the area.
- Improved stock water supplies due to newer and modern extraction methods.
- Social contact and community support.
- Improved first aid facilities.
- Improved airstrip landing facilities.

- Regular emergency air transport.
- Employment opportunities.
- Possible power, water and communications links.

Mt Magnet Impact

The Wagoo Hills Vanadium Project will have a number of positive impacts on the closest town, Mt Magnet, 80kms to the north-west of the project site.

Experience with previous mining activities indicates a substantial spin-off in expenditure will be generated for goods and services sourced from the town.

All road transport will be directed through or within the boundary of the town of Mt Magnet. This will occur during the 12 to 18 months construction phase and the regular supply of reagents and goods during the operational phase expected to be in excess of 30 years.

Benefits will also flow to the larger centres of Geraldton and Kalgoorlie. Geraldton will benefit from the coal mining and coal transportation operations plus the supply of reagents and fuels to Windimurra. Either Geraldton or Kalgoorlie may benefit should fly-in/fly-out operations be based in these centres.

Public Roads

Use of public roads will increase as a result of road transport to and from the project.

With a fly-in/fly-out operation, private traffic increase will be minimal. The main increase in road usage will result from fuel, coal and reagents transport. See Section 4.2.5.

Discussion will be held with the Shire of Mt Magnet regarding the use and maintenance of the Mt Magnet-Sandstone-Youanmi Road System.

5.2.7 Decommissioning

The plant site, accommodation sites, roads and the airstrip will be rehabilitated on completion of mining, with all structures (including power transmission lines and water pipelines) and equipment removed to ground level; all pipes, pits, holes, etc, sealed and the ground at each site ripped and seeded for regeneration. The full rehabilitation programme will be developed in consultation with the Department of Mines and will comply with the requirements of that Department.

5.3 The Mingenew Coal Quarry

5.3.1 Site Disturbance

The area of land affected by the coal quarrying operations will be small and the impacts will be temporary as overburden material will be backfilled into the pit after extraction of the coal and the site will be returned to its present use for grain production. There will be no adverse impact on indigenous flora or fauna.

5.3.2 Run-off

The quarry area is flat and currently there is no surface drainage and rainfall is directly absorbed into the soil profile. This situation will be maintained during quarrying operations by adhering to a site drainage plan. This plan will include the construction of a bund wall around temporary waste dumps and topsoil dumps which will collect any run-off and allow it to seep into the soil. A small amount of iron sulphide (less than 1%) in the coal and some of the waste material, has the potential to oxidise and to form weakly acidic solutions when percolated with rainwater. As the dump material is likely to be exposed to rain for less than 6 months before being used as backfill, the potential for formation of acid solutions is minimal.

The drainage plan will also include channels for drainage of any excess water during periods of heavy rainfall from waste dump areas and other surfaces into a sump at the base of the quarry. Any water at the coal face being excavated will also be pumped to this sump. The nature of the geology beneath the pit suggests that any downward percolating weakly acid solutions from this sump will be neutralised by naturally occurring carbonates.

5.3.3 Waste Dumps and Rehabilitation

There will be no permanent overburden dumps associated with the coal quarry. After each section of the pit is quarried out overburden will be transferred from the dumps into the pit and the area will be restored and re-contoured into the existing landscape. The separately stockpiled surface soils which will be removed at the start of the excavation operation will then be replaced on the backfilled areas. These areas will be returned to grain production behind the advancing quarry.

Rehabilitation will be carried out in consultation with the Department of Mines.

5.3.4 Noise and Dust Control

The contract employees at the quarry will be exposed to the noise generated by excavation equipment. PMA will therefore require the contractor to ensure that no employee is exposed to excessive noise levels and that workers are either within

appropriate machinery cabins or are wearing hearing protection devices in accordance with the provisions of the Mines Regulation Act 1946 and Regulations.

Dust at the mine site will be controlled by water spraying from a dedicated water cart. The water spraying requirements will be supplied from a nearby bore which will be licensed by the Water Authority. No impact on water levels in the area are anticipated due to low extraction (approximately 10,000 m^3/annum).

5.3.5 Land Use

The impact of the coal quarry on current land use will be temporary as the site will be restored to grain production.

5.3.6 Social and Environmental Impacts

As the coal quarry is located more than 4km from the nearest farmhouse and 20km from the town of Mingenew, there is an adequate buffer area to ensure that the quarrying operations do not disturb any nearby residents. The only potential sources of disturbance are noise and dust. Noise from the excavation equipment will occur only during daylight hours and is not likely to be audible over such a distance except perhaps in very still conditions.

Blasting, however, is likely to be audible but will only be an occasional occurrence of very short duration and will only be carried during daylight hours. PMA will liaise with local residents to determine whether blasting operations are creating any disturbance and will adopt a prior notification system to adjacent land owners if this is considered desirable.

Dust at the quarry site will be controlled by water spraying for occupational health reasons and there is no possibility of off-site effects.

Blasting material, fuel and oils will be stored on site in accordance with the requirements of the Mines Regulations Act 1946 and Regulations and of other statutory regulations.

Visually the quarry site is located well away from major road routes and from the nearest farm houses.

5.4 Infrastructure at Windimurra

5.4.1 Workforce Accommodation

The campsite and airstrip at Windimurra are situated in an area of low shrubland which has been degraded by past intensive grazing. No flora or fauna of significance

occurs in these areas and it is considered that development will have little impact on the environment other than local vegetation removal. An extensive native vegetation planting will be developed in and around the village and this is expected to enhance the attractiveness of the area for the fauna, particularly birds.

The workforce itself will be limited in its activity to the immediate vicinity around the site due to the nature of the proposed fly–in/fly–out operation. This will restrict the number of private vehicles and limit the leisure time available to the workers. Shift workers will be transported out of the area after their rostered period.

Use of off–road vehicles will also be strictly regulated and firearms, hunting and the keeping of domestic animals (dogs, cats, etc) will be prohibited.

Domestic Waste

At this stage it is proposed to bury all domestic waste on the project site within the waste dumps.

Sewerage

Sewage disposal from the construction camp, permanent houses and from mine administration offices will be by septic tanks and leach drains and will conform to the appropriate standards of the Shire of Mt Magnet.

5.4.2 Water Supply

There is a potential for minor impacts on surface water quality downstream from the project area due to increased turbidity of water running off work areas and trace contamination with oil from vehicles.

No dams for stock are located in the area of influence at the mine therefore surface water quality is not considered to be an important issue in terms of the Windimurra Pastoral Lease. Measures incorporated for the management of run–off, however, will ensure that run–off downstream from the site is unaltered in quality.

Groundwater drawdown caused by operation of the borefield has the potential to deplete water supplies obtained from stock bores or wells. This effect will depend on the distance between the borefield and the stock bores, the depths of the stock bores below the water table, and the amount of borefield draw on the upper aquifer. Preliminary investigations indicate that within the PMA borefield area there will develop a local cone of depression of the groundwater level of around 5 to 10 metres. Away from PMA's immediate borefield area the drawdown will decrease.

