CSBP & Farmers Ltd
Norsk Hydro a.s

Proposed
Ammonia/Urea Plant

Environmental Review and Management Programme
Draft Environmental Impact Statement

Kinhill Engineers Pty Ltd

CSBP & FARMERS LTD
- and -
NORSK HYDRO a.s

PROPOSED AMMONIA/UREA PLANT

**ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME/
DRAFT ENVIRONMENTAL IMPACT STATEMENT**

- Prepared by -

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June 1987

PROPOSED AMMONIA/UREA PLANT
ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME
DRAFT ENVIRONMENTAL IMPACT STATEMENT

The Environmental Protection Authority (EPA) and the Commonwealth Department of Arts, Heritage and Environment (DAHE) invite people to make a submission on this proposal.

An Environmental Review and Management Programme/draft Environmental Impact Statement (ERMP/draft EIS) for the proposed integrated ammonia/urea plant has been prepared by CSBP and Farmers Ltd and Norsk Hydro a.s in accordance with Western Australian and Commonwealth Government procedures. The report will be available for comment for ten weeks, beginning on 4 July 1987 and finishing on 11 September 1987.

Following receipt of comments from government agencies and the public, the proponents will prepare a final EIS. The EPA and the Commonwealth Minister for Arts, Heritage and Environment will each 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 and the DAHE will be acknowledged. Submissions will be evaluated in the development of each of the reports and recommendations made to the State and Commonwealth Government. Submissions will be treated as public documents unless confidentiality is requested and may be quoted either in full or in part in each report.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the ERMP/draft EIS, or with 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 ERMP/draft EIS:

- clearly state your point of view
- indicate the source of your information or argument if this is applicable
- 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 sections, chapter or recommendation in the ERMP/draft EIS.
- If you discuss different sections of the ERMP/draft EIS, keep them distinct and separate, so there is no confusion as to which section you are considering.
- Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name
- address
- date.

The closing date for submission is 11 September 1987.

Submissions should be addressed to:

The Chairman
Environmental Protection Authority
1 Mount Street
Perth, WA 6000

Attention: Mr W. Pradhan

- or -

The Secretary
Department of Arts, Heritage and Environment
GPO Box 1252
Canberra, ACT 2601

Attention: Mr C. Gallagher

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SUMMARY

The proponents - CSBP & Farmers Ltd (CSBP), and Norsk Hydro a.s (Norsk Hydro) of Norway - intend to establish a $450 million facility in the Kwinana industrial area that will use natural gas to manufacture 500,000 t/a of ammonia, and approximately half the ammonia produced to manufacture 430,000 t/a of urea, subject to overall feasibility of the project.

Ammonia is used in the production of nitrogenous fertilisers including urea, a concentrated nitrogenous fertiliser that is used extensively by Western Australian farmers. While ammonia is already produced in the State, all urea is sourced from overseas, leaving farmers totally dependent on imports. The ammonia/urea project will link production of the two products, in what will be the first ammonia/urea plant of its size in Australia and one of the largest in the world.

In 1984, international authorities predicted an impending global shortage of ammonia and estimated that an additional thirty to forty world-scale plants would be required by the year 2000. It was logical to investigate the feasibility of building such a plant in Western Australia, because of the ready rural market for nitrogenous fertilisers. In addition, ammonia production uses natural gas as a raw material, and the Western Australian Government is actively encouraging the development of major industries to consume surplus gas from the North-West Shelf project. CSBP responded to the challenge and was joined by Norsk Hydro in 1985 to study in detail the feasibility of establishing a world-scale ammonia/urea plant in the State.

CSBP and Norsk Hydro submitted a comprehensive proposal to the Western Australian Government in August 1985. Following assessment of this and competing proposals in March 1986, the Government selected CSBP and Norsk Hydro to proceed with a full feasibility study, including negotiation of gas supply with the State Energy Commission of Western Australia.

The proponents submitted a Notice of Intent, outlining the environmental considerations associated with the proposal, to the Environmental Protection Authority (EPA) in April 1986. The EPA advised that the preparation of an Environmental Review and Management Programme (ERMP) would be necessary. Due to the need for Commonwealth export licences for the products, the Australian Department of Arts, Heritage and Environment also required that a draft Environmental Impact Statement (EIS) be prepared. This ERMP/draft EIS meets the requirements of both authorities. After a public review of the document, the proponents will be required to respond to submissions received, and these responses, together with the ERMP/draft EIS document and submissions, will be taken into consideration during the assessment of the project by the EPA and the Department of Arts, Heritage and Environment.

Of the total plant production, approximately 150,000 t/a of ammonia and 330,000 t/a of urea will be exported, directing revenue into the State. Some 100,000 t/a each of urea and ammonia will be supplied to the local market, thus reducing current import expenditure.

Permanent employment for some 200 people will be generated once the plant is operational, and a temporary workforce of up to 1,200 will be required over the twenty-five—month construction period.

The establishment of a world-scale ammonia/urea plant in Western Australia will also create opportunities for the development of downstream industries.

Two detailed site selection studies - one commissioned by the proponents and the other by the State Government - were undertaken for the plant. The regional centres of Bunbury and Geraldton and the Kwinana industrial area were evaluated against the following criteria:

. proximity to the natural gas pipeline
. proximity to established local ammonia consumers
. central location for local urea distribution
. access to both standard and narrow-gauge railway
. access to ship-loading facilities
. availability of engineering support services, workforce and infrastructure
. environmental suitability
. overall cost.

Both studies concluded that Kwinana is the most suitable site for the plant.

The actual location in Kwinana selected is a split site comprising 20 ha of land owned by BP Refinery (Kwinana) Pty Ltd, alongside the Kwinana Nitrogen Company Pty Ltd (KNC) ammonia plant and CSBP's fertiliser works, and 10 ha of land owned by the Fremantle Port Authority and the Industrial Lands Development Authority. The latter area, located to the south of the CSBP works, will accommodate a storage facility for urea.

The principal inputs to the plant will be natural gas, air and water; major outputs will be the products ammonia and urea, water vapour, carbon dioxide, wastewater and air.

The ammonia manufacturing process consists of the following stages:

. removal of sulphur compounds from the natural gas feedstock;

. steam reforming of natural gas into hydrogen and carbon oxides;

. conversion of carbon monoxide and steam to hydrogen and carbon dioxide;

. removal of carbon dioxide;

. methanation of remaining traces of carbon oxides by reaction with hydrogen;

. purification of the gas stream by removal of water, methane, excess nitrogen and inert process air gases, leaving a mixture of hydrogen and nitrogen known as synthesis gas (or 'syngas');

. compression, heating and catalysis of syngas to form ammonia.

The urea process is outlined as follows:

. reaction of carbon dioxide and ammonia to form a mixture of urea, ammonium carbamate, water and excess ammonia;

- stripping of the mixture with fresh carbon dioxide to separate the urea solution, which is then depressurized to remove dissolved gases;

- heating of the urea solution to evaporate water;

- granulation of the urea solution.

Ammonia will be stored in one 30,000 t refrigerated steel tank contained within a full-height concrete bund, the capacity of which will be in excess of that of the tank. Ammonia destined for export will be transported via pipeline to the Kwinana Bulk Cargo Jetty, some 1,800 m away, and onto ships via a mobile loading arm. Ammonia for the local market will be transferred via pipeline to the existing KNC storage tank nearby.

Granulated urea will be stored inside a specially designed building to the south of the CSBP works. Transfer from the urea manufacturing section to the storage building and to CSBP will be via covered overhead conveyor. Urea for the export market will be transferred from storage to the wharf via a high-capacity conveyor for loading onto bulk cargo ships.

Transport of ammonia and urea locally will use the existing distribution systems.

After detailed consideration of alternative cooling systems for the plant, a combination of air-cooling and use of a cooling tower was selected to ensure that the plant's water usage was minimized. Water will be supplied by six bores located near the plant site, to provide a total cooling and process water requirement of 264 m^3/h. The development of this groundwater supply is being investigated further in conjunction with the Water Authority of Western Australia.

At present, studies show that this quantity of groundwater is available; however, the further investigations will concentrate on management of this resource to ensure that abstraction is undertaken in an environmentally acceptable manner and that water usage is kept to a minimum.

The use of a cooling tower will necessitate a continuous blow-down of water from the cooling water circuit to prevent build-up of salts originating from groundwater. This water, which will be the main liquid effluent stream from the process plants, will be discharged into Cockburn Sound via an existing open drain.

All process condensate streams will be collected and treated and the water reused in the plant. This scheme has been devised to meet two requirements:

- minimum need for make-up water
- minimum additional nitrogen load to Cockburn Sound.

Stormwater runoff from the process area, which may contain urea dust and oil waste, will be treated in a holding pond before being channelled to the open drain. Runoff from other areas will be diverted directly to the drain.

Evaluation of the composition of the wastewater stream that will enter Cockburn Sound, using water quality criteria identified by the Department of Conservation and Environment (1981), has indicated that the Sound will not be adversely affected by the proposed discharge.

It is estimated that the nitrogen content in wastewater from the plant will represent about 2% of the long-term objective for nitrogen loading to Cockburn Sound and, in this context, will not be a significant contributor of nitrogen.

Atmospheric discharges will originate from the following sources:

- cooling tower (water vapour and traces of chlorine and a biocide dispersant);
- ammonia reformer stack (nitrogen, oxygen, water vapour, carbon dioxide, argon and traces of sulphur dioxide and oxides of nitrogen);
- ammonia process vents (carbon dioxide, water vapour and hydrogen);
- urea vents and tank (air, water vapour and ammonia);
- granulation scrubber vent and tank (air, water vapour and traces of ammonia and urea dust);
- ship-loading facility (ammonia vapour);
- ammonia flare (nitrogen and water vapour).

All emissions from the urea granulation plant will be scrubbed with diluted urea solution to reduce urea dust concentrations, with urea collected by the scrubbers being returned to the process.

All ammonia emissions from the urea plant will be scrubbed and returned to the process for recovery.

During plant start-up and shut-down, which involve purging of the process equipment with nitrogen, waste gases will be generated. Those produced in the ammonia section will be burnt in the flare and released to the atmosphere in the form of water, carbon dioxide and nitrogen. Waste gases from the urea section, consisting of carbon dioxide, nitrogen, oxygen and hydrogen, will be scrubbed and discharged directly into the atmosphere.

Most of the gaseous emissions from the plant will be normal atmospheric components - nitrogen, oxygen, carbon dioxide, water vapour and inert gases - and these have no direct impact on the environment. The anticipated concentrations of oxides of nitrogen, oxides of sulphur and chlorine have been compared with guidelines for such emissions published by the Australian Environment Council and the National Health and Medical Research Council (1985) and, in all cases, were found to be in compliance; therefore, it has been concluded that there will be no adverse impacts arising from these sources. The trace emissions of biocide dispersant and urea dust are also considered unlikely to cause any adverse environmental impacts.

Of the gases released to the atmosphere, only ammonia has the potential to produce detectable odours. It has been calculated that normal concentrations of ammonia will be well below odour detection levels at residential areas.

Solid wastes produced by plant operations will be negligible, consisting principally of used catalysts, which will be either sold for reprocessing or disposed of by sanitary landfill.

Construction wastes will be disposed of in the normal manner, and those practices generally used by the construction industry for minimizing noise and dust will be adopted.

Noise generated during plant operation will be within statutory levels.

Plant infrastructure will include a two-storey administration office, stores and workshop buildings, first aid facilities, fire-station, canteen, ablution facilities and a car-park. The site will be security-fenced, and access will be via a gatehouse.

The plant will be designed to be compatible with its setting, with use being made of site landscaping and neutral colours for buildings.

The existing road system servicing the area is well able to cater for the increase in vehicle movements that will be generated during construction and operation of the plant.

The proponents commissioned Det norske Veritas, a specialist firm in risk analysis, to undertake a preliminary assessment of risks and hazards associated with the plant. The risk analysis process identifies the potential hazards involved, estimates the frequency at which failure events may occur, assesses the consequences of failure events and then compares the determined risks with acceptance criteria, in this case nominated by the EPA. Det norske Veritas (1987) concluded that the levels of risk associated with the plant will be in compliance with these criteria. This conclusion is in accordance with the results of the Kwinana cumulative risk analysis recently released by the Department of Resources Development (Technica 1987).

The extensive experience of both CSBP and Norsk Hydro in the operation of fertiliser and chemical plants has enabled them to propose an effective programme of environmental and safety management for the plant. Detailed emergency procedures will be developed in consultation with the relevant authorities, and personnel will be trained in these prior to plant operation.

A programme similar to the existing CSBP monitoring programme for liquid discharges, atmospheric emissions, ambient air quality, groundwater quality and noise and dust levels will become part of the performance monitoring of the plant. Results of this programme will be available to the relevant authorities.

Provided the necessary project approvals are secured and subject to overall project feasibility, process design of the plant is planned to commence in January 1988, with construction scheduled from September 1988 and commercial operation from October 1990.

1 INTRODUCTION

1.1 BACKGROUND

The domestic gas phase of the North-West Shelf project supplies natural gas, via the State Energy Commission of Western Australia (SECWA), to major residential and industrial areas and complexes from Karratha in the north of the State to Bunbury in the south.

Since the development of the North-West Shelf natural gas field, the Western Australian Government has been faced with the problem of a decline in the forecast consumption of natural gas. To offset this problem, the State Government has been actively encouraging the development of major industries that consume natural gas.

In 1984, international authorities predicted an impending global shortage of ammonia. The magnitude of the shortage was considered to warrant the establishment of an additional thirty to forty world-scale plants by the year 2000. As the production of ammonia can utilize natural gas as a feedstock, the State Government pursued the development of such a plant in Western Australia.

To this end, in 1985, the State Government extended to interested parties an invitation to undertake a study of the design, construction and operation of an ammonia plant in conjunction with facilities for the manufacture of urea, a fertiliser used widely in Western Australia, but not presently manufactured in the State. Following the assessment of submissions received, the State Government appointed CSBP & Farmers Ltd (CSBP), and Norsk Hydro a.s (Norsk Hydro) of Norway to undertake a full feasibility study for the project on an exclusive basis.

The feasibility study was based on a proposal to construct and operate a plant with the capacity to produce about 1,500 t/d of ammonia and about 1,300 t/d of urea, of which approximately two-thirds of the manufactured product would be exported.