Two existing pastoral stock watering facilities outside PMA's local cone of depression area may be affected by the proposed drawdown. These are Malameter Well and Stag Well. Initial calculations suggest that the water in these facilities may be lowered by 1–2m after one years pumping from the borefield. This estimate will be further evaluated by test pumping bores and modelling the aquifer system and borefield.

However, it is considered that water supplies can be guaranteed as there are various alternative management responses to the drawdown. PMA is mindful that Log and Stag paddocks, are important to the station lessee in that large numbers of stock are occasionally depastured in these paddocks for short periods. If necessary, alternative water supplies for these animals could be achieved, for example, by the provision of large tanks or by the deepening of the wells and bores.

A process water dam will be constructed in the plant area to accommodate water from the borefield dewatering and tailings dam return water. A groundwater management program will be adopted to balance the project requirements from the borefield with the quantities of water recovered from the tailings.

Groundwater Quality

It can be confidently predicted that pumping from PMA's proposed dedicated borefield will not affect the fresh (drinkable) water supply to the Pastoral Lessee's homestead. The Pastoral Lessee pumps this water from a bore some 5km south of the homestead to a holding tank. This fresh water bore is some 10km from the proponent's proposed saline borefield. The Lessee's water will be sampled regularly during the operation of the borefield to check for any salinity increase. If this water was to be affected in a way which makes it unfit for human consumption, the homestead would be connected to the project's potable water supply.

Other Borefields

The largest user of groundwater in the area is expected to be the Youanmi Gold Mine some 45km south–east of Windimurra. There is no possibility of drawdown interference.

5.4.3 Power Supply

Power generation will be carried out at the plant site. The power line to the accommodation village will be a direct route.

Powerlines will cross land which is used for pastoral activities and the impact on these activities will be negligible.

5.4.4 Airstrip

The development of the airstrip will result in intermittent noise in its immediate vicinity.

Routine aircraft movements comprise 2 flights in and 2 flights out per week. Given that the airstrip may have 4 flights per week and that the duration of the noise during aircraft movements is short, the impact of intermittent noise from the source is unlikely to be significant.

6. PUBLIC PARTICIPATION AND CONSULTATION

PMA has developed and implemented a consultation programme designed to ensure that interested parties including the general public, had information relating to the Wagoo Hills Vanadium Project and the Mingenew Coal Project and opportunities for discussing the projects with the Company. The project has received considerable media coverage to date including local television and newspaper articles. Discussions have also been held with land owners, Local. Authorities, interest groups and a wide range of Government Agencies including:

- Department of Mines
- Department of State Development
- Environmental Protection Authority
- Social Impact Unit
- Water Authority of Western Australia
- Department of Conservation and Land Management
- Department of Industry Technology and Commerce
- Main Roads Department
- Agricultural Protection Board of Western Australia (APB)

Other parties which have been consulted include the WA Farmers Federation, the Association of Mining and Exploration Companies, Confederation of WA Industry (Inc) and Local Land Conservation District Committees.

The general response from these parties has been supportive for the proposal. However, there were a number of issues raised which have been addressed in this document. Some of these questions and PMA's response is provided below.

The following issues and suggestions have been raised by Government agencies and the public during consultation commencing September 1991.

- Impact on Roads in the Mt Magnet Shire (Raised by the Shire of Mt Magnet)

  Concern was raised by the Shire as to the increased road traffic from the proposed project.

PMA intends employing reputable transport contractors who are familiar with heavy haulage on gravel roads in the area and PMA will have further consultation with Shire authorities prior to commencement regarding maintenance of these roads. See Sections 4.2.5, 5.2.3 and 5.2.6.

- Alternative Accommodation Facilities at Mt Magnet (Raised by the Shire of Mt Magnet)

  PMA is appreciative of the suggestions and advice regarding alternative accommodation at Mt Magnet and the significant facilities available in the town. A final decision has not been made and further discussion will take place. Costs, road condition and distance will be the major factors in the final assessment.

- Local Employment Opportunities

  Both the Mingenew and Mt Magnet Shire Officers have raised the issue of employing local people for the projects workforce. PMA has a policy of encouraging local employment and flow-on economic benefits to the local communities.

  The potential level of employment and the type of local support activities are important factors and are yet to be finalised. Enterprising farmers at Mingenew, are understood to be forming their own co-operative to tender for the coal quarry operation and transport contracts.

- Workforce Accommodation at Mingenew

  Shire Officers have advised PMA of the opportunities regarding accommodation in the town of Mingenew.

  PMA will encourage contractors to utilise local accommodation if required.

- Ethnographic and Archaeological Work

  The Western Australian Museum (Department of Aboriginal Sites) and the Social Impact Unit have informed the proponent that there were some concerns regarding mythological significance in the vicinity of the company leases.

  The proponent has instigated a site survey and will make the results available to the Museum and relevant authorities in the near future. This issue has been addressed in Sections 3.1.6 and 3.2.5.

- The Feasibility of Aboriginal Employment and Training (Raised by the Social Impact Unit)

  The proponent is keen to employ local people for its workforce where possible.

- Employment of Workers from Regional Centres (Raised by the Social Impact Unit)

  PMA has addressed this subject in section 2.1.

- The Fly In/Fly Out Operation (Raised by the Social Impact Unit)

  PMA has addressed this subject in section 2.1.

- Impact on Ground Water Levels – Windimurra Pastoral Station

  The Groundwater and Environmental Branch of the Water Authority of Western Australia (WAWA) raised the question of remedial action should there be an adverse impact on the water supplies.

  PMA has addressed this subject in section 5.4.2.

- Town Water Supply at Mt Magnet

  The Water Authority of Western Australia has requested that the proponent has further consultation regarding the supply of drinking water at Mt Magnet if the workforce were housed at Mt Magnet township.

  The proponent will advise the Water Authority of its final decision of the location of the workforce accommodation.

- Impact (Transport Routes) on Groundwater Catchment Areas

  The Groundwater and Environmental Branch of the Water Authority of Western Australia (WAWA) requested that dedicated transport routes to Windimurra not incorporate Neeve's Road and Gnangara Road, north of Perth and Forest Road, south of Perth. These roads are within Perth's main groundwater catchment areas.

  PMA has confirmed their commitment not to use these roads, and will only use major roads approved for roadtrains carrying bulk commodities and/or dangerous goods. PMA has further addressed this subject in Sections 4.2.5 and 5.2.3.

- Noise (Mingenew Coal Project)

  Concern was expressed by a neighbouring property owner regarding the potential of excessive noise due to the quarry operations.

  This aspect of the proposal is discussed in Section 5.3.4.

- Impact on Groundwater Levels and Watercourses Adjacent to the Mingenew Coal Project

  Concern was expressed by a neighbouring property owner regarding the possible affect the quarry operation may have on his water supply.

  This aspect of the proposal is discussed in Section 3.2.3.

- Impact on the Pastoralist Earning Capacity at Windimurra

  This issue has been raised by the Lessee of the Windimurra Pastoral Lease.

  PMA has employed the services of Mr David Wilcox, an internationally acknowledged and leading authority on pastoral country and rangeland rehabilitation in Western Australia, to report on this subject. Also see Section 5.2.6.

- "Green Tongue" Sickness Through Dust Contamination

  The Department of Mines has raised the issue of dust control where vanadium dust may cause vanadium sickness.

  PMA has addressed this issue in detail in Section 5.2.2.

- Dust, Noise, Waste Disposal and Landscaping at Windimurra

  Raised as a concern by the Pastoral Lessee at Windimurra.

  These issues are addressed in Sections 5.1.4, 5.3.4 and 5.4.

- Fire Arms, Pets and Off-road Driving

  Raised as a concern by the Pastoral Lessee at Windimurra.

  The issues are addressed in Section 5.4.1.

- Rehabilitation and Soil Erosion at Windimurra

  The local Sandstone Land Conservation District Committee wishes PMA to become a member of the District Committee and to participate in local land rehabilitation studies.

  PMA has accepted the Chairman's invitation.

PMA intends to use this PER as a basis for further discussion with interested parties.

7. ENVIRONMENTAL MANAGEMENT AND MONITORING

7.1 Introduction

PMA recognises that development of this project will impact on the environment, and the various facets of the proposed development have been planned to minimise this impact.

Throughout this PER document, and in particular in section 5.0 (Environmental Issues and Management), PMA has set out the management and monitoring activities the company intends to undertake. The purpose of this section is to summarise these activities.

7.2 Environmental Management and Monitoring at the Vanadium Mine

- As described in Section 5.1.2 a Surface Water Drainage Management Plan will be developed in consultation with the Department of Mines and the Department of Agriculture.

- Waste dumps will be managed in accordance with "Guidelines for Waste Dump Design and Rehabilitation". These Guidelines include assessments for the success of the rehabilitation strategy for the Department of Agriculture.

- A management strategy will be developed to minimise the spread of the Saffron Thistle. This strategy will be developed in consultation with the Department of Agriculture.

7.3 Environmental Management and Monitoring of the Process Plant

- A monitoring program will be implemented to measure vanadium dust in the most likely areas of emissions, (e.g. exhaust ducts), and at strategic locations within the project area. The method of measurement, frequency of measurement, and location of measuring points will be agreed in consultation with the Department of Mines.

- A transportation management and contingency plan will be developed to ensure that the transportation of hazardous materials is undertaken safely. A driver training program will be incorporated into the plan and will include regular review of driver awareness. Similarly, the integrity of transportation equipment will be monitored on a regular basis.

  The transportation management and contingency plan will be developed in consultation with the Explosives and Dangerous Goods Division of the Department of Mines and Western Australian Hazardous Materials Emergency Management Scheme.

- A comprehensive management plan for the tailings dam shall be developed in consultation with the Department of Mines and the EPA. The plan will be in accordance with the "Guidelines for the Preparation of a Notice of Intent and Works Approval Application for New Tailings Dams or Extensions to Existing Dams".

7.4 Environmental Management and Monitoring at the Mingenew Coal Quarry

- A surface water drainage management plan will be developed in consultation with the Department of Mines and the Department of Agriculture.

- The site will be rehabilitated in accordance with guidelines laid down by the Department of Mines and will be monitored to assess the success of the rehabilitation.

7.5 Environmental Management and Monitoring of Infrastructure

- The borefield will be regularly monitored to determine the effect of off-take on salinity and the level of the groundwater.

- The Pastoralist's fresh water supply will be monitored to ensure that good quality water is available.

7.6 Environmental Officer

PMA proposes to appoint an Environmental Officer who will have the following responsibilities:

- Implementation and co-ordination of the monitoring, management and rehabilitation plans and programs discussed in Sections 7.2, 7.3, 7.4 and 7.5.

- Liaison with Government departments, local shires and communities as required, in relation to environmental matters.

- Seeking of advice from specialist consultants on an as required basis.

8. COMMITMENTS

8.1 Introduction

Although a feasibility study has been completed on the vanadium mine and associated process plant described in this PER, the detailed design of the Wagoo Hills Vanadium Project has yet to be finalised. Nevertheless, the information available, and the range of Acts and Regulations which PMA must comply with and which cover all aspects of the proposal, lead PMA to conclude that the environmental implications of the project will be minor and will be equivalent to other medium scale mining ventures in the Goldfields region.

8.2 List of Commitments

Commitments represent the proponents solutions to potential environmental problems imposed by the development proposal. Essentially they are undertakings by the proponent regarding the way in which the proposal will be implemented. It is expected that the commitments will be included in the conditions imposed on the project by the Minister for the Environment at the end of the PER process.

With respect to the Wagoo Hills Vanadium Project and Mingenew Coal Project, Precious Metals Australia will:

- Comply with the requirements of all applicable Acts and Regulations.
- Design and implement a monitoring programme of groundwater levels and water quality in the borefield and other bores in the vicinity of the project area at Windimurra before operational start and to the satisfaction of the Water Authority of WA.
- Undertake to guarantee continuity of stock water if changes in groundwater levels, caused by the Project, adversely affect pastoral activities.
- Guarantee to provide the Pastoral Lessee with a potable water supply if the project adversely affects his current source of fresh water.
- Minimise clearing of land consistent with safe and efficient operations.
- Design and rehabilitate all waste dumps in consultation with the Department of Mines and in accordance with the "Guidelines for Waste Dump Design and Rehabilitation" of that Department.
- Design the tailings dams in consultation with the Department of Mines and in accordance with the "Guidelines for the Preparation of the New Tailings Dams" of that Department.

- Prepare drainage management plans for the vanadium mine and process plant at Windimurra and for the coal quarry at Mingenew in consultation with the Department of Mines.

- Ensure that vanadium dust is controlled to below limits established in the Mines Regulations Act 1946 and Regulations, by incorporating dust extraction and collection equipment in the process plant.

- Develop an effective operator training and awareness program to ensure that the process plant is well operated and any potential occupational health problems are quickly identified and are rectified immediately.

- Control coal dust and total dust and noise levels in the project areas in accordance with the applicable acts and regulations.

- Implement measures in the process plant to conserve water.

- Ensure that all handling, packaging and road transport of inputs to the process plant and products from that plant comply with the requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail and the Dangerous Goods (Road Transport) Regulations 1983 and amended Regulations 1988.

- Develop a transportation management and contingency plan to ensure that the transportation of hazardous materials is undertaken safely. A driver training program will be incorporated into the plan and will include regular review of driver awareness. Similarly, the integrity of transportation equipment will be monitored on a regular basis.

  The transportation management and contingency plan will be developed in consultation with the Explosives and Dangerous Goods Division of the Department of Mines and the Western Australian Hazardous Materials Emergency Management Scheme (WAHMEMS).

- Submit a final design of the storage facility for the sodium salt reagent at Windimurra to the Department of Mines and the EPA for approval as part of the Environmental Management Program prior to the construction of the process plant.