Following the submission to the Environmental Protection Authority (EPA) of a Notice of Intent (NOI) in April 1986, the State Government decided that a detailed analysis of potential sites should be conducted. The proponents (CSBP and Norsk Hydro) complied by commissioning a site selection study to evaluate prospective sites adjacent to the natural gas pipeline. The resulting study found that the environs of Geraldton, Kwinana, Wagerup and Bunbury were the most suitable for detailed study, and that, of these, Kwinana was the best location. The results of the site selection study were forwarded to the State Government in confidence in May 1986.

Due to the regional importance of the proposed plant, the Government decided to commission an independent site selection study. The subsequent report, prepared by three consultant groups, was released by the Minister for Minerals and Energy on 23 July 1986. Although it did not consider a site at Wagerup, it found that each of the other locations had factors in their favour, but that, overall, Kwinana was the most suitable location. In particular, the study estimated that if one of the country sites were chosen over Kwinana, it would add some $40 million to the overall cost of the project.

In releasing the report, the Minister stated that, while the State Government was keen for the plant to be located elsewhere in Western Australia, the evaluation of economic, social and safety factors by highly qualified consultants presented a very strong case for the siting of the plant in the Kwinana industrial area.

Following consideration of the NOI, the EPA advised the proponents that, under existing environmental legislation, implementation of the proposed project would have to be preceded by the preparation of an Environmental Review and Management Programme (ERMP). Similarly, the Federal Government, through the Department of Arts, Heritage and Environment, required that a draft Environmental Impact Statement (EIS) be prepared.

The proponents have commissioned Kinhill Engineers Pty Ltd (Kinhill) to prepare this ERMP/draft EIS to assess the environmental factors relevant to the design, construction and operation of the proposed ammonia/urea plant. Det norske Veritas, of Sydney, has been commissioned to undertake a preliminary risk assessment as an input to the ERMP/draft EIS.

1.2 SCOPE AND STRUCTURE OF THE REPORT

The primary objectives of this ERMP/draft EIS are:

- to provide the public and government with an overview of the proposal and the associated environmental impacts;
- to provide an opportunity for interested parties to make comment;
- to enable the project to proceed, subject to the environmental impacts being considered acceptable.

The intention of the document is not to satisfy licence conditions under relevant legislation, as these will be the subject of detailed discussions with the relevant authorities; therefore, details are kept to a minimum. The emphasis of the report is on the broad environmental impacts associated with construction and operation of the plant, and the proponents' proposed management plans and commitments in regard to these.

The environmental appraisal covers the physical, social and biological environment of the plant site and its immediate environs, as well as the wider area surrounding Kwinana.

The format of the document is as follows:

- A summary of major points is provided at the beginning of the document.
- Section 1 provides details of the proponents, a brief history of the project to date, statutory requirements and the environmental approval process, and the interactions between the proposed plant and other industrial developments in the Kwinana industrial area.
- Section 2 analyses the need for an ammonia/urea plant in terms of natural gas supply and expected benefits that will be accrued by local industry, the agricultural sector and the local, regional and State economies.

- Section 3 evaluates project alternatives with regard to regional site selection, urea fertiliser for the agricultural sector, process technology, ammonia storage, cooling system and method of transport.

- Section 4 outlines all aspects of the proposal, including ammonia and urea production processes, waste disposal, plant components, plant safety, the construction, commissioning and operational phases, and the project schedule.

- Section 5 describes aspects of the existing physical, biological and social environment, including consideration of aspects relating to meteorology, groundwater, land use, noise, landscape, Cockburn Sound and existing risks and hazards.

- Sections 6 and 7 evaluate the impacts that the plant will have on the existing biological and social environments, respectively, during both the construction and operational phases. Aspects of the biological environment that are considered include groundwater supplies, atmospheric and liquid discharges, and solid waste disposal. The assessment of the social environment considers noise, aesthetics, traffic, odours, risks and hazards, and their implications upon planning.

- Section 8 outlines the proposed programme of environmental management that will be implemented to ensure that impacts are minimal.

- Section 9 sets out the main conclusions of the environmental assessment.

Details of the preliminary risk assessment are included in the ERMP/draft EIS; the full report of Det norske Veritas forms a separate technical appendix to the ERMP (Det norske Veritas 1987).

1.3 THE PROPONENTS

The proponents for the project are CSBP and Norsk Hydro.

CSBP is the only primary producer of fertilisers in Western Australia and its production constitutes about one-third of the Australian total. It has been a manufacturer of fertiliser for more than seventy-five years and operates five manufacturing sites, the largest of which is at Kwinana. CSBP operates Kwinana Nitrogen Company Pty Ltd (KNC), the larger of the two existing ammonia plants in Western Australia, on behalf of the plant's owner, the Wesfarmers group, and bases its current production of nitrogen fertilisers on supply from this plant. CSBP has a well established fertiliser distribution network within Western Australia. The company provides full agronomic support to its customers, both to promote fertiliser use and to help ensure maximum utilization efficiency.

Norsk Hydro is the leading producer and marketer of fertilisers world-wide. The company, majority-owned by the Norwegian State, was founded eighty years ago specifically to produce nitrogenous fertilisers. It has since diversified extensively, but maintains a primary commitment to the fertiliser sector, as reflected by its recent major acquisitions in Western Europe. Norsk Hydro has developed an international distribution network largely based on its own terminal facilities and sales offices. In this way, it has established a fully integrated production/marketing system, ensuring maximum cost-effectiveness and security of supply to its customers. A particular commitment has been to the Asian market because of that region's substantial growth potential. Norsk Hydro continues to expand its distribution network. Product is currently sourced from its own operations in Western Europe and the Middle East, as well as from other producers. Exports from the proposed plant will be readily absorbed into this distribution system.

The proponents will seek other partners for the venture before it is implemented.

1.4 STATUTORY REQUIREMENTS

The following Acts apply to the construction and operational phases of the project:

- State:
  - Town Planning and Development Act, 1928 (as amended)
  - Industrial Lands (Kwinana) Agreement Act, 1964 (as amended)
  - Local Government Act, 1960 (as amended)
  - Metropolitan Region Town Planning Scheme Act, 1959 (as amended)
  - Environmental Protection Act, 1986
  - Factories and Shops Act, 1963 (as amended)
  - Occupational Health, Safety and Welfare Act, 1984 (as amended)
  - Health Act, 1911 (as amended)
  - Machinery Safety Act, 1974 (as amended)
  - Construction Safety Act, 1972 (as amended)
  - Poisons Act, 1964 (as amended)
  - Rights in Water and Irrigation Act, 1914 (as amended);
- Commonwealth:
  - Environment Protection (Impact of Proposals) Act 1974 (as amended).

The relevant application of each Act is described briefly as follows:

- The Town Planning and Development Act, 1928 (as amended) empowers the Town of Kwinana to control development under the provisions of its Town Planning Scheme. It will be necessary to apply to the Town Council for development approval ('Application for approval to commence development') and separate building approvals.
- The Industrial Lands (Kwinana) Agreement Act, 1964 (as amended) effects the disposition of certain lands at Kwinana for industrial purposes.
- The Local Government Act, 1960 (as amended) provides authority to the Town of Kwinana with respect to local planning and zoning regulations.
- The Metropolitan Region Town Planning Scheme Act, 1959 (as amended) provides the State Planning Commission with regional planning powers to control development. An application for development approval will be submitted via the Kwinana Town Council.
- The Environmental Protection Act, 1986 and the Environment Protection (Impact of Proposals) Act 1974 (as amended) require that the proponents prepare documentation of the proposal, stating the environmental impacts, for evaluation by relevant authorities before environmental approval can be granted.

- The Factories and Shops Act, 1963 (as amended) and the Occupational Health, Safety and Welfare Act, 1984 (as amended) lay down regulations to ensure the good health and safety of employees and the general public.

- Under the provisions of the Health Act, 1911 (as amended), the local authority is delegated the responsibility of controlling 'offensive trades'. If the Town Council classifies the proposed operation as 'noxious', it will be necessary to apply for registration of the site as an 'Offensive trade - chemical works'.

- The Machinery Safety Act, 1974 (as amended) sets out the safety requirements for machinery.

- The Construction Safety Act, 1972 (as amended) makes provisions for the safety and welfare of persons engaged in construction and other work, and for incidental and other purposes.

- The Poisons Act, 1964 (as amended) regulates and controls the possession, sale and use of poisons and other substances, and constitutes a Poison Advisory Committee.

- The Rights in Water and Irrigation Act, 1914 (as amended) may regulate the containment of liquid wastes and runoff water in on-site holding ponds. In addition, the Act will regulate extraction of superficial groundwater supplies for use as plant process water when water extraction in the groundwater area requires licensing.

In addition to these Acts, it is recognized that regulations relating to the export of raw or primary processed material requiring export licences will apply to the operation of the plant.

Control of the shipping of both refrigerated liquid ammonia and bulk urea will be the responsibility of the Fremantle Port Authority (FPA). In relation to the shipping of ammonia, it is likely that the FPA will adopt the Association of Australian Ports and Marine Authorities rules for the safe transport, handling and storage of dangerous substances and oil in port areas.

The Dangerous Goods (Road Transport) Regulations, 1983, (as amended), administered by the Department of Mines, will not specifically apply to the project, as the existing ammonia and urea distribution system will be utilized for the product destined for the local market.

The plant will be constructed and operated pursuant to the requirements of all relevant Acts and regulations.

1.5 THE ENVIRONMENTAL APPROVAL PROCESS

The environmental approval process, illustrated in Figure 1.1, was initiated by the proponents, who submitted an NOI in April 1986 for consideration by the EPA.

Following its review of the NOI, the EPA required that the proponents prepare an ERMP under the powers given in the Environmental Protection Act, 1971 (this Act has since been repealed by the Environmental Protection Act, 1986).

The ERMP is designed to fulfil the requirements of the State Government. The EPA makes the document available for public review for a time period set by the

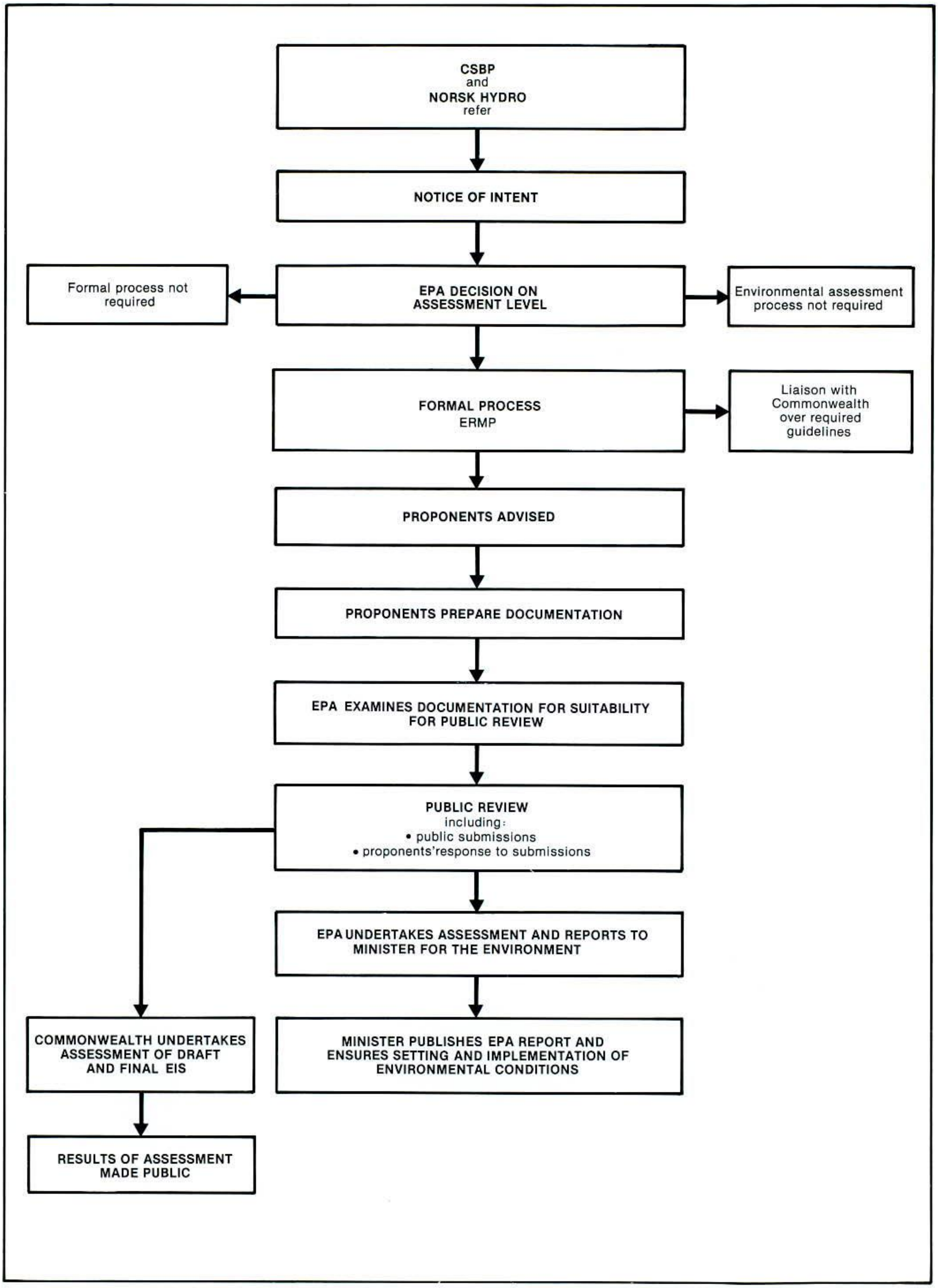

Figure 1.1
ENVIRONMENTAL APPROVAL PROCESS

Authority. Taking account of public submissions and the proponents' response to them, the EPA undertakes an assessment of the ERMP. The EPA's assessment report is presented to the Minister for the Environment and the Minister ensures that environmental conditions are set and implemented.

The Federal Government has constitutional powers under the Environment Protection (Impact of Proposals) Act 1974, with its associated administrative procedures, to require that a draft EIS be prepared under the following circumstances:

- where Foreign Investment Review Board approval is required for overseas borrowings to finance the venture;

- where the export of raw or primary processed material requires an export licence from the Commonwealth;

- where the development affects land or sea under the jurisdiction of the Commonwealth.

For this proposal, the need for an export licence necessitates adherence to Federal Government environmental approval requirements, and the Department of Arts, Heritage and Environment has confirmed that the preparation of a draft EIS will be required.