- Submit final design details of exhaust stacks and exhaust cleaning devices prior to construction for approval by the EPA as part of the Environmental Management Programme.

- Prepare specific proposals for site decommissioning in the event of termination of the project and implement those proposals after review and approval of the relevant Government Agencies at the time.

- Rehabilitate the surrounds of the vanadium mine site and the process plant and village areas at Windimurra following decommissioning of the project.

- Liaise with residents living in the vicinity of the coal quarry to ensure that blasting operations there do not cause a disturbance and modify those blasting operations if necessary.

- Backfill the coal quarry with overburden material, replace topsoil, and restore the site to its current use for grain production.

- Prohibit domestic pets in the project area as a condition of employment.

- Restrict off-road driving and prohibit hunting by employees as a condition of employment.

- Maintain strict fire control procedures.

- Develop a management strategy to minimise the spread of Saffron Thistle. This strategy will be developed in consultation with the Department of Agriculture.

9. CONCLUSIONS

The Proponent believes that the economic and social benefits associated with the Wagoo Hills Vanadium Project can be achieved without unacceptable environmental or social impacts. PMA is committed to the formulation and implementation of management and monitoring programs to ensure that all of its operations are acceptable during the life of its project.

The vanadium mine is roughly equivalent in terms of environment considerations to a medium sized gold mining operation and is located in a relatively remote area on a small part of a very large pastoral lease which has been used for sheep grazing for many years. Site impacts will therefore be minimal both in terms of the natural and social environment.

Emissions from the process plant will meet strict established standards in terms of ground level concentrations. Drainage from the mine and process plant will also be controlled by a specific drainage management plan and water supply from the borefield will be designed and monitored to ensure that the pastoral lease water supplies are not affected.

The process plant involves the use of various hazardous chemicals but again this is equivalent to a typical gold mining operation and the handling, transport, storage and use of all of these materials will be strictly in accordance with statutory regulations. Noise and dust will also be strictly controlled both through plant design and by operational procedures and monitoring. Occupational health will be a primary objective of PMA and it is considered that there is no possibility of deleterious health effects off-site from the process plant.

The coal quarry at Mingenew will be a small quarrying operation located in a cleared farm paddock which has been used for about 50 years for grain production and which is more than 4km from the nearest farm house. The quarry will be backfilled progressively and returned to grain production.

The Wagoo Hills Vanadium Project complies with a number of key Government policies and will accrue considerable economic benefits as well as employment benefits to the State and local communities. The project meets the following West Australian Government policies for development:

- Decentralisation – the Western Australian Government has actively sought to promote development away from the Perth Metropolitan Area and its immediate vicinity. Decentralisation of industry has been encouraged in particular as a means of promoting population growth and economic activity in regional areas.

- Export Promotion – both the Commonwealth and State Governments have policies of encouraging exports as a means of improving the Australian economy. This project is export oriented and has the potential for export earnings of $900,000,000 over its life.

- Sustainable Development – the proposed vanadium processing plant will conform to the philosophy of sustainable development. Sustainable development is development which does not jeopardise the health or productive capability of future generations by causing environmental degradation. The challenge of sustainable development is to find new processes, technologies and products which are environmentally friendly but at the same time deliver the goods and services that society demands. The efficient utilisation of natural resources in producing such products is a fundamental component of sustainable development. PMA believes that the present proposal satisfies this objective of efficient utilisation of natural resources.

- The project offers Australia a new added value resource industry.

10. APPENDICES

APPENDIX 10.1

GUIDELINES FOR THE PER

WAGOO HILLS VANADIUM PROJECT AND MINGENEW COAL PROJECT

PUBLIC ENVIRONMENTAL REVIEW GUIDELINES

Overview

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe what they propose to do, to discuss the potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be managed so that the environment is protected.

If the proponent can demonstrate that the environment would be protected then the proposal will be found environmentally acceptable; if the proponent cannot show that the environment would be protected then the Environmental Protection Authority (EPA) would recommend against the proposal.

Throughout the process it is the aim of the EPA to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. Nonetheless, the environmental review in Western Australia is proponent driven, and it is up to the proponent to identify the potential environmental impacts, and design and implement measures which protect the environment.

For this proposal protecting the environment means that the natural and social values associated with the Wagoo Hills (80km east of Mt Magnet) and Mingenew areas are protected. Where they cannot be protected, proposals to mitigate the impacts are required.

These Guidelines identify key issues that should be addressed by the Public Environmental Review (PER). They are not intended to be exhaustive and it is the proponents responsibility to consult with all relevant authorities to identify the issues and to compile an appropriate report on the proposal.

The PER is intended to be a brief document, its purpose should be explained, and the contents should be concise and accurate as well as being readily understood by interested members of the public. Specialist information and technical description should be included where it assists in the understanding of the proposal. It may be appropriate to include ancillary or lengthy information in technical appendices.

The PER should contain sections covering the following :

INTRODUCTION

- identify the proponent, including contact names and addresses;
- briefly describe the objectives of the proposal, the location, land tenure and the basic outline of the proposal including the scope and timing; and
- identify the responsible government authorities and the assessment and approval processes that are required.

THE PROPOSAL

- The PER should examine the need for the proposal and the alternatives considered for the various components of the preferred proposal;
- the important components of the entire proposal (from mining to processing to transport of the product) should be described, including construction and operational phases, infrastructure requirements, anticipated impacts (air emissions, process and waste materials handling, etc), content of contaminants in residue dams or waste dumps, management procedures, rehabilitation, decommissioning and contingency planning;
- quantify the various aspects of the proposal as much as possible, particularly those aspects which relate to potential environmental impacts; and
- develop the framework for an environmental management programme for the operation.

EXISTING ENVIRONMENT

- describe the biological and physical environment of the area and also the region, but particularly the project area, which should be described in sufficient detail so that the specific biological and physical parameters of the project area can be understood in the regional context;
- describe the cultural and heritage values of the area including any archaeological or ethnographical interest in the area; other aspects of the human environment (social impacts, nearest residents, background noise levels, landscape values, etc) should be described if relevant; and
- describe the present and any proposed land uses and any other aspects of the environment which are important in relation to the proposal.

ENVIRONMENTAL IMPACTS AND MANAGEMENT

The main section of the PER describes the environmental impacts and their management. The key issues related to the potential impacts are identified below :

Key issues

The vanadium mine and processing plant at Wagoo Hills is the major component of the proposal, with the small coal mine near Mingenew being a minor part of the proposal. The key issues for the vanadium mine and processing plant component are :

- transport, handling and contingency planning for the dangerous goods and other materials;
- dust control including ore handling, beneficiation and product handling;
- groundwater abstraction and management;
- workforce accomodation options and management;
- operational environmental management issues (mining plan, tailings dams, waste dumps, rehabilitation);
- environmental monitoring for leachate and dust; and
- impact on the town of Mt Magnet.

The key issues for the coal mine are :

- operational environmental management issues (mining plan, waste dumps, rehabilitation);
- dust control during mining and crushing; and
- impact on the town of Mingenew.

Any other key issues identified by the proponent during the preparation of the report should also be addressed.

Public participation and consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the PER (such as discussions with the Shire and local communities). This section should describe the activities undertaken, the dates, the groups and individuals involved and the objectives of the activities. This section should be cross referenced with the Environmental impacts and management section which should clearly indicate how community concerns have been addressed. Where these concerns are dealt with via other departments or procedures, outside the Environmental Protection Authority process, these can be noted and referenced here.

ENVIRONMENTAL COMMITMENTS

The commitments being made by the proponent to protect the environment should be clearly defined and separately listed. Where an environmental problem has the potential to occur, there should be a commitment to rectify it. They should be numbered and take the form of :
who will do the work; **what** the work is; **when** the work will be carried out; and to **whose satisfaction** or to what standard/licence condition the work will be carried out.

All actionable and auditable commitments made in the body of the document should be numbered and summarised in this list.

APPENDIX 10.2

CORRESPONDENCE WITH GOVERNMENT AGENCIES

WATER AUTHORITY
of Western Australia

1ST FLOOR, S.G.I.O. BUILDING
45 CATHEDRAL AVENUE
GERALDTON, W.A.
Postal Address: P.O. Box 43 Geraldton
Western Australia, 6530
Telephone: (099) 21 0888. Fax: (099) 21 7675

Your Ref
Our Ref GG
Enquiries MR K GRIFFIN
Tele Direct 099-210888

PRECIOUS METALS AUSTRALIA
PO BOX 200
SOUTH PERTH W AUST 6151

-2 JAN 1992

	READ	ACTION
AKM	✓	
RJHS	X	
PDO		
WAM		
KJS		
WS	X	
CC		
FILE	PER	

ATTENTION: MR SEABROOK

Dear Sir

WAGOO HILLS VANADUIM PROJECT

The Water Authority requirements for this project concern groundwater use, waste product disposal and transport of hazardous substances.

1. Groundwater Use

The proponent hold a Groundwater Well Licence to explore for water on their tenements. They will require to prove the water resource then a production licence will be issued with conditions applying that will ensure a monitoring and reporting program is in place to maintain the viability of the resource. Conditions applied will also ensure other users of groundwater resources are protected.

2. Waste Products Disposal

The proponent will be required to licence the tailings dam through the Environmental Protection Authority.

The Water Authority has the delegated responsibility for setting licence conditions for the control and disposal of all liquid wastes.

Conditions will be set for specific waste water constituent limits, monitoring and reporting requirements and waste liquid management at the site.

3. Transport of Hazardous Substances

The Authority will insist that the company transporting any hazardous substances be as per the established procedures and any spills that are likely to impact on any surface water or groundwater resources are to be reported to the Regional Office along with clean up procedures.

For any further queries on these matters, please contact K. GRIFFIN of this office on 099-210850.

Yours faithfully

K. Griffin /cjo

K GRIFFIN
REGIONAL WATER RESOURCES OFFICER
MID WEST REGION

DECEMBER 24, 1991
(52MG004)LD

SOCIAL · IMPACT · UNIT

Mr R A D Sippe
Director
Evaluation Division
ENVIRONMENTAL PROTECTION AUTHORITY

Attention: Colin Murray

WAGOO HILLS VANADIUM PROJECT AND MINGENEW COAL PROJECT - DRAFT PER

This Unit has examined the draft PER prepared by Precious Metals Australia (PMA) Ltd.

The social issues addressed in the document are generally adequate and Mr Andrew McKee has agreed to provide some additional information in the PER on the ethnographic and archaeological report, (work being done by consultant), key issues raised during the public participation programme and tendering by local people for the Mingenew coal project. PMA will also address the feasibility of Aboriginal employment and training.

The other component to be addressed in further detail is 'source of workforce' and further details should be provided on the justification for fly-in/fly-out. The proponent should discuss employment source options with an emphasis on regional centres.

Ann Verschuer
DIRECTOR

19 December 1991

D274:my

Capita Centre (Ground Floor) 197 St. George's Terrace Perth W.A. 6000 Tel: (09) 222 9988 Fax: (09) 321 1473

Western Australian museum

Francis Street Perth
Western Australia 6000
Telephone (09) 328 4411
Facsimile (09) 328 8686

Department of Aboriginal Sites
3rd Floor Construction House
35 Havelock Street
West Perth WA 6005
Telephone: (09) 322-7144
Facsimile: (09) 321-4525

Date: 19 December, 1991

Your Ref:

Our Ref: 77186RR:ec
1mckee17-12

Mr Andrew McKee
P.M.A.
P.O Box 200
SOUTH PERTH W.A. 6151

Dear Mr McKee

RE: **Wagga Hills**

I am writing to you to relay some concerns expressed to us that there are areas of mythological significance in the vicinity of your leases. It is not clear if they actually impact on your area of interest but in view of the concerns expressed, it would be highly advisable for you to engage a consultant to carry out a survey.

I have also received advice from Aboriginal people in Meekatharra that they are aware of sites in the general area of Wagga Hills. Again, these may not be within your lease, but in the event of a survey, these people should also be conulsted.

Yours faithfully

Robert Reynolds
Acting Assistant Registrar
DEPARTMENT OF ABORIGINAL SITES

23 DEC 1991

	READ	ACTION
AKM		
RJHS		
PDO		
WAM		
KJS		
CC		
FILE		

Branches:
Western Australian Maritime Museum
Cliff Street, Fremantle
Western Australia 6160
Telephone (09) 335 8211

Fremantle Museum
Finnerty Street, Fremantle
Western Australia 6160
Telephone (09) 335 8211
Fax (09) 430 5120

Geraldton Museum
Marine Terrace
P.O. Box 112, Geraldton
Western Australia 6530
Telephone (099) 21 5080
Fax (099) 21 5158

Albany Residency Museum
Residency Road, Albany
Western Australia 6330
Telephone (098) 41 4844
Fax (098) 41 4027

Museum of the Goldfields
P.O. Box 25
Kalgoorlie, Western Australia 6430
Telephone (090) 21 8533
Fax (090) 91 2791

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

HEAD OFFICE
HACKETT DRIVE CRAWLEY
WESTERN AUSTRALIA
Phone (09) 386 8811
Telex AA 94585
Facsimile (09) 386 1578

STATE OPERATIONS HEADQUARTERS
50 HAYMAN ROAD COMO
WESTERN AUSTRALIA
Phone (09) 367 0333
Telex AA 94616
Facsimile (09) 367 0466

Please address all correspondence to Executive Director, P.O. Box 104, COMO W.A. 6152

Your Ref: 031677F0216
Our Ref: Dr Atkins
Enquiries: 09 3670425
Phone:

19 NOV 1991

Dr Paul van der Moezel
c/- Alan Tingay & Associates
35 Labouchere Rd
SOUTH PERTH WA 6151

Dear Paul

REQUEST FOR RARE FLORA INFORMATION

I refer to your request of 7 November, 1991 for information on rare flora in the Mt Magnet area.