A memorandum of understanding between the State and Federal Governments, signed in 1976, ensures collaboration when a proposal is subject to the requirements of both for environmental assessment. In this event, guidelines for a single ERMP/draft EIS are agreed by both Governments (Appendix A). The State Government takes the lead role in liaison with the proponents, taking into account any special Commonwealth requirements.

The Commonwealth requires a similar public review period for the draft EIS, but stipulates that the release of the ERMP/draft EIS be advertised nationally.

The Commonwealth requires the proponents to respond in writing to each of the public submissions received in regard to the draft EIS. These public comments, together with the proponents' response and the draft EIS, then become the final EIS upon which environmental approval is considered.

1.6 INTERACTION WITH OTHER DEVELOPMENTS

The site for the proposed ammonia/urea plant is within the Kwinana industrial area. This area already accommodates a diverse range of major industries, which include:

- Alcoa of Australia Ltd alumina refinery - refines bauxite to alumina and exports this alumina, together with alumina refined at Pinjarra, through ship-loading facilities;

- SECWA Kwinana power station - generates power, with a capacity to use oil, coal or natural gas as fuel;

- BHP Steel International Group/Australian Iron & Steel Pty Ltd - with the closure of the blast furnace, only the Wire Products and Rod and Bar Divisions are now operational, together with the use of the jetties for general cargo;

- BP Refinery (Kwinana) Pty Ltd (BP Refinery) - provides a wide range of fuels and lubricating oils from local and imported crude oils;

- CSBP - primarily a fertiliser plant, also produces a diverse range of chemical products for local market requirements;

- KNC (operated by CSBP) - manufactures ammonia, nitric acid and ammonium nitrate solution;

- Western Mining Corporation Ltd (WMC) nickel refinery - refines Kambalda ore for local and export markets and operates a small ammonia plant as part of this refinery operation;

- Co-operative Bulk Handling Ltd grain terminal - major storage and ship-loading facility for local harvest of grains;

- Cockburn Cement Ltd - produces cement and lime for local markets;

- other industries, including Coogee Chemicals Pty Ltd, Nufarm Chemicals Pty Ltd (Nufarm), Liquid Air (WA) Pty Ltd and Commonwealth Industrial Gases Ltd;

- various engineering, fabrication and construction industries, including CBI Constructors Pty Ltd, Electric Power Transmission Pty Ltd, Transfield (WA) Pty Ltd and Steel Mains Pty Ltd.

In addition to the ammonia/urea plant, industrial developments currently proposed or committed in the Kwinana industrial area include:

- a zirconia plant (ICI Australia Operations Pty Ltd) - an area of 20 ha has been made available, with construction subject to the results of pilot plant studies being conducted in Melbourne;

- a sodium cyanide plant (Australian Gold Reagents Pty Ltd, a company jointly owned by CSBP, Coogee Chemicals Pty Ltd and the Australian Industry Development Corporation) - this project has been subject to EPA assessment of a Public Environmental Report (PER) and public submissions, and is currently awaiting a decision by the State Government;

- a chlor-alkali plant (CSBP) - currently being commissioned;

- a liquefied petroleum gas (LPG) plant (Wesfarmers Kleenheat Gas Pty Ltd) - following development approval in 1985, preparatory site work has commenced, and production is expected in late 1988;

- marine support facility - the timing and method of development are subject to continuing assessment and negotiation between the State and Federal Governments.

The locations of these existing and committed/proposed industries in the Kwinana industrial area are shown in Figure 1.2.

The proposed ammonia/urea plant will interact with other developments in the following ways. It will:

- have the capacity to supply ammonia to KNC, CSBP, WMC, the proposed sodium cyanide plant and new users as required;

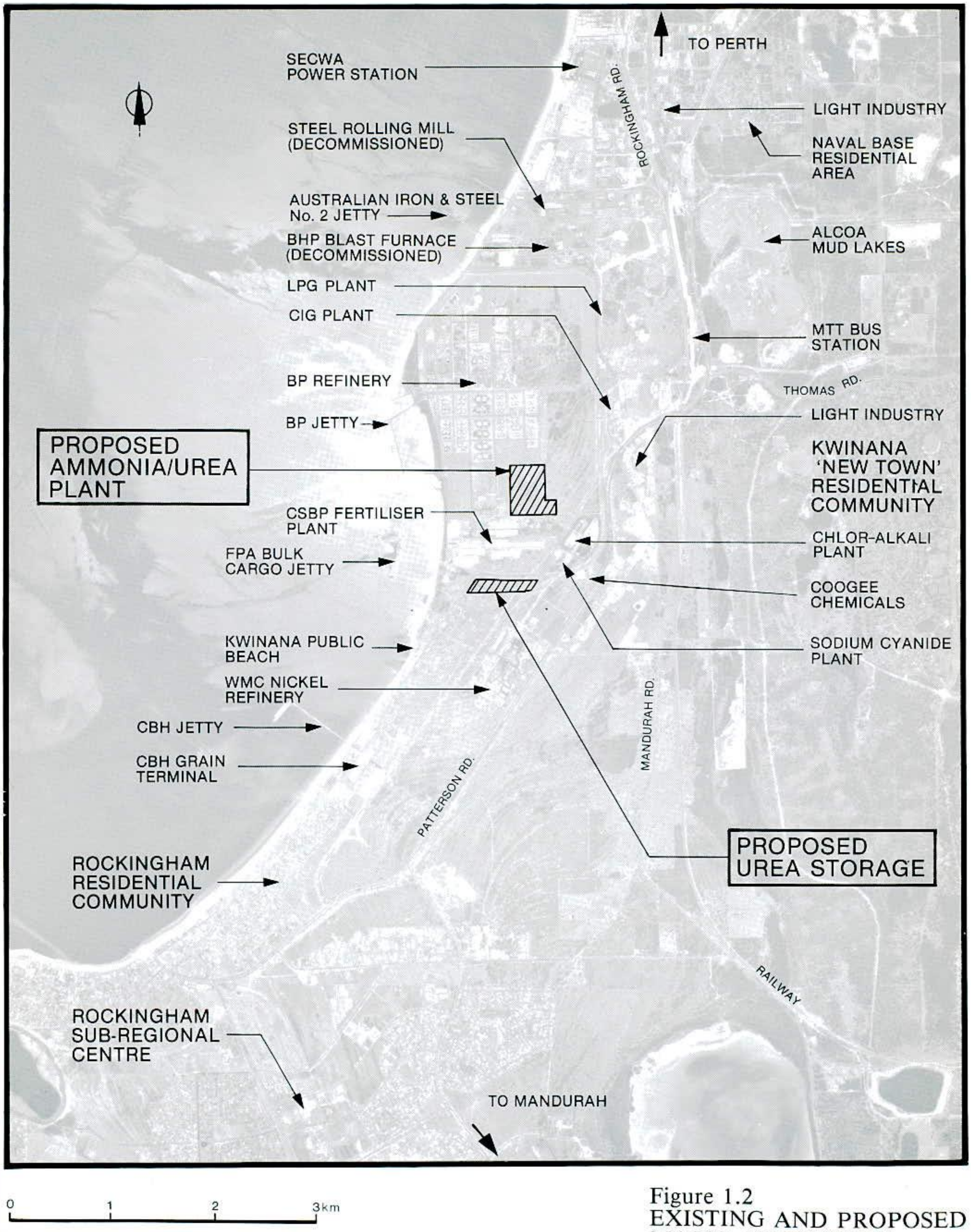

Figure 1.2
EXISTING AND PROPOSED
MAJOR INDUSTRIES

- supply urea to CSBP for distribution to local users;
- use the port facilities for the export of urea and ammonia;
- use local engineering services to complement the permanent maintenance workforce at the plant;
- be a significant consumer of natural gas;
- contribute significantly to the gas throughput and hence the yield of LPG from the LPG extraction plant.

2 NEED FOR THE PROJECT

Section 2 discusses the benefits that the establishment of the proposed ammonia/urea plant at Kwinana will provide to various sectors of the Western Australian community and to the State and Australian economy.

2.1 BENEFITS TO THE STATE

Ammonia and urea are used extensively in Western Australia: the latter primarily as a nitrogenous fertiliser; the former as a raw material for other nitrogen-based fertilisers, and also in areas such as ammonium nitrate manufacture, nickel refining and industrial refrigeration.

Western Australia has two small ammonia plants, which satisfy some local requirements, but imports all its urea requirements from overseas. The ammonia-based fertiliser diammonium phosphate (DAP) and some sulphate of ammonia are also imported.

If the new plant is established, it is proposed to produce 500,000 t/a of ammonia, of which half will be used in the manufacture of urea. Of the remainder, approximately 100,000 t/a will be sold to local consumers and the balance exported.

At present, both ammonia producers and most users are located in the Kwinana industrial area. The total Western Australian usage of ammonia for 1985-86 was 60,000 t, made up as follows:

- WMC 20,000 t
- KNC 26,000 t
- CSBP 14,000 t

An output of 430,000 t/a of urea will be manufactured in the proposed plant, of which about 100,000 t/a will be sold locally and the remainder exported. Urea is used extensively in the wheat-belt areas of the State (see Figure 2.1) as a nitrogenous fertiliser, with the actual amount distributed in 1985-86 totalling 50,000 t. Some 60% of urea currently distributed in Western Australia by CSBP is channelled through its Kwinana works, due to the availability of the wharf facility and Kwinana's central location in relation to the wheat-growing area.

It is proposed that export sales be distributed through Norsk Hydro's established international export market and that opportunities for interstate sales of the products be pursued. The income generated from the sale of ammonia and urea overseas will assist in reducing the trade deficit ($3,383 million in the 1985-86 period [Australian Bureau of Statistics 1987]) and will be significant in that it involves secondary processing and, therefore, adds value to a raw material that would otherwise be exported as liquefied natural gas.

Increased export tonnages will increase revenue to the State from wharf and associated charges. The project will also reduce Australian import expenditure and eliminate the existing dependence upon imported urea, thereby improving security of supply to farmers and other consumers.

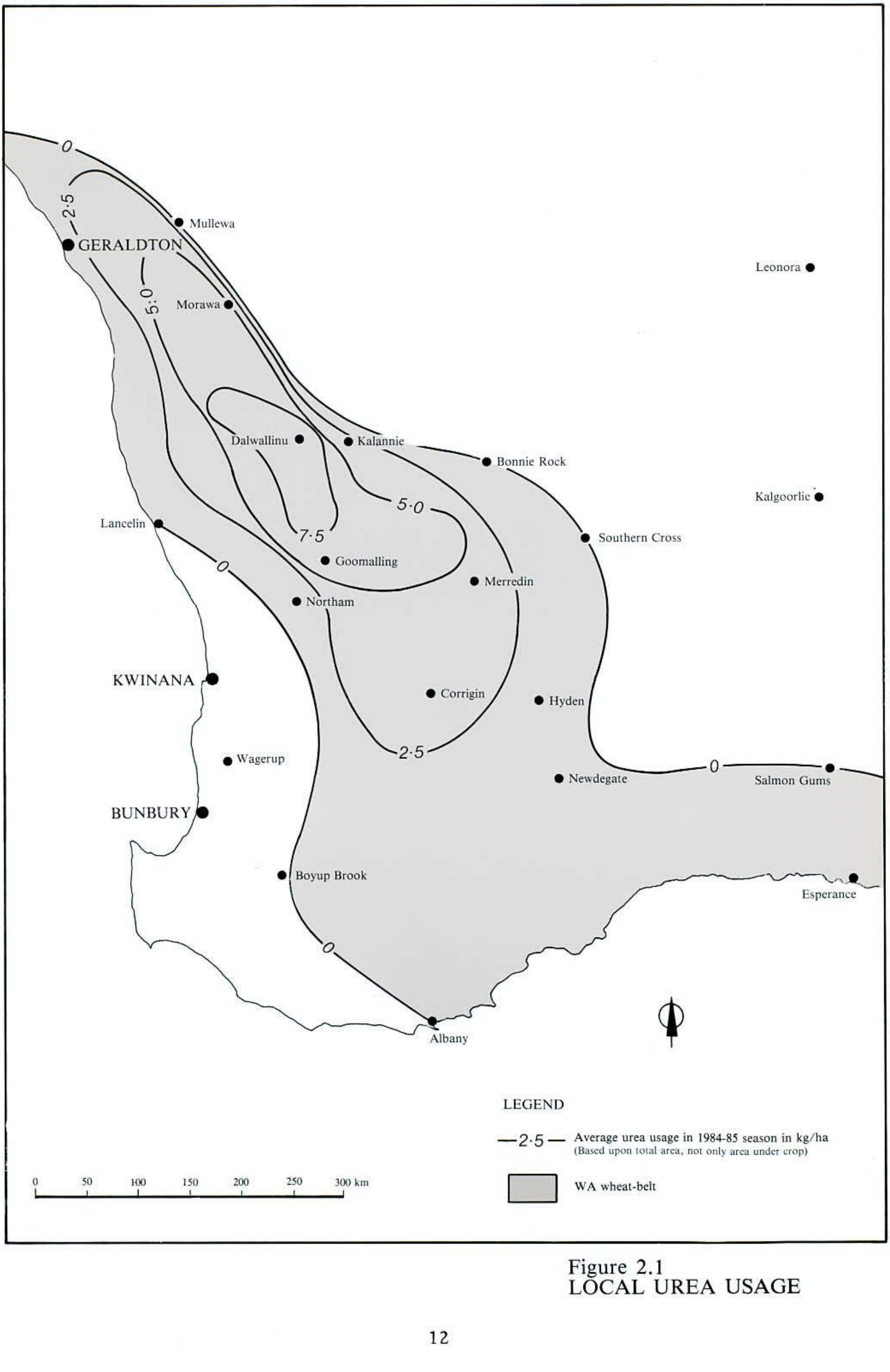

Figure 2.1
LOCAL UREA USAGE

By creating temporary jobs during the construction phase and ongoing jobs when in operation, the project will assist in decreasing unemployment in the State, which was at a level of 8.3% in February 1987. The capital cost of the project is expected to be around A$450 million, of which more than 60%, or about A$300 million, will be Australian content, representing a huge investment for the State.

2.2 NATURAL GAS SUPPLY

If the proposed plant is established, natural gas will be drawn from the existing Dampier-Wagerup natural gas pipeline for use as a feedstock in the process to produce ammonia. The gas demand will be approximately 56-60 TJ/d, making the plant the second largest consumer of natural gas in the State and dramatically reducing SECWA's surplus gas supply.

2.3 BENEFITS TO INDUSTRY

The proposed project will provide the potential for flow-on to the manufacturing industry by establishment of downstream industries.

Apart from being a precursor to urea, ammonia is used as an intermediate product in other nitrogen-containing fertilisers, such as sulphate of ammonia, ammonium phosphate, Agras, Agran and NPK fertilisers. It is also utilized in the production of ammonium nitrate and nitric acid, to remove sulphides from nickel ores, and can be utilized as a heat transfer agent in refrigeration.

Although used primarily as a fertiliser, urea is also used in the manufacture of urea-formaldehyde resins.

2.4 BENEFITS TO AGRICULTURE

Agriculture is one of the most important industries in Western Australia. The gross value of agricultural commodities produced in the State for the 1985-86 period was A$2,214 million (Australian Bureau of Statistics, in press). Fertilisers represent a significant expenditure in the production of these commodities, as most rural areas of the State consist of poor, nutrient-deficient soils. Should the plant be established, it is expected that the cost of locally manufactured ammonia-based fertilisers will be reduced, with consequent cost savings to Western Australian farmers. The current dependence upon imported urea will also be eliminated, thereby assisting price stability.

Urea has agricultural advantages over other fertilisers:

- It has the highest nitrogen content (46%), which, in turn, reduces cartage and application costs.
- It enters the soil in the ammonium form, which is more resistant to leaching than the nitrate form.
- It dissolves in water easily and is therefore suitable for foliar application, irrigation injection and spray broadcasting.

2.5 BENEFITS TO THE COMMUNITY

Construction and operation of the plant will generate direct and indirect employment in Kwinana.

A construction workforce of up to 1,200 will be required. When fully operational, the plant will employ up to 200 people - shift operators, day workers, maintenance personnel, technical staff, administration staff and management. At present, approximately 54% of CSBP's employees at the Kwinana works are from the Kwinana or Rockingham areas, and it is expected that many of the personnel for the proposed plant will also be drawn from the local workforce. Employees will receive on-site training in specific skills.

The plant will also stimulate indirect employment, through support industries and the provision of goods and services, in numbers conservatively double those directly employed. This will include the provision of ongoing contract maintenance services (approximately thirty to forty jobs), which will complement the permanent maintenance workforce associated with the plant.

3 EVALUATION OF ALTERNATIVES

Section 3 evaluates the range of alternatives that were considered for the proposed plant in order to achieve the most environmentally sound and economic operation. The 'no-project' option is also discussed.

3.1 'NO-PROJECT' OPTION

The consequences of a 'no-project' option would be the loss of benefits from the production of ammonia and urea as outlined in Section 2. These can be summarized as follows:

- Substantial export revenue would be foregone, and the existing dependence upon imported urea would continue; together, these factors would have a negative impact of over $100 million per annum on Australia's balance of trade.

- Western Australia would forego:

  - the opportunity for increased consumption of SECWA's surplus natural gas supply;

  - benefits to industry through the manufacture of intermediate products;

  - benefits to agriculture through locally manufactured ammonia-based fertilisers.

- The local community in and around Kwinana-Rockingham would not have the opportunity to benefit from the generation of direct and indirect employment resulting from the construction and operation of the plant.

3.2 ALTERNATIVES TO UREA IN AGRICULTURE

Each year, approximately 6 million hectares of the 14 million hectares developed for agriculture in Western Australia are cropped to cereals (wheat, oats, barley and triticale) or grain legumes (lupins).

The vast majority of the remainder (some 7 million hectares) is occupied by sheep, mainly merinos for wool, and cattle, predominantly beef breeds grazing subterranean clover or medic-based pastures.

Fertilisers used on pastures and grain legume crops predominantly supply phosphorus, sulphur and potassium to plants. This is applied mainly as superphosphate (9.1% phosphorus, 10% sulphur) and muriate of potash (49.8% potassium).

Applications to cereal crops account for about half the total tonnage of fertiliser used and include about 80,000 t/a of elemental nitrogen.

The nitrogen originating from fertiliser supplements the supply derived from the organic matter accumulating under the legume pastures, which are generally rotated with cereal crops every two to three years.

All of the fertiliser nitrogen used in the State has its origins as ammonia, with urea constituting the largest single source, followed by the Agras products and DAP, with ammonium sulphate and ammonium nitrate (Agran 34-0) accounting for smaller proportions still (Table 3.1).

Table 3.1 Nitrogen fertiliser sales in Western Australia, 1985-86

Source	Registered analysis		Proportion of total nitrogen (%)*
	% nitrogen	% phosphorus	
Urea	46.0	0	38.0
Agras no. 1**	17.5	7.6	26.0
Agras no. 2**	12.0	10.0	5.0
DAP	17.5	20.0	24.0
Ammonium sulphate	21.0	0	1.0
Ammonium nitrate	34.0	0	4.0
Others	-	-	2.0

* Total usage approximately 76,000 t nitrogen.
** Registered CSBP trade names.

In Western Australia, very little urea is applied in blends with other fertilisers. Rather, it is common practice to apply urea either immediately before or after the crop is sown with a separate application of phosphate fertiliser (superphosphate, double superphosphate or triple superphosphate) or as a broadcast application three to eight weeks after the crop has emerged.

Normal nitrogen application rates are 10-50 kg of nitrogen per hectare, with urea being applied at rates of 30-70 kg/ha. In recent years, the average application rates for both nitrogen and urea have increased by 2-5% per annum.

The pre-eminence of urea as a source of nitrogen is attributable largely to its current low cost, the lower transport cost due to its higher nitrogen concentration (46% compared to 34% in ammonium nitrate), and the greater ease of handling compared to ammonium nitrate, which is subject to packaging and transport restrictions.

The ammonia-based compound fertilisers - particularly the Agras products, which are ammonium sulphate/ammonium phosphate compounds - have particular advantages in many circumstances in Western Australia, where their robust handling characteristics, sulphur content, beneficial impact on manganese availability and on the incidence and severity of the cereal root disease 'take-all' give them a value above and beyond their simple nutrient content.

For summer irrigated pastures, urea has little advantage over ammonium nitrate or ammonium sulphate because of the likely losses of nitrogen from the volatilization of ammonia formed from urea. For horticultural applications, it is preferred over other single-nutrient nitrogen sources, only because it has a price advantage. Horticultural users have available to them a range of NPK compound fertilisers, with varying nutrient ratios, which account for a significant proportion of the nitrogen used in these enterprises.

3.3 SITE SELECTION

In 1985, the State Government invited interested parties to submit proposals to undertake a feasibility study of the design, construction and operation of an ammonia/urea plant. Upon assessment of the submissions received, CSBP and Norsk Hydro were appointed in March 1986 to undertake negotiation of a Framework Agreement for the project and a full feasibility study.

Following the submission to the EPA of an NOI in April 1986, the State Government requested that a detailed analysis of suitable sites be conducted. The proponents commissioned Kinhill and the risk analyst firm of Det norske Veritas to evaluate prospective sites, which resulted in Kwinana being determined to be the optimum site in preference to the environs of Geraldton and Bunbury. This conclusion was substantiated by a similar site selection study commissioned by the State Government.

The selection of Kwinana as the location for the project was subsequently endorsed by the Western Australian Government in July 1986.

A summary of the site selection evaluation is presented as follows.

3.3.1 Selection criteria

Three centres along the route of the natural gas pipeline from Dampier (see Figure 3.1) were evaluated as possible sites for the plant - Geraldton (500 km north of Perth), Kwinana (in the south-west corridor of the Perth metropolitan region) and Bunbury (175 km south of Perth). The following criteria were used in the assessment:

- proximity to established ammonia consumers;
- proximity to the Western Australian urea market;
- use of existing CSBP and KNC facilities for handling ammonia and urea to domestic consumers;
- access to both standard and narrow-gauge rail systems;
- deep water access to allow the use of large bulk carriers for product export;
- access to the gas trunk pipeline;
- availability of engineering support facilities in the area;
- availability of suitable areas of land for the new facilities;
- proximity to a population centre to supply the labour force;
- foundation conditions suitable for tankage, reactors, stripping columns and heavy rotating machinery;
- environmental considerations - in particular, an acceptable level of imposed risk to surrounding land users;

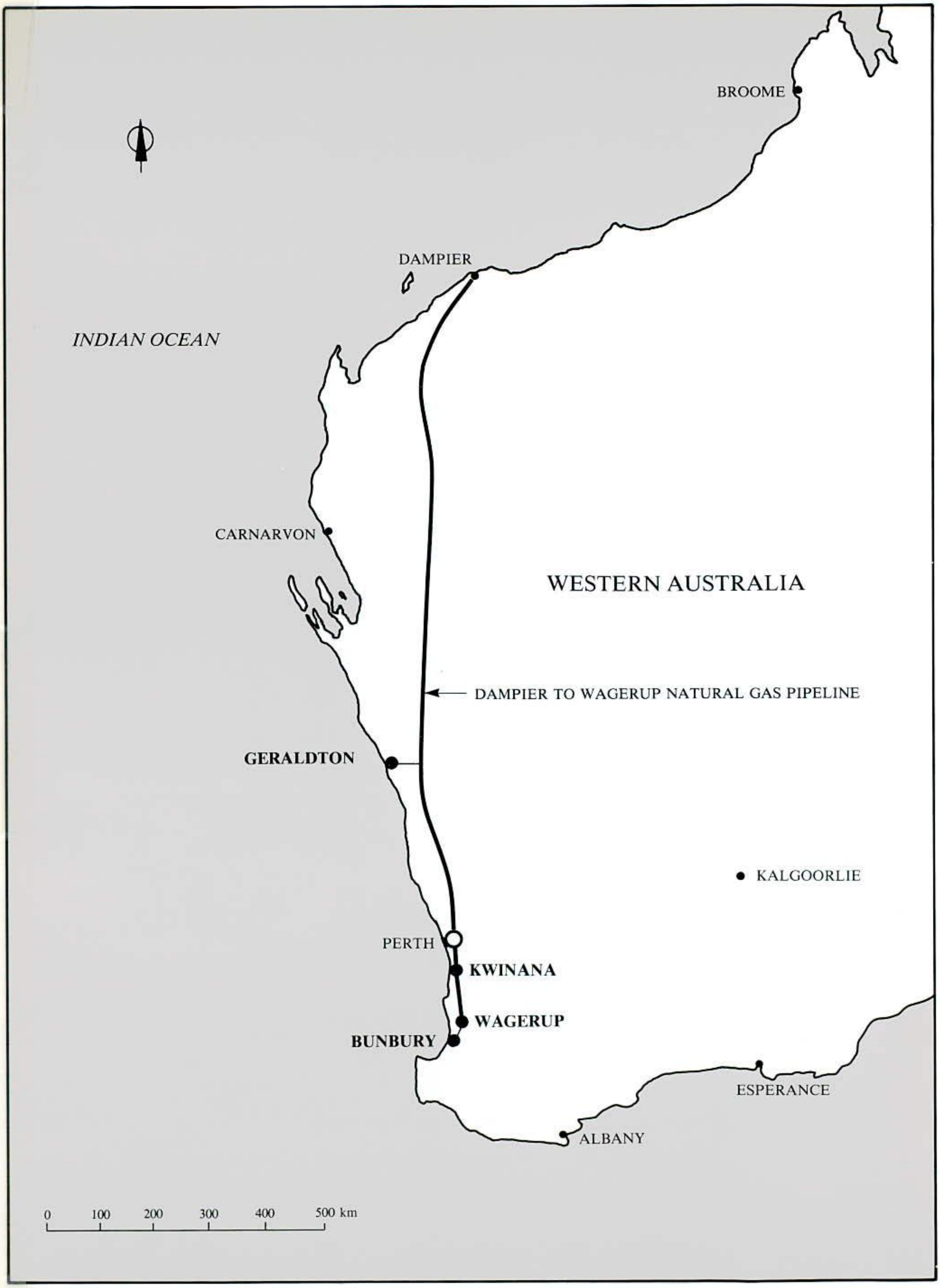

Figure 3.1
ALTERNATIVE LOCATIONS

. overall cost considerations.

Another criterion considered was compatibility with State Government objectives. The State Government has a commitment to decentralization and the establishment of industry in centres away from Perth when alternative locations can be proven to be economically viable. At the same time, planning decisions made over thirty years ago, also endorsed by the current Government, have resulted in the establishment of a well-serviced heavy industrial area at Kwinana, where cross-linkages between industries have developed. Therefore, the siting of the industry at any of the three regions that were considered would be generally in accordance with the Government's objective, which, primarily, is to establish another major industry in the State consistent with State policies on environmental protection and safety.

3.3.2 Evaluation of sites

Six prospective sites were evaluated: one in Geraldton, two in Kwinana, two in Bunbury and one in Wagerup; for the purpose of this discussion, the less favourable Kwinana site is omitted and the Wagerup site is included as part of the Bunbury region. Each of these sites is discussed as follows.

Geraldton 'Narngulu'

The Geraldton 'Narngulu' property, shown in Figure 3.2 and known as Lot 2286, comprises approximately 81 ha.

Geraldton, at the northern extremity of the wheat-belt, is favourably placed in relation to the high urea consumption areas, and the existing rail system would not require upgrading. The northern half of Lot 2286 aligns with an existing narrow-gauge rail spur running off the Geraldton-Mullewa main-line.

The site is less than 2 km from the existing 150 mm lateral to the natural gas pipeline. An additional 300 mm diameter lateral of over 50 km length would need to be constructed if the plant were located at this site.

As Lot 2286 is located away from the port area, an ammonia pipeline to the port and additional ammonia storage facilities at the port would be required. Both of these considerations would incur additional costs and risk. The EPA guidelines for residential areas (Department of Conservation and Environment 1985) restrict the ammonia pipeline route to a minimum distance of 150 m from residential areas. Geraldton is particularly disadvantaged in this regard because of the large number of residential areas that the pipeline would have to pass through. Further, a preliminary risk assessment undertaken for the site selection study by Det norske Veritas indicated that, with the current port arrangement at Geraldton, there are no storage sites sufficiently distant from residential areas to be acceptable. The Det norske Veritas study also showed that ammonia plants located in close proximity (up to 4.5 km) to airports are at risk, which is the case at Narngulu.

A further constraint imposed upon the Geraldton site is the ability to cater for the number of construction workers that will be involved on this project. As the construction period is limited and the peak employment level of 1,200 workers would be short-lived, it is unlikely that permanent accommodation would be developed in response to this demand.

Another consideration is the LPG extraction plant, which is currently under construction in Kwinana. This plant will extract the LPG fraction from the natural gas and return the remainder back to the pipeline for use by consumers.