Attached is a printout from the Department's Priority Species List (species that are declared rare [R, or X for those presumed to be extinct], poorly known [1 - 3], or require monitoring [4]). There are no specific declared rare flora populations known in this area.

Attached also are the conditions under which this information has been supplied. Your attention is specifically drawn to the sixth point which refers to the requirement to undertake field investigations for the accurate determination of rare flora occurrence at a site. The information supplied should be regarded as an indication only of the rare flora that may be present.

An invoice for $90, being the set charge for the supply of this information, will be forwarded.

It would be appreciated if any populations of rare flora encountered by you in the area could be reported to this Department to ensure their ongoing management.

If you require any further details, or wish to discuss rare flora management, please contact my Senior Botanist, Dr Ken Atkins on 09 3670425.

Yours faithfully

.....
for Syd Shea
EXECUTIVE DIRECTOR

14 November, 1991

DECLARED RARE AND PRIORITY FLORA LIST
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

SPECIES	PRI CODE	CALM REGION	DISTRIBUTION	FLOWERING PERIOD
Labichea eremaea	1	GRE	West of Sandstone	Aug
Mirbelia stipitata	3	GRE,GLD	Nth Sandstone, Nth Laverton	-
Neogoodenia minutiflora	4	GRE	Eurardy, Yalgoo, Mt Magnet	Aug
Pityrodia canaliculata	1	GRE	Sandstone	Aug-Sep

Western Australian museum

Francis Street Perth
Western Australia 6000
Telephone (09) 328 4411
Facsimile (09) 328 8686

15 NOV 1991

Date 13 November, 1991

Your Ref:

Our Ref: 233/85

Ms Sue Gordon
Senior Environmental Scientist
Alan Tingay & Associates
35 Labouchere Road
SOUTH PERTH WA 6151

Dear Ms Gordon

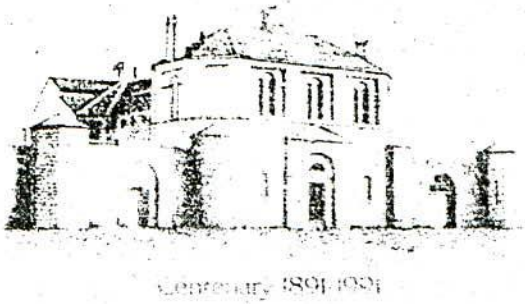
A computer search of our registers was carried out for the areas listed in your letter of 6 November 1991.

No records of the Black-footed Rock Wallaby were listed for the designated area.

The charge for staff time to run the computer search is $60.00, based on our rate of $60.00 for the first hour or part thereof and pro-rata thereafter. An invoice is enclosed.

Yours sincerely

G.J. MORGAN
Acting Head, Division of Natural Science



Western Australian museum

Francis Street Perth
Western Australia 6000
Telephone (09) 328 4411
Facsimile (09) 328 8686

25 MAR 1991

ACTION | READ | AKM | RJES | PDO | WAM | KJS | CC | FILE

Date: 20 March 1991

Your Ref: 00 131 533

Our Ref: 7/235/1/174 LA/VM

Enquiries: L. Atkins

Department of Aboriginal Sites
3rd Floor Construction House
35 Havelock Street
West Perth WA 6005
Telephone: (09) 322-7144
Facsimile: (09) 321-4525

Exploration Manager
Precious Metals Australia Limited
PO Box 200
SOUTH PERTH WA 6151

Dear Mr O'Shea,

ABORIGINAL SITES: MURCHISON MINERAL FIELD AREA

Thank you for your letter of 15 March 1991.

A search of our records indicates that there are no Aboriginal sites known to this Department on the above land. However, as there has not been a comprehensive study of the area, it is possible that sites which have not yet been recorded may exist.

All Aboriginal sites are covered by the provisions of the *Aboriginal Heritage Act 1972-80* regardless if they are known to this Department or not. Section 17 of the Act makes it an offence to in any way alter an Aboriginal site without written permission from the Minister for Aboriginal Affairs.

In order to comply with the provisions of the Act, I recommend that you engage a consultant anthropologist/archaeologist to conduct a study of your area of interest. The aim of this study is to ensure that Aboriginal sites are located and recorded in detail.

It is our preference that you modify your development plans to avoid impacting sites. If however, this is not possible, and in order to avoid a breach of Section 17, the landowner can submit a notice in writing to the Trustees of the Western Australian Museum seeking the Minister's consent to use the land in question.

The Department can provide you with the names of consultants if required. Please do not hesitate in contacting me if you require any further advice.

Yours sincerely,

Robert Reynolds
Acting Assistant Registrar
DEPARTMENT OF ABORIGINAL SITES

AGRICULTURE PROTECTION BOARD OF WESTERN AUSTRALIA

Baron-Hay Court
South Perth WA 6151
Ph (09) 368 3333
Telex AA93304

Your ref
Our ref 82.83
Enquiries PEARSON
Date 22.01.91

Mr P O'Shea
PMA
P O Box 200
SOUTH PERTH WA 6151

Dear Sir

It is difficult to answer your letter of 14 January 1991, concerning quarantine on Windimurra station without more detail of the proposed operation. The idea of the quarantine is to prevent the spread of saffron thistle seed and we try to achieve this without limiting commercial activity.

It is highly unlikely we would oppose the granting of a mining lease but we would impose restrictions on any lease granted. The exception to this would be if the top soil was mined and removed from the station. We may then consider the risk to be such that it could not be controlled by restrictions.

The restrictions usually involve gaining permission to move anything off the quarantined area and permission normally requires inspection to ensure the item is weed free. This is to some extent negotiable. For example if ore from underground was to be removed and you had undertaken a saffron thistle control programme to keep the work area and access routes free from saffron thistle we would possibly permit free movement in those free areas. In other words the restriction would become that you maintain the area and access free of saffron thistle.

Unfortunately I am unable to advise you of the exact areas on the station that are under quarantine as records on that are not kept in this office. I have requested our officer in that area to forward the information to you.

Yours sincerely

E G Pearson

E G PEARSON
AGRICULTURE PROTECTION ADVISER

APPENDIX 10.3

LIST OF POTENTIAL VERTEBRATE FAUNA AT WINDIMURRA

LIST OF POTENTIAL VERTEBRATE FAUNA AT WINDIMURRA

AMPHIBIANS

Pseudophryne guentheri
Neobatrachus wilsordei

REPTILES

GECKOS

Diplodactylus mainii
Diplodactylus pulcher
Diplodactylus squarrosus
Gerhyra variegata

LEGLESS LIZARDS

Delma australis
Delma fraseri
Lialis burtonis
Pygopus nigriceps

SKINKS

Cryptoblepahrus carnabyi
Cryptoblepharus plagiochephlus
Ctenotus mimetes
Ctenotus schomburgkii
Ctenotus uber
Egernia depressa
Egernia inornata
Eremiascincus richardsonii
Lerista macropisthopus
Menetia greyii
Morethia obscura
Tiliqua occipitalis
Tiliqua rugosa