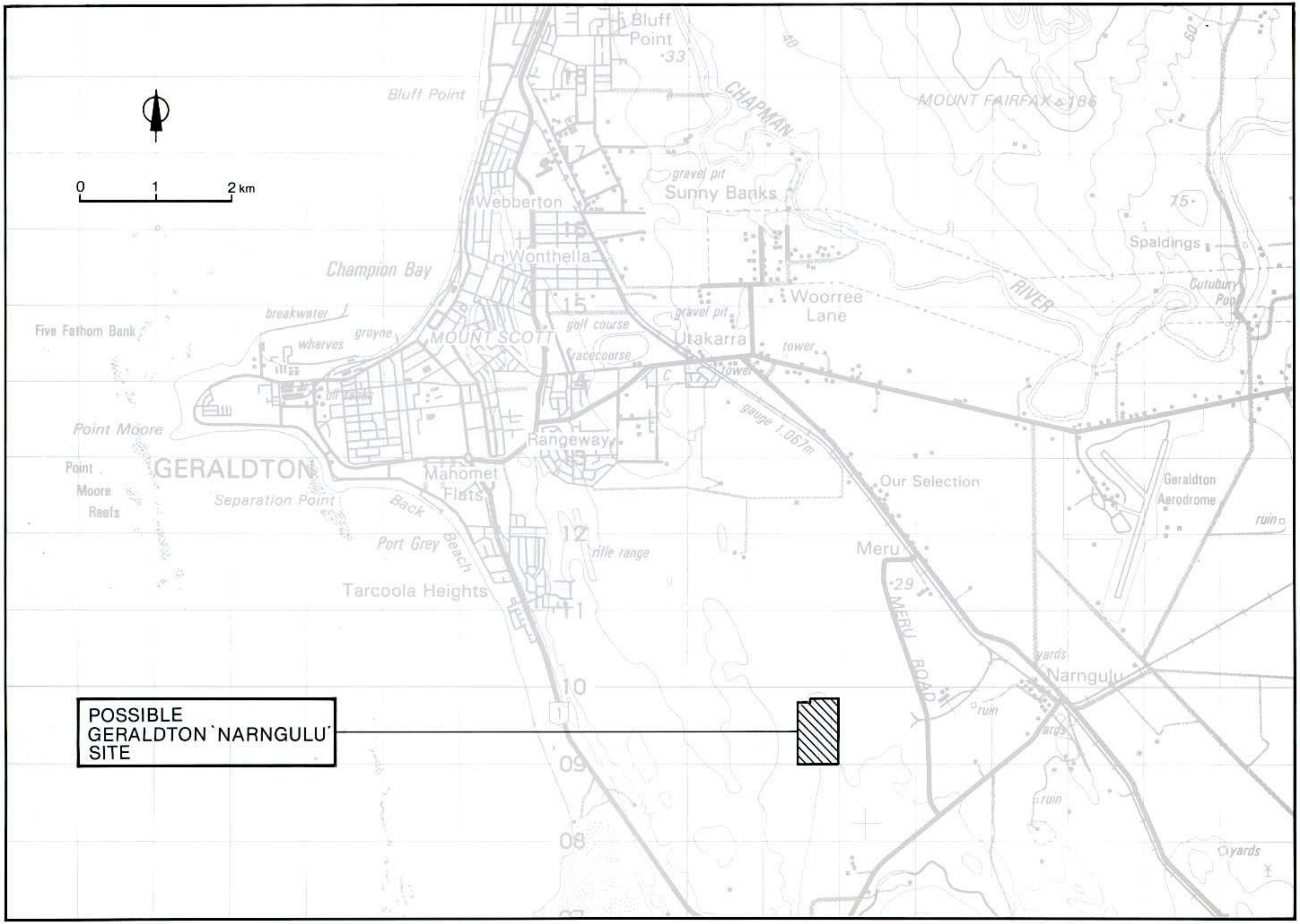

Figure 3.2
GERALDTON—POSSIBLE
SITE LOCATION

It is extremely desirable to SECWA that the proposed ammonia/urea plant be located downstream of the LPG plant; if this were not so, the LPG components of the natural gas consumed by the ammonia/urea plant would represent a loss to SECWA, since they could not be sold to the operators of the LPG plant. Narngulu is located upstream of the LPG extraction plant.

Bunbury 'Picton'

The prospective site at Picton is located immediately north of the Picton rail loop between Temple Road and South Western Highway. The property, known as Lot 49 and shown in Figure 3.3, is in the Shire of Dardanup, immediately east of the boundary with the City of Bunbury.

Bunbury is supplied with natural gas via a 273 mm diameter pipeline from Wagerup to Worsley and a 168 mm diameter pipeline from Worsley to Bunbury. The site would require 50 km of new pipeline from Wagerup to Eaton Drive, in addition to a further 2 km within a new easement from Eaton Drive to the plant.

Bunbury is located west of the southern one-third of the wheat-growing areas, and to supply the bulk of these areas by rail, it would first be necessary to transport the urea to the Perth Metropolitan Area. Rail access is available for the transport of urea to Kwinana. The Picton site is on the opposite side of South Western Highway from the Picton rail loop, and discussions with Westrail indicate that a siding could be constructed across the highway to service the plant. The site would then be less than 7 km by rail from the port area and linked to the Metropolitan Area and the south-west rail network.

The prospective Picton site, as with Geraldton 'Narngulu', is located away from the port and would require an ammonia pipeline to, and additional ammonia storage at, the port, thereby incurring similar risks in regard to distance from residential areas as the 'Narngulu' option, although a proposed service corridor would link the site to the port.

The location of the ammonia storage facilities, which would be the same for the Bunbury 'Port' and Wagerup options, would disadvantage all three sites because of the potential difficulties associated with evacuation of adjacent industries in the event of a major ammonia release, and the relative location of residential areas in East Bunbury and the homes owned by SECWA near the Turkey Point power station (Figure 3.3). The Bunbury 'Picton' site is also in close proximity to an airport.

The impacts of the proposal via the number of construction workers entering the Bunbury region would be similar, although of a slightly lesser magnitude, to those discussed for the Geraldton region.

Wagerup

Wagerup is located in the Shire of Waroona, 60 km north of Bunbury on South Western Highway.

The Wagerup alumina refinery and its natural gas supply line were commissioned in 1985. The refinery was valued at $300 million (1978 dollars) and was constructed using a workforce drawn from Bunbury, Mandurah/Pinjarra and Perth. A similar arrangement could be used for the construction of the ammonia/urea plant.

A site adjacent to the alumina refinery area was evaluated. The site, known as Lot 145 and comprising approximately 83 ha, lies 3.5 km north of the Yarloop

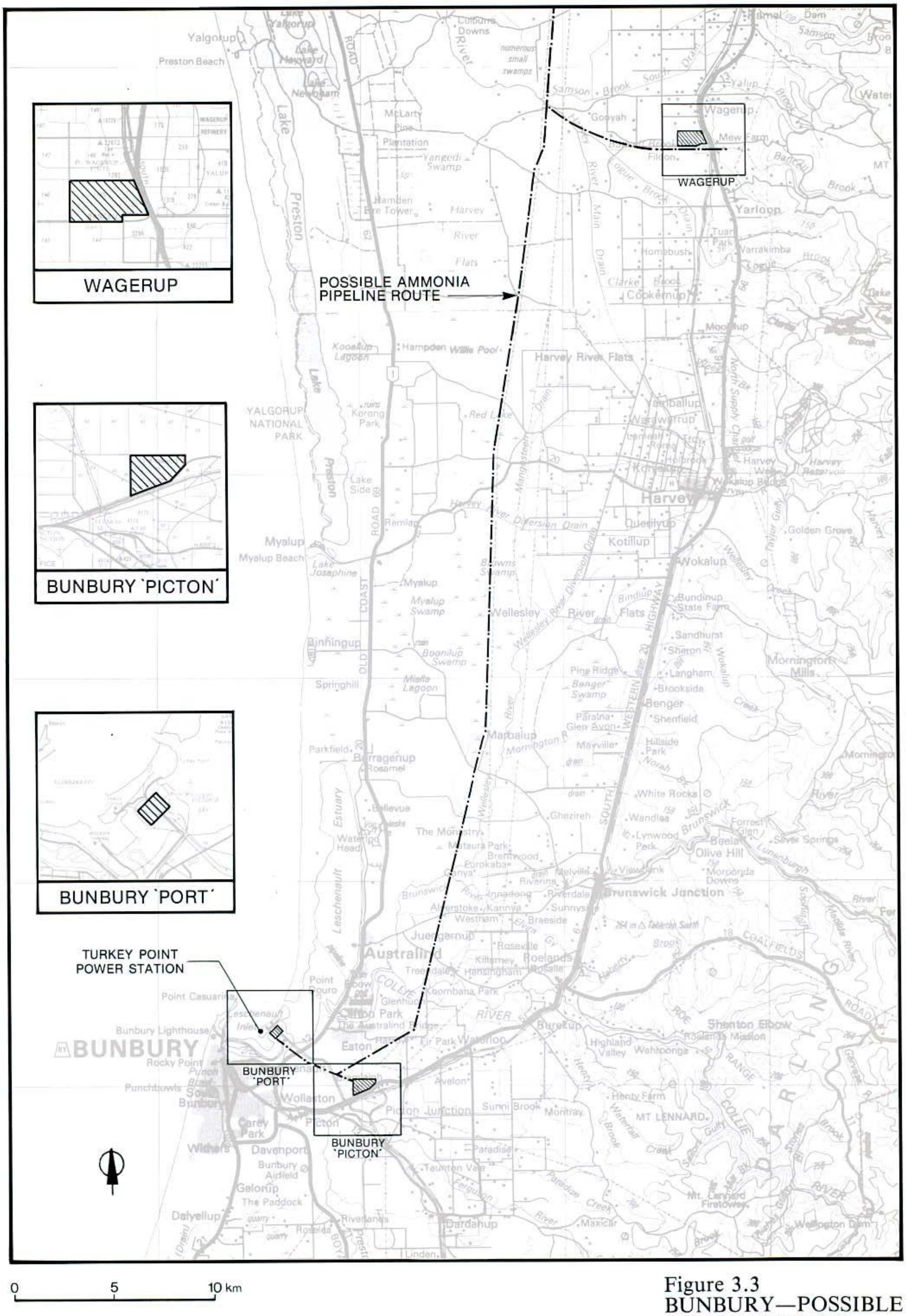

Figure 3.3
BUNBURY—POSSIBLE SITE LOCATIONS

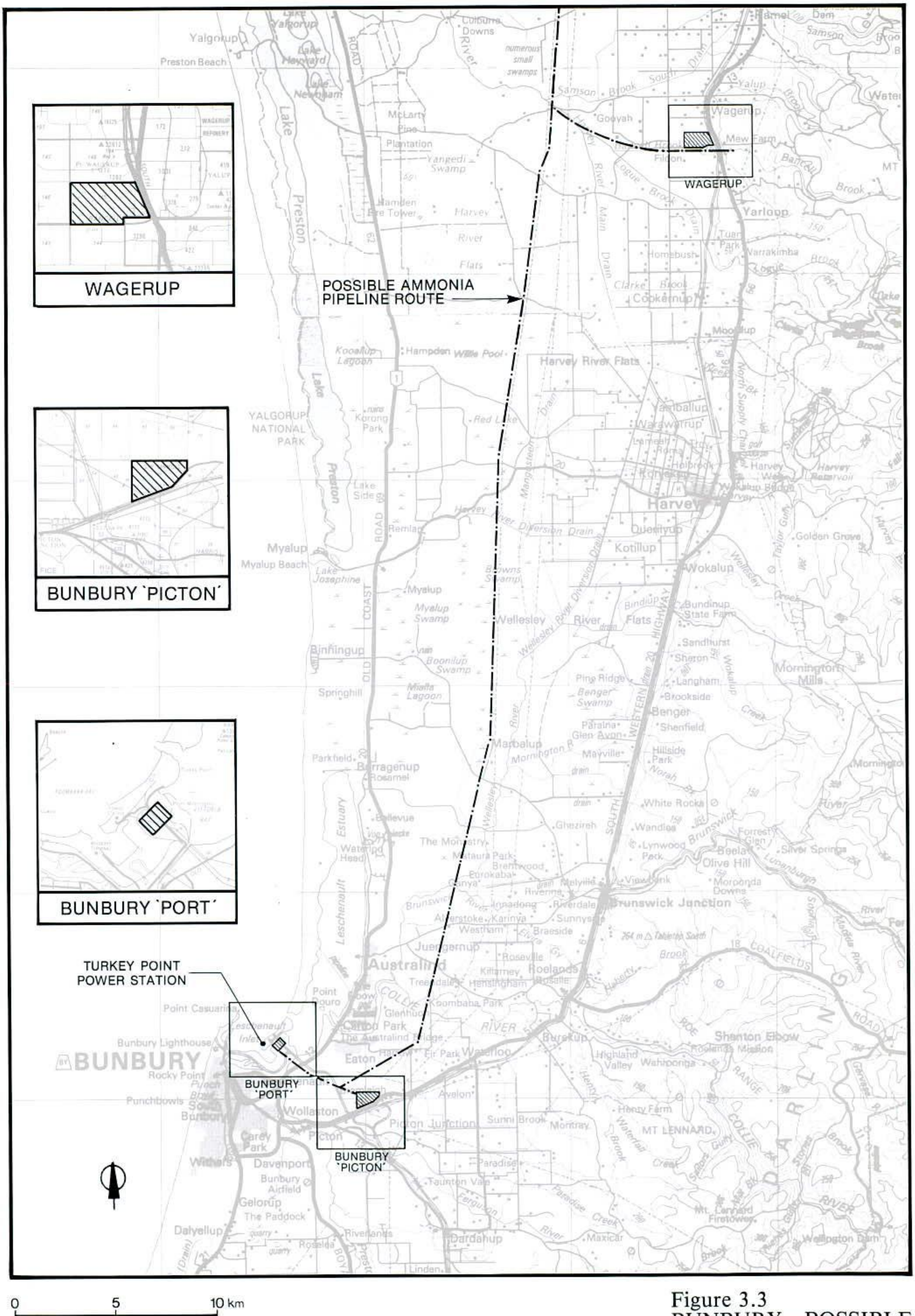

Figure 3.3
BUNBURY—POSSIBLE SITE LOCATIONS

town site. The property is bounded by South Western Highway, Bancell Road and Wellington Road and by the refinery site to the north (see Figure 3.3).

The main Perth-Bunbury railway runs along the eastern boundary of the property adjacent to South Western Highway. Rail connection would involve a pair of turn-outs onto the site, plus additional track for flexibility of rail movements within the site.

The natural gas pipeline servicing the Wagerup refinery runs along the southern boundary of the property adjacent to Bancell Road. Natural gas connection to the site would involve placing a new 300 mm diameter pipeline in the Wagerup easement for a distance of 7.5 km from the main-line, or some arrangement to share the existing lateral might be feasible.

Being located away from the port, the Wagerup site is under the same constraints and risks associated with the required ammonia pipeline and ammonia storage facilities as discussed for Bunbury 'Picton'. In addition, the length of the ammonia pipeline required from the Wagerup site (60 km) might be technically difficult to implement. Therefore, selection of this site could result in delays to the project and might ultimately lead to considerable additional capital and operating costs.

The Wagerup site adjoins the Wagerup alumina refinery, but is on the opposite side of South Western Highway, which could impose a visual impact on travellers using the highway unless considerable effort was put into landscape design.

Bunbury 'Port'

The Bunbury 'Port' option is a 35 ha site located in the port area, north of the inner harbour, as shown in Figure 3.3.

The site would require 50 km of 350 mm diameter gas pipeline from Wagerup to Eaton Drive, as for the Bunbury 'Picton' option, and a further 7 km from Eaton Drive to the port area.

The site is low-lying and would require substantial quantities of fill to bring it to the same level as the existing rail system. Considerable preloading of the site to obtain soil stabilization for foundation works would be required before the proposed plant could be constructed, and this would be likely to cause delays to the overall construction programme.

The location of the plant and ammonia storage facilities presents potential difficulties in meeting the EPA guidelines in relation to risk, as assessed by Det norske Veritas in its preliminary risk assessment.

The Bunbury 'Port' site would utilize an area designated for port usage, where it could be expected that warehousing and tankage would be established to support the export of products. Establishment of the ammonia/urea plant would restrict the area for this use.

Due to its open vista to Bunbury, Australind and Eaton, a plant at this location would dominate the skyline.

The impacts imposed by the number of construction workers required for the project would be similar to the options previously discussed.

Kwinana

This option comprises a split site of 20 ha on existing BP Refinery land, immediately north of the CSBP fertiliser complex, and 10 ha of FPA/Industrial Lands Development Authority (ILDA) land south of the CSBP complex (refer Figure 3.4).

Natural gas is available via a line installed from the main pipeline to KNC and BP Refinery.

Kwinana is centrally located in relation to the wheat-growing areas. The CSBP fertiliser plant is served by a dual-gauge rail siding and both southern and northern facilities and can be readily linked to the existing rail network. Urea destined for the domestic market can be transferred to the despatch facility of the existing CSBP complex by conveyor, obviating the need for a new rail siding to on-load urea.

With respect to ammonia storage, there is already a 10,000 t ammonia storage facility at KNC, adjacent to the plant site. A further 30,000 t tank will be constructed to cater for export of the product, whereas at the other sites, a tank capacity of 40,000 t would be required.

Product transport is another area where Kwinana has definite advantages over the other options. The major current and predicted local users of ammonia are located at Kwinana and the existing pipeline distribution system can be utilized. Should the plant be sited elsewhere in the State, about 100,000 t/a of ammonia would have to be transferred by rail tankers to Kwinana.

At present, most of the urea for the local market is distributed through Kwinana, which is centrally located to the Western Australian wheat-belt and the arterial railway system that supplies it.

The Kwinana plant site is alongside the existing KNC ammonia plant and CSBP fertiliser works, and the proposed plant will be similar in appearance to these facilities. The urea storage facility will be located on FPA/ILDA land that is being progressively acquired for industrial use. This building is likely to be about 15 m high, thereby having only a minimal visual impact.

As Kwinana is within daily commuting distance of most of the Perth Metropolitan Area, it is unlikely that one particular area will be subject to the settlement of the majority of the project workforce. In addition, as many of the construction and operational workers likely to be involved in this project will have a home base in Perth, there will be no need for the provision of workforce accommodation specifically for the project.

When operational, the proposed ammonia/urea plant will employ some 200 persons, of which some 50% will require a high degree of professional training and experience. While it would probably not be difficult to attract such persons to either the Geraldton or Bunbury regions, there is a higher probability of them being available from the larger Perth population base.

3.3.3 Conclusion

The net result of the various factors discussed is that establishment of the plant in the Kwinana region will incur substantially lower capital and recurring costs than the other alternatives.

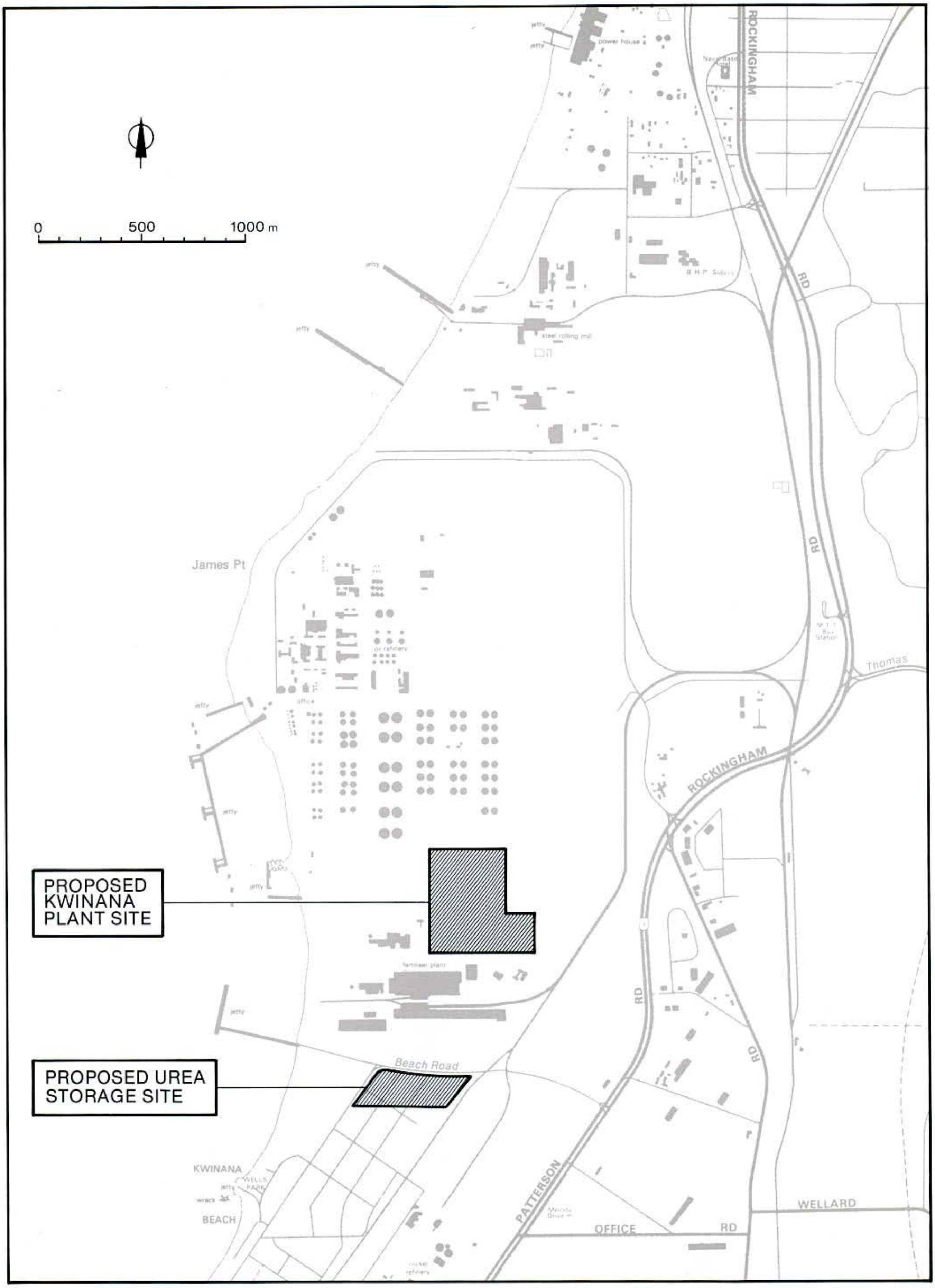

Figure 3.4
KWINANA—
SITE LOCATION

Table 3.2 presents a summary of the qualitative factors that were analysed in selecting Kwinana as the proposed site.

The combination of these qualitative factors and the cost of construction and operation of the plant shows that the site selected at Kwinana is by far the most suitable for the establishment of the plant. As discussed in Section 1.1 and earlier in this section, an independent site selection study commissioned by the State Government confirmed this conclusion.

3.4 TECHNOLOGY

3.4.1 Ammonia process

The basic difference between ammonia manufacturing processes is the choice of raw material. Ammonia can be produced from:

- coal (via partial oxidation)
- heavy oil (via partial oxidation)
- water (via hydrolysis)
- natural gas (via steam reforming).

Of the raw materials listed, the use of natural gas is by far the most energy and cost effective. None of the alternative raw materials offers any advantage to either the State or the proponents.

The proposed plant will utilize the best technology available for the production of ammonia from natural gas. The technologies under consideration represent the state of the art with respect to energy efficiency, reliability, environmental impact and the degree of potential for hazard.

3.4.2 Urea synthesis process

The raw materials for all urea production processes are ammonia and carbon dioxide. The principal difference in manufacturing processes is related to the method of solidifying the urea product, either through crystallization or evaporation. The crystallization processes offer advantages in lower content of biuret in the final product, but are disadvantaged in regard to energy efficiency. Evaporation processes have been used almost exclusively in urea plants constructed in recent years.

3.4.3 Urea finishing process

To make the finished product, the concentrated urea solution may be either prilled or granulated. The prilling of urea has certain limitations as to flexibility in selecting the size of the prills and also imposes a more difficult (and costly) task in controlling dust emission.

The granulation technology has recently undergone great improvements with respect to energy efficiency, product properties and environmental control. Among the new generation of granulation processes, the fluidized-bed technology has established itself as a very competitive and reliable alternative with minimal environmental impact.

Table 3.2 Summary of qualitative analysis of sites

	Geraldton 'Narngulu'	Kwinana	Wagerup	Bunbury 'Port'	Bunbury 'Picton'
Compatibility with State objectives	+	+	+	+	+
Risks:					
. plant	O	O	O	●	O
. port storages	●	O	●	●	●
. pipelines	●	O	●	O	●
. projectiles	●	O	O	O	●
Social:					
. construction	●	O	●	●	O
. operation	O	O	O	O	O
Community perceptions	++	--	+	+	++
Landscape impact	O	O	●	●	O
Environmental impact:					
. flora/fauna	O	O	O	O	O
. liquid wastes	O	O	O	O	O
. gaseous wastes	O	O	O	O	O
. solid wastes	O	O	O	O	O
. anthropological	O	O	O	O	O
Lead time:					
. approvals	●	O	●	O	●
. infrastructure	●	O	●	●	●
LPG plant	●	O	O	O	O
Product transport:					
. ammonia	●	O	●	O	●
. urea	●	O	●	O	●
Transport efficiency:					
. road	O	O	O	O	O
. rail	O	O	O	O	O
. port	O	O	O	O	O
Land use/expansion	O	O	O	●	O
Skilled labour availability	●	O	●	●	●
Public sector infrastructure cost burden	++	+	++	++	++
Depletion of natural resources	O	O	O	O	O

● Major impact
O Minor impact
++ Strongly positive
\+ Positive
\- Negative
-- Strongly negative

3.5 AMMONIA STORAGE

Ammonia for export and that which is not consumed directly in the urea plant will be held in storage. A storage capacity of 30,000 t is required for the project, and additional storage of 10,000 t is available from the existing KNC tank.

Two basic options can be used for storing ammonia: pressurized storage at ambient temperature or refrigerated storage (-33°C) at atmospheric pressure. The scope of the project storage requirements precludes the former as a serious option.

For reasons of safety, it is standard industry practice to use double-integrity storage tanks. The primary containment tank is always of steel construction, and the secondary containment can be either of steel, reinforced (including prestressed) concrete or earth. Concrete bunding has an advantage over steel in that it offers greater protection from penetration by flying objects or other external impact. Earth bunding does not offer this same advantage.

3.6 COOLING SYSTEM

3.6.1 Options

The cooling system is the principal component of the proposed ammonia/urea plant where there is an opportunity to select between alternative methods, and where the selection involves consideration of environmental issues. Alternatives for meeting the total cooling load of the plant (240 MW) are shown schematically in Figure 3.5 and discussed as follows:

- **Air cooling:** Air cooling involves the same principle as operates in an automobile radiator, where a forced air draft is passed across the surface of heat exchanger fins to facilitate heat transfer from the coolant. The principal advantage of this system is that the only emissions are heated air and noise. However, the relatively low heat transfer properties of air require that large volumes must be passed across the cooling fins, and a constraint to this method is the potential high level of noise from the fan units that are required to accomplish this. These noise levels can be reduced by the use of larger fans with lower air velocities.

- **Cooling tower:** A cooling tower dissipates heat by the evaporation of some of the water that is passed through the tower, a cooling process analogous to an evaporative air-conditioner or the old 'Coolgardie safe'. Heat transfer is achieved partly by warming of the air and, in greater part, by the evaporation of a portion of the water.

  For the proposed plant, bore water extracted adjacent to the plant site could be used as make-up to replace losses by evaporation, 'drift' and blow-down. Drift - water lost as mist or droplets entrained by the circulating air and discharged to the atmosphere - can be minimized by good design. Blow-down is water intentionally bled from the system to maintain an acceptable level of dissolved salts in the circulating water, which concentrates due to evaporative losses.