DRAGONS

Ctenophorus inermis
Ctenophorus reticulatus
Ctenophorus scutulatus
Pogona minor

MONITORS

Varanus caudiolineatus
Varanus eremius
Varanus gouldii
Varanus tristis

SNAKES

Aspidites ramsayi
Morelia stimsoni
Acanthophis pyrrhus
Denisonia fasciata
Furina ornata
Pseudechis australis
Pseudonaja modesta
Pseudonaja nuchalis
Rhinophochalus monachus
Vermicella bertholdi
Vermicella bimaculata
Vermicella fasciolata
Vermicella semifasciata

BIRDS

Emu
Collared Sparrowhawk
Wedge-tailed Eagle
Brown Falcon
Crested Pigeon
Galah
Port Lincoln Ringneck

Mulga Parrot
Bourke's Parrot
Pallid Cuckoo
Horsfield's Bronze-Cuckoo
White-backed Swallow
Welcome Swallow
Tree Martin
Richards Pipit
Black-faced Cuckoo-shrike
White-winged Triller
Red-capped Robin
Hooded Robin
Gilberts Whistler
Rufous Whistler
Grey Shrike-thrush
Crested Bellbird
Grey Fantail
Willie Wigtail
Chiming Wedgebill
Cinnamon Quail-thrush
White-browed Babbler
White-winged Fairy-wren
White-browed Scrubwren
Weebill
Western Gerygone
Chestnut-rumped Thornbill
Slaty-backed Thornbill
Yellow-rumped Thornbill
Southern Whiteface
Spiny-cheeked Honeyeater
White-browed Treecreeper
Yellow-throated Miner
Singing Honeyeater
White-plumed Honeyeater
White-fronted Honeyeater
Crimson Chat
Zebra Finch
Australian Magpie-lark
Black-faced Woodswallow
Little Woodswallow
Grey Butcherbird
Pied Butcherbird
Grey Currawong
Australian Magpie
Torresian Crow

MAMMALS

INDIGENOUS MAMMALS

Short-beaked Echidna
Common Dunnart
Fat-tailed Dunnart
Hairy-footed Dunnart
Wongai Ningaui
Black-footed Rock Wallaby
Western Grey Kangaroo
Common Wallaroo (Euro)
Red Kangaroo
Hills Sheathtail-bat
White-striped Mastiff-bat
Little Mastiff-bat
Greater Long-eared Bat
Lesser Long-eared Bat
Gould's Wattled Bat
Little Broad-nosed Bat
Western Broad-nosed Bat
Sandy Inland Mouse
Spinifex Hopping Mouse

INTRODUCED MAMMALS

House Mouse
Rabbit
Dingo
Fox
Feral Cat

APPENDIX 10.4

ROCKWATER PROPRIETARY LTD
WATER SUPPLIES

Rockwater
PROPRIETARY LIMITED
94 ROKEBY ROAD, SUBIACO, WESTERN AUSTRALIA 6008
P.O. BOX 237, SUBIACO, WESTERN AUSTRALIA 6008
TELEPHONE: (09) 382 4922
INTERNATIONAL: 619 382 4922
FACSIMILE: (09) 381 3264

PRECIOUS METALS AUSTRALIA PTY LTD

WINDIMURRA P.E.R.

DESCRIPTION OF PROPOSED PROJECT

WATER SUPPLIES

Process Water

Water supplies of 3,000 cu m/day (1.1×10^6 cu m/yr) will be used as make-up for mineral processing, together with 1600 cu m/day return from tailings. They will be obtained from local groundwater sources: sand and calcrete in a large alluviated palaeodrainage lying 4 km north-east of the mine site.

A borefield is planned to be constructed in the palaeodrainages, to draw the groundwater. Six bores producing 500 cu m/day each are anticipated to be needed. Collector pipeline, a surge dam, and transfer pipeline are incorporated in the water delivery system.

Two or three additional bores might be required to supply the total water requirement at start-up, until tailings return is achieved. They would later be used for stand-by.

Potable Water

The potable water supplies for a workforce of 60 to 65 people will be about 132 cu m/d. These will be obtained by treating process water using the reverse osmosis method, or by construction of bores into bedrock aquifers that contain fresh water.

DESCRIPTION OF EXISTING ENVIRONMENT

PHYSICAL ENVIRONMENT

Surface Water

The project site is located in slightly elevated ground in which there is dendritic drainage arising locally, conducting the infrequent rainfall runoff. It lies on a local topographic divide. Most of the drainages run in an overall easterly direction into depressions and claypans along the south-western margin of an alluviated palaeodrainage. It apparently evaporates or infiltrates locally, because there is no creek channel or other means of water transport except perhaps sheet flow at times of heavy flooding.

Regionally, the project area is adjacent to a surface water sink which is part of a palaeodrainage that used to run north-westwards then west and south-westwards into an elongate lake system south from Challa homestead.

From the examination of surface-water characteristics it is concluded that the site has negligible susceptibility to flooding. On the other hand, there is very little potential for harvesting large quantities of surface water. In the catchments downstream from the mine site, no dams have been identified.

Groundwater

The main body of groundwater near the project site is contained in the alluvium of the palaeodrainage located to the east of the site. Minor amounts of groundwater have been encountered in bedrock near the mineral deposit.

Alluvial Aquifers

The alluvium of the palaeodrainage (Cza, Fig. 1.3) is calcreted sand and silt at the surface, underlain by clay and sand to depths of about 80 m. A test hole drilled at site WM12A yielded the following results.

(1) The water table is at 3 m below ground surface.

(2) An upper aquifer of ferricrete/calcrete and basal quartz grit extends from the water table to 8 m depth; the basal grit (1 m thick) is more permeable than the other material.

(3) Plastic clays from 8 to 57 m depth are interpreted to be impermeable.

(4) A lower alluvial aquifer of sand with clay lies at 57 to 76 m depth.

(5) Weathered and fractured gabbro bedrock drilled to 87 m depth contained groundwater.

(6) Groundwater salinities increased with depth, from 2000 - 2500 mg/L TDS in the upper aquifer, to 14,000 mg/L TDS in the bedrock.

(7) Airlift yields ranged from 200 to 480 cu m/d, varying with depth. The yields from production bores are expected to be higher.

Sampling of stock bores/wells in the palaeochannel has yielded groundwater salinities of 1700 to 8600 mg/L TDS applicable to the upper aquifer. Variations in salinity of the water in the deep alluvial aquifer are not known.

The geometry of the aquifers can only be inferred at this stage, but geological interpretation indicates at least 12 km length. Width is not established, but could be 2 km.

Based on the above parameters there appears to be a large margin of safety in the capability of the palaeochannel aquifer to yield the required 3000 cu m/d of process water. $= 1.1 \times 10^6 m^3/year$.

Bedrock

Gabbro bedrock contains small quantities of groundwater of salinity 900 to 1300 mg/L TDS, as indicated by sampling of drillholes in and near the mineral deposit.