- **Sea-water cooling:** Sea-water cooling would involve the pumping of sea water from Cockburn Sound through heat exchange units, then pumping it back into the Sound. Some of the heat exchange in the proposed plant would be accomplished by indirect sea-water cooling, whereby there is an

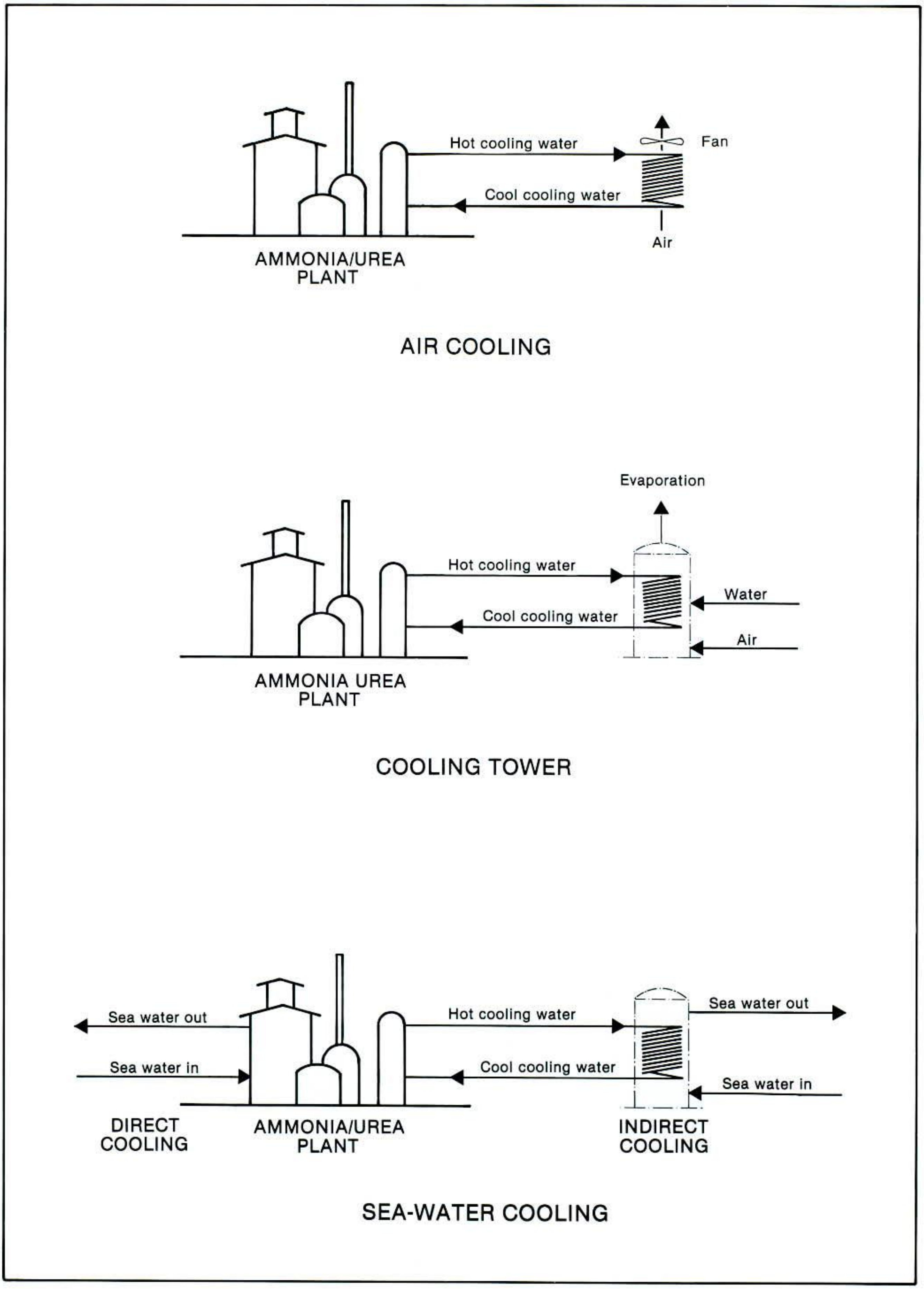

Figure 3.5
COOLING SYSTEM OPTIONS

intermediate freshwater cooling system and two heat exchangers. The first exchanges the process heat with the closed-circuit cooling water system; the second transfers the heat from the closed-circuit cooling water system to the sea water. The use of an indirect system would minimize the risk of contamination of the sea water by process components. Some processes, e.g. steam condensing, would be cooled by direct sea-water cooling.

- **A combination of these three options.**

3.6.2 Assessment of options

The first requirement of the initial engineering investigations was to select the appropriate media or combination of media that warranted closer consideration. Table 3.3 summarizes the specific options considered for splitting the cooling functions. The manufacturing process is such that at least 30 MW cannot be cooled by air cooling alone.

Table 3.3 Alternative cooling options

Option	Cooling tower/sea-water cooling load (MW)	Description
1	243	Total cooling load - all cooling tower or sea water
2	210	Optimal use made of air coolers
3	100	Optimal use made of air coolers plus air fin condensers
4	30	Maximum possible air cooling

The initial engineering investigations identified options 2 and 3 as the preferred options, and the environmental implications of these were examined in greater detail.

When using sea-water cooling, the heat functions in Table 3.3 translate into the sea-water rates (m^3/h) shown in Table 3.4 for discharge temperature rises of 5°C, 8°C and 10°C above ambient water temperature.

Table 3.4 Sea-water cooling discharge rates

Option	Discharge rate (m^3/h)		
	Temperature rise = 5°C	Temperature rise = 8°C	Temperature rise = 10°C
2	36,100	22,600	18,050
3	17,200	10,750	8,600

The environmental feasibility of sea-water cooling was found to be dependent upon the degree of initial mixing and dilution of the heat and the chlorine loading that could be realistically achieved subsequent to discharge (chlorine would need to be added continuously or in doses to the cooling water to control fouling). Because the effects of chlorine and heat upon marine biota show a logarithmic dose-response curve, it is environmentally advantageous to maximize initial dilution. This aspect was consequently modelled for the two preferred options to define an outfall design that would minimize the potential environmental impact.

The location of a cooling water outfall off shore from the CSBP plant site at Kwinana is substantially constrained by the preclusion of submarine pipes through the shipping channel that parallels the shoreline. This limits the location of the outfall to the inshore edge of the channel, at which point the water depth is 10 m. A multi-port diffuser at this location should be unidirectional away from the coast (i.e. all diffuser ports would be located on the offshore side) to maximize the initial momentum of the discharge away from the shore and away from the probable water intake nearer to the beach.

The application of recommended water quality criteria for Cockburn Sound (derived from Department of Conservation and Environment 1981) indicates that relatively high near-field dilution would be required following discharge. Assuming a low residual chlorine concentration in the cooling water outfall of 0.1 mg/L, and given the recommended water quality criterion for Cockburn Sound of 0.002 mg/L chlorine, a fifty-fold dilution within the near-field mixing zone would be required. This would need to be achieved mostly by initial mixing dynamics (i.e. those dominated by the momentum and buoyancy of the discharge items) because subsequent dispersive mixing in the quiescent waters of Cockburn Sound would be low. Ideally, a fifty-fold dilution should be achieved as the heated water plume rises through the water column to the surface.

Table 3.5 summarizes the results of preliminary modelling of initial mixing of the cooling water at a 10°C temperature rise. The table shows that fifty-fold initial dilution would only be approached where the flow of 8,600 m^3/h was discharged through a twenty-port diffuser at a velocity of 5 m/s.

Table 3.5 Sea-water cooling diffuser configurations and initial dilution

Flow (m^3/h)	No. of ports	Port diameter (m)	Diffuser length (m)	Discharge velocity (m/s)	Dilution factor
18,050	10	0.36	24	5	27
		0.46	25	3	18
		0.80	28	1	6
	20	0.25	45	5	33
		0.33	47	3	23
		0.56	51	1	10
8,600	10	0.25	23	5	34
		0.32	23	3	23
		0.55	26	1	9
	20	0.15	43	5	47
		0.23	45	3	34
		0.39	48	1	13

A more practical objective for the cooling water outfall may be to achieve a thirty-fold initial dilution. Table 3.6 shows diffuser configurations that would be required to achieve this objective.

Table 3.6 Sea-water cooling diffuser configurations to achieve thirty-fold dilution

Flow (m^3/h)	No. of ports	Discharge velocity (m/s)	Dilution factor
18,050	20	5	33
8,600	20	3	34
8,600	10	5	34

Preliminary calculations of mid-field dilution in Cockburn Sound indicate that, given a discharge flow of 18,050 m^3/h and an initial thirty-fold dilution immediately adjacent to the outfall, a fifty-fold dilution factor may only be achieved at a distance of some 1,000 m from the outfall. This concurs with the intuitive prediction that the discharge would tend to act as a streamflow and confirms the requirement to maximize initial dilution.

The high capital cost of the sea-water intake and outfall systems, together with the high operational cost involved in achieving the required initial dilutions, effectively precludes the practicability of using a substantial sea-water component in meeting the cooling requirements for the plant. There are no environmental or engineering advantages in using a greater volume of sea water (i.e. to accomplish a lower temperature rise), because the critical environmental consideration is the residual chlorine concentration. The residual chlorine load would, in fact, be greater at larger flow rates.

3.6.3 Conclusion

Detailed feasibility assessments of these principal strategies for achieving process cooling at the proposed plant have clearly indicated a marked preference for the use of air coolers for the majority of services. However, certain services will have to be water-cooled due to the absolute temperature requirements of the process. The recommendation for those services is to avoid the use of sea water and to use indirect water-cooling via a cooling tower.

The optimum arrangement was found to be dividing the load such that about 140 MW will be air-cooled and about 100 MW will be water-cooled. This will require a quantity of make-up water to the cooling tower of about 200 m^3/h, which will be supplied from groundwater.

The combination of air-cooling and use of a cooling tower represents an optimum of minimum environmental effects and cost implications for the project.

A detailed description of the preferred cooling system is provided in Section 4.4.6. The likely impacts of cooling system emissions upon the biological environment are assessed in Section 6.

3.7 TRANSPORT OF PRODUCT

The transport of ammonia and urea product was one of the principal criteria that led to the selection of the proposed site (Section 3.3).

For the proposed site, there are no practicable alternatives to the use of a pipeline for ammonia export, as the ammonia must be loaded into the ship's tank as a liquid at -33°C. This requires that ammonia be pumped from the refrigerated storage tank via an insulated export line into the ship's tank, which has its own refrigeration system. The export line will be cooled by the circulation of liquid ammonia through the line prior to export.

For bulk export of large tonnages of urea, there is no viable alternative to the use of conveyors for the loading of ships.

The proximity of the proposed plant to KNC and the CSBP Kwinana works allows the utilization of the existing facilities for the distribution of ammonia and urea to domestic markets. Ammonia will be transported via the existing piped distribution system from KNC to the other major consumers (the CSBP Kwinana works and the WMC nickel refinery); this will obviate the need to convey ammonia by road to these markets. As the CSBP Kwinana works is the major distribution centre for urea in the State, use of its established facilities will enable the transport of urea, principally by rail, to the regional distribution centres.

4 PROJECT DESCRIPTION

Section 4 describes in detail all aspects of the project, including the processes by which ammonia and urea will be manufactured, the components of the plant, generation of noise and waste products, plant safety features, the construction, commissioning and operational phases of the project and the overall project schedule.

4.1 SCOPE

The proposed plant will manufacture ammonia and urea, with some of the ammonia being used in the production of urea.

Production from the ammonia process plant will be 1,500 t/d, or 500,000 t/a. Of this, half (250,000 t/a) will be used for producing urea. The remainder will be piped to a refrigerated storage tank of 30,000 t nominal capacity before being loaded aboard ships for the export market or will be transferred via pipeline to the existing KNC tank and distribution network for use in the domestic market.

Production of urea will reach about 1,300 t/d, or 430,000 t/a, when the plant is operating at full capacity. Urea to be used by the domestic market (approximately 100,000 t/a) will be distributed by the existing CSBP distribution system and the balance will be exported.

Product distribution is shown schematically in Figure 4.1.

The proponents are presently investigating the viability of increasing the production capacity of the plants to about 575,000 t/a of ammonia and 500,000 t/a of urea.

The major inputs to the plant will be about 385,000 t/a of natural gas used in the process and in steam generation, about 0.5 million cubic metres per annum of process water, about 1.6 million cubic metres per annum of cooling water and about 6.2 million tonnes per annum of process air. Minor inputs will include about 2,400 t/a of urea-formaldehyde used to enhance the formation of the solid urea product and about 2,700 t/a of miscellaneous process chemicals.

Major outputs will be the ammonia and urea products, together with approximately 2.8 million tonnes per annum of water vapour from the cooling system, about 467,000 m^3/a of wastewater, 315,000 t/a of carbon dioxide, and air and atmospheric components (principally nitrogen and oxygen). The waste products are discussed further in Section 4.5.

The plant will operate continuously at full production. Allowing for maintenance and other shut-downs, it is anticipated that the plant will operate for about 7,920 h/a, or 330 d/a, and this has been used as the basis for the ERMP/draft EIS.