Shear-zones and quartz reef cutting the bedrock in the vicinity might yield useful quantities of groundwater. Aquifers are likely to be intersected to depths of about 80 m, and to have static water level of 20 to 30 m below ground surface. The supply from a successful bore is likely to be 100 to 200 cu m/d.

ENVIRONMENTAL IMPACTS AND MODIFICATIONS

SURFACE WATER

There is potential for minor impacts on surface water quality downstream from the project area: increased turbidity of water running off work areas, and trace contamination with vehicular oil and mineral matter. Such effects will be kept to a minimum by silt traps designed for construction downstream of the waste dumps, tailings dams, and on all road drainage.

No water-storage dams for stock have been identified in the area of influence of the mine, therefore surface-water quality would not appear to be a critical issue. However, it will be addressed because stock probably drink at claypans downstream from the mine, after periods of creek flow.

GROUNDWATER

Water-level drawdown caused by operation of a borefield could deplete the water supplies obtainable from nearby stock bores or wells. The effect will depend on the distances between borefield and stock installations, the depths of penetration of the latter below the water table, and the amount of borefield draw on the upper aquifer.

The planned borefield comprises eight bores; in normal operation five of them will be pumped at 600 cu m/d each. Bores will be located on a 1 km grid as shown in Figure 1.3, depending on the drilling and test-pumping results. Aquifer modelling will be undertaken to determine practical bore spacings, and to predict water-level drawdown.

With the proposed borefield configuration, two existing stock-watering facilities might be affected by significant drawdown: Malamiter Well and Stag Well. Calculations using existing data indicate drawdowns of 1 - 2 m after a year's pumping.

Water supplies can be maintained at existing stock-watering points by deepening the bore/well, by piping water to such locations by adjusting the borefield layout, or by limiting the extraction from the upper alluvial aquifer. Given the range of alternatives, the water supplies can be guaranteed to be maintained.

Vegetation in the paleochannel area is densest around claypans and on low-lying clayey soil. It is very thin on rubbly calcrete outcrop. Whether the species of this area are likely to be affected by water-table reduction of a few meters (locally) is addressed elsewhere in this Review.

DATED: 31 OCTOBER 1991

ROCKWATER PTY LTD

J R PASSMORE
PRINCIPAL HYDROGEOLOGIST

APPENDIX 10.5

NATURE OF CHEMICAL REAGENTS AND PRODUCTS

The major chemicals that will be transported to Wagoo Hills for the production of vanadium oxides and the products from the process are:

Reagents

Sodium Salt (Organic)
Sulphuric Acid
Ammonium Sulphate
Alumina Trihydrate
Sodium Hydroxide

Products
Vanadium Pentoxide
Vanadium Trioxide
Sodium Sulphate (potentially)

The proponent will ensure that all reagents and products will be transported, stored and handled in a safe manner and in accordance with all statutory guidelines.

This appendix provides facts sheets on each of the materials listed above.

Sodium Salt Organic Reagent

Source:
By-product of industry in Western Australia's South West. (Its use in the production of vanadium is novel and as such patents have been applied for).

Appearance/Physical Characteristics:
The material is produced as a moist filter cake and has a light brown or buff colour. The moisture content, that is percentage of water is high at around 35 to 40% and the material is non-flammable. Hence, there is no fire danger associated with this material.

Of every 1 tonne of material transported, only 40 to 50% is actually the sodium organic salt, the remainder is water, sodium hydroxide, sodium carbonate and sodium sulphate.

Visually the material has the appearance and consistency of wet "potter's clay" although it has a lower density (ie it is light).

ADG* Classification:
The material is classified as Class 6.1(b) with a subsidiary risk of Class 8..
Subsidiary Risk arises from a certain portion of caustic soda trapped in the filter cake - see facts sheet for "sodium hydroxide". Each 1 tonne of material received contains around 0.04 tonnes of sodium hydroxide.

*ADG = Australian Code for the Transport of Dangerous Goods by Road and Rail 7/April/87 no P15.

Interpretation of ADG Classification:
The ADG classifies toxic chemicals into two groups:

- 6.1(a) - Poisonous
  Substances which are liable to cause death or serious injury to human health if swallowed or inhaled or by skin contact,

- 6.1(b) - Harmful
  Substances which are harmful to human health if swallowed or inhaled or by skin contact,

and are allocated among three packaging groups, being:

- Packaging Group I - toxic substances presenting a severe risk of poisoning.

- Packaging Group II - toxic substances presenting a serious risk of poisoning.

- Packaging Group III - harmful substances presenting a relatively low risk of poisoning.

The organic soda salt reagent is given the lower level of categorisation.

The proponent will ensure that the containers used to transport the material meet all the requirements of the Mines Department, Division for the Transport of Explosive and Dangerous Goods.

Sulphuric Acid (98%)

Source:
Produced worldwide and locally for use in many industries.

Appearance/Physical Characteristics:
Colourless, oily liquid.

ADG Classification:
Class 8, Packaging Group II.

Chemical Formula:
H_2SO_4

Interpretation of ADG Classification:
Class 8 comprises substances which are able to damage live tissue.

Ammonium Sulphate

Source:
Produced as a byproduct of mineral processing in Western Australia.

Appearance/Physical Characteristics:
White granular salt.

ADG Classification:
None. Non-flammable, non-toxic.

Chemical Formula:
$(NH_4)_2SO_4$

Alumina Trihydrate

Source:
Produced by Alcoa of Australia in Western Australia.

Appearance/Physical Characteristics:
White to buff sandy material.

ADG Classification:
None. Non-flammable, non-toxic.

Chemical Formula:
$Al_2 O_3 \cdot 3H_2O$

Sodium Hydroxide (Liquid 50% W/W)

Source:
Produced worldwide and locally for use in many industries and domestically.

Appearance/Physical Characteristics:
Viscous clear liquid.

Common Name:
Caustic Soda.

Chemical Formula:
NaOH

ADG Classification:
Class 8, Packaging Group II

Interpretation of ADG Classification:
Class 8 comprises substances being able to damage living tissue.

Vanadium Pentoxide

Source:

Produced as a major product of the Wagoo Hills Vanadium Project.

Appearance/Physical Characteristics:

Metallic flake, of random shape of around 2–3cm wide and 2–3cm long. Thickness is 2–4mm. Colour is metallic with a purple hue.

ADG Classification:

a) Final Form; ie, Fused Flake is not a harmful or dangerous substance (no ADG Classification). This is the form in which the material will be transported. Prior to the production of the fused flake, the vanadium will exist as a granular or non–fused form.

b) Intermediate, non fused form – ADG Classification 6.1(a). Brownish powder. Slightly soluble in water. May act as an oxidising agent. Toxic if swallowed. Irritating to eyes and mucous membranes.

Respirable vanadium dust and fume in the workplace will be maintained below the mines regulation 0.05mg/m^3.

Vanadium Trioxide

Source:

Produced as a major product of the Wagoo Hills Vanadium Project.

Appearance:

Black granular crystals.

ADG Classification:

Dust or powder associated with the crystals is classified as a 6.1(a) poison, and displays identical symptoms as non–fused vanadium pentoxide (see above).