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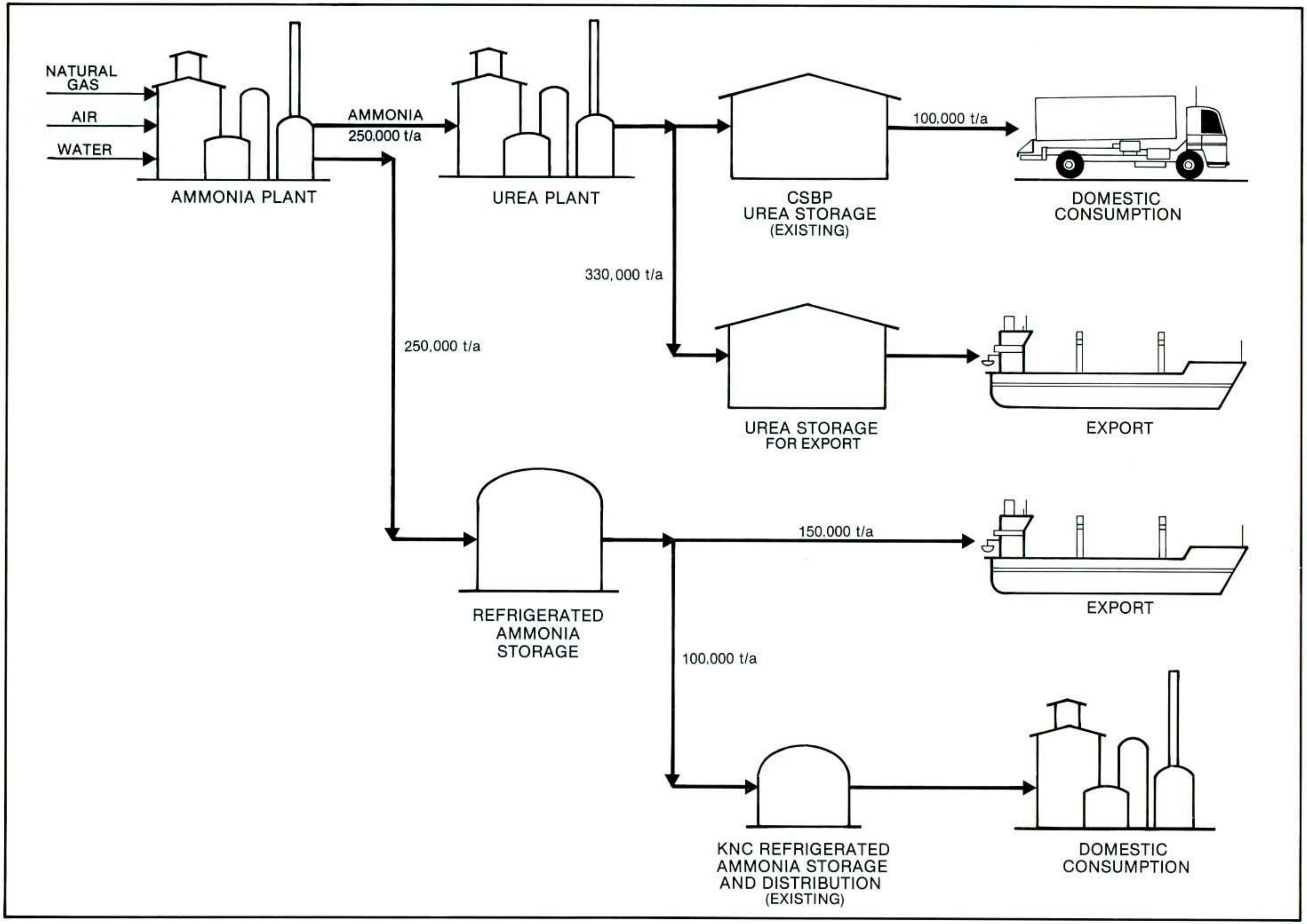
Figure 4.1
PRODUCT DISTRIBUTION



4.2 PROCESS DESCRIPTION

As shown in Figure 4.2, the processes employed in the production of ammonia and urea are complementary in that:

- the ammonia produced in the ammonia plant is used as feedstock in the production of urea;
- carbon dioxide, a by-product from the ammonia plant, is used as feedstock for the urea plant;
- the process used to produce ammonia generates waste heat, whereas the process used to produce urea requires the addition of heat. Heat transfer between the two processes will be accomplished via the use of steam;
- process steam condensate (water) produced by the urea plant can be used to complement process water usage in the ammonia plant.

4.2.1 Ammonia process description

The natural gas feedstock principally comprises methane and other hydrocarbon gases. The process to produce ammonia, a chemical combination of hydrogen and nitrogen, firstly involves the production of hydrogen from the natural gas and steam, followed by mixing of the hydrogen with nitrogen obtained from air and, finally, reacting the hydrogen and nitrogen mixture to form ammonia. The carbon component of the natural gas reacts with the oxygen component of the air and steam to form carbon dioxide, which is removed as a by-product of the process.

The following steps of the ammonia process are shown schematically in Figure 4.3:

- Desulphurization: The natural gas may contain small quantities of both natural sulphur compounds and sulphur compounds (mercaptans) introduced as an odorizer by SECWA. These compounds are adsorbed onto a bed of zinc oxide in order to prevent them fouling catalysts used further down the process. The zinc oxide bed is sized for two years' operation, after which it requires replacement.
- Reforming: Steam and process air (compressed air) are introduced to the process, and the natural gas is broken down into hydrogen and carbon monoxide by temperature and pressure in the presence of a catalyst. This process involves primary and secondary stages.
- Carbon monoxide conversion: The process gas is passed over two further catalysts - one at high temperature followed by the other at a lower temperature - where the carbon monoxide reacts with water to form further hydrogen and carbon dioxide.
- Carbon dioxide removal: The bulk of the carbon dioxide in the process stream is removed by absorption onto the liquid methyldiethanolamine (MDEA), leaving a mixture of hydrogen and nitrogen and some residual traces of carbon dioxide. The carbon dioxide absorbed by the MDEA is stripped from this liquid by reduction in pressure and heating prior to the MDEA being reused in the process. The MDEA stripping system exemplifies the use of a combined chemical and physical system for the removal of carbon dioxide. Other systems commonly used include the use of other

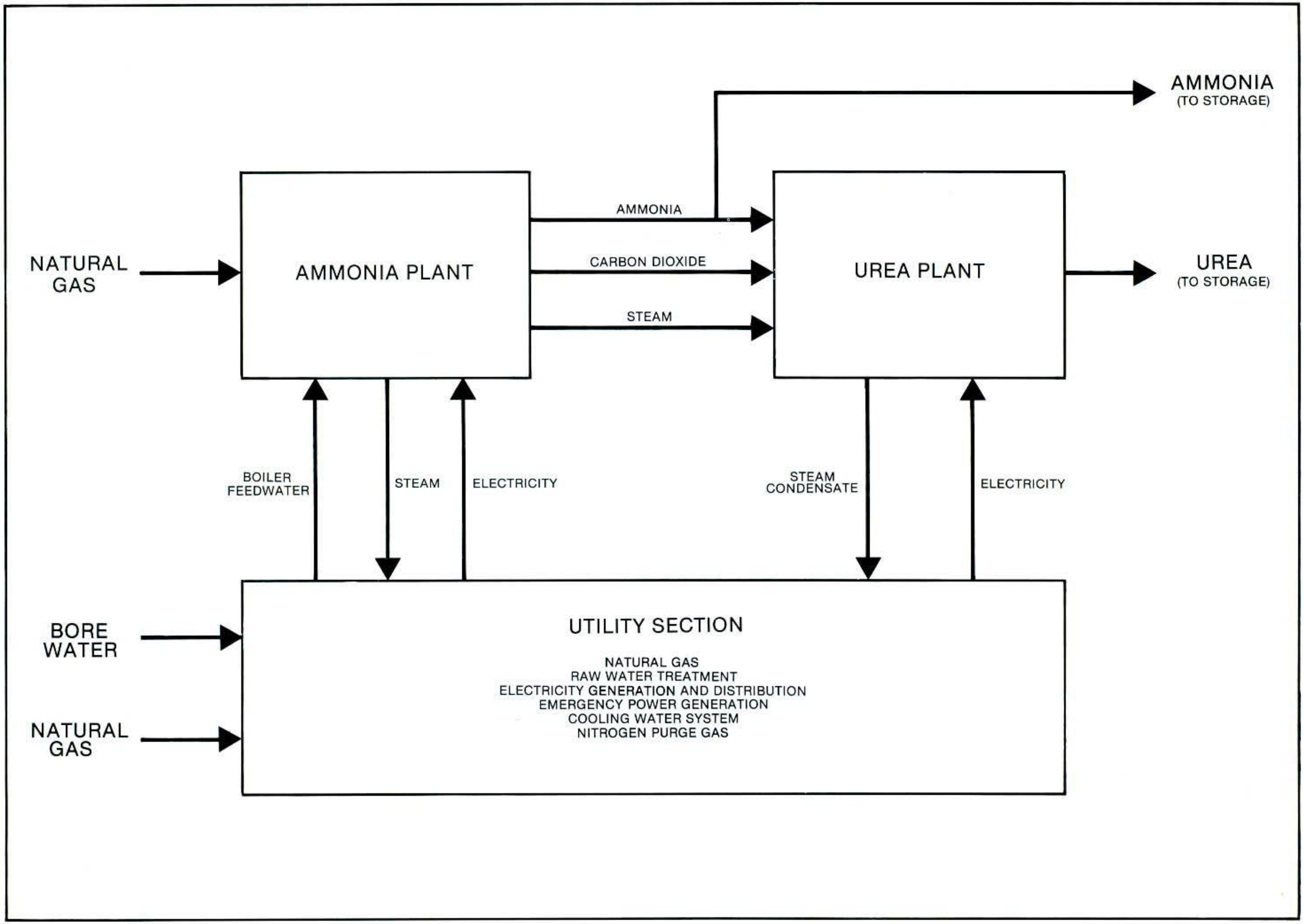


Figure 4.2
INTERACTION BETWEEN AMMONIA
AND UREA PROCESSES

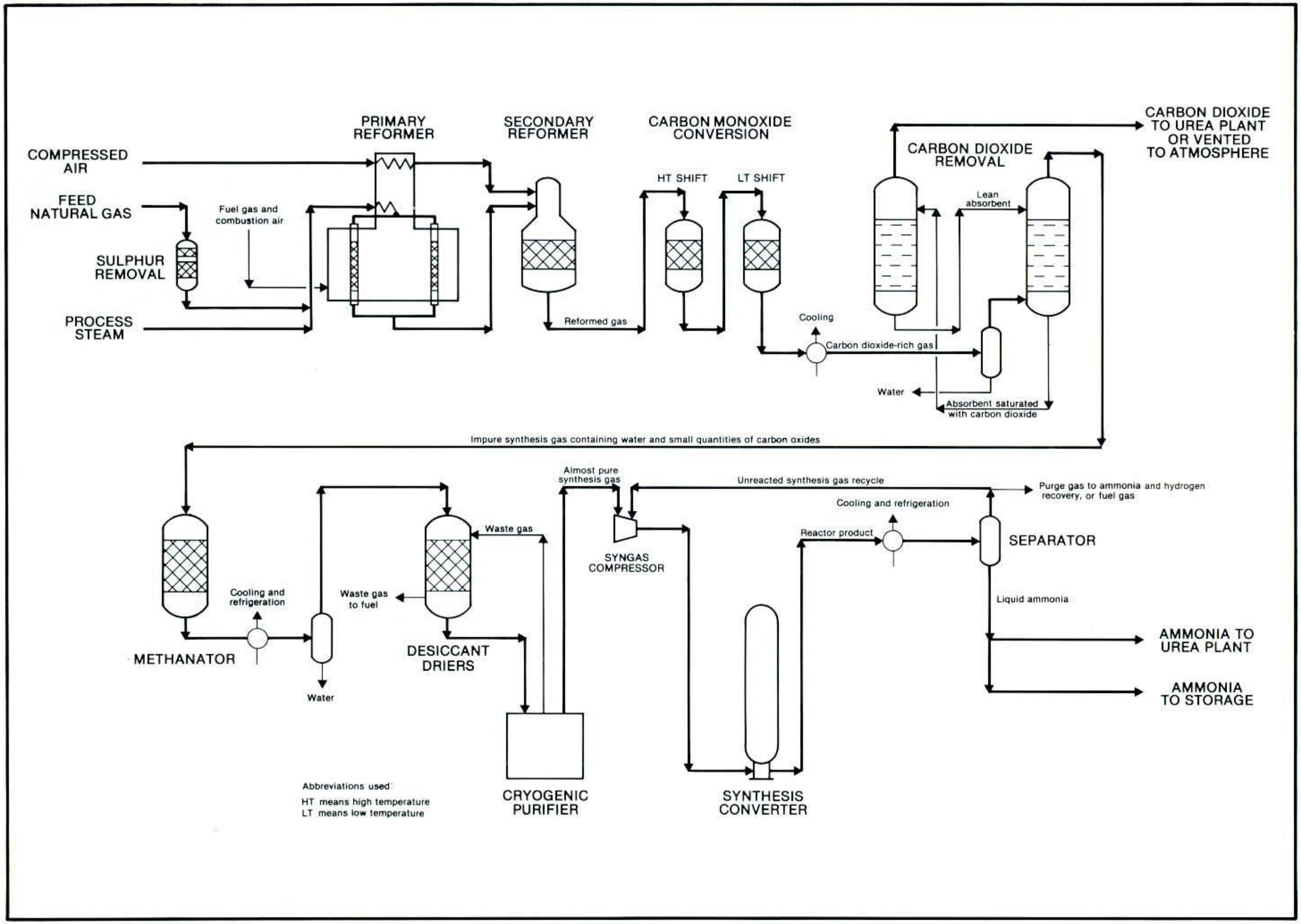


Figure 4.3
THE AMMONIA PROCESS

chemicals such as methylethylamine, potassium carbonate or Selexol (dialkyletherpolyethyleneglycol-type).

- Methanation: The process gases are passed over a catalyst, where the remaining traces of carbon dioxide are reacted with some of the hydrogen to form methane.

- Purification: Several types of systems are used for synthesis gas purification. The cryogenic system utilized in the Braun process is outlined here as an example. Purification of the gas stream firstly involves cooling to condense water vapour, followed by desiccant drying and further cooling to -175°C, at which temperature the methane, excess nitrogen and some of the inert gases contained in the process air are removed and used as fuel elsewhere in the process. The remaining mixture of hydrogen and nitrogen is known as synthesis gas or 'syngas'.

- Ammonia synthesis: The syngas is compressed, heated and passed over a catalyst to partially react and form ammonia, which is removed by cooling; the unreacted syngas is recycled to the catalyst with incoming syngas. The ammonia product can be either directed to the urea plant or refrigerated to -33°C and stored.

The steam produced in the ammonia plant will be used as process steam, in steam turbines to drive compressors and in the urea plant, thereby ensuring that no steam is wasted. All water removed from the process will be cleaned in a steam stripper. The outlet steam from the steam stripper will be used as process steam; the outlet water will be used as boiler feedwater.

Waste products and emissions associated with the ammonia process are described in Section 4.5.

4.2.2 Urea process description

Carbon dioxide and ammonia are reacted to form urea and water via an intermediate compound known as ammonium carbamate. The water is then evaporated and the concentrated urea formed into granules.

The following steps of the urea process are shown schematically in Figure 4.4:

- Urea synthesis: Urea is synthesized by reacting carbon dioxide and ammonia under elevated temperature and pressure conditions. This system consists of a high-pressure condenser, in which ammonia and carbon dioxide react to form the intermediate product ammonium carbamate, and a high-pressure reactor, in which the carbamate partly decomposes into urea and water.

  The mixture leaving the reactor - consisting of urea, water, unconverted carbamate and excess ammonia - is stripped with fresh carbon dioxide. This process removes most of the ammonia and decomposes most of the carbamate from the urea solution: the ammonia and carbon dioxide gases produced are recirculated to the high-pressure condenser.

  The urea solution, still containing some dissolved gases and carbamate, is then depressurized in the rectifier and heated to remove these substances. The vapour - containing ammonia, carbon dioxide and water - is separated and fed to a condenser, where a low-pressure carbamate solution is formed; this is recycled to the synthesis section.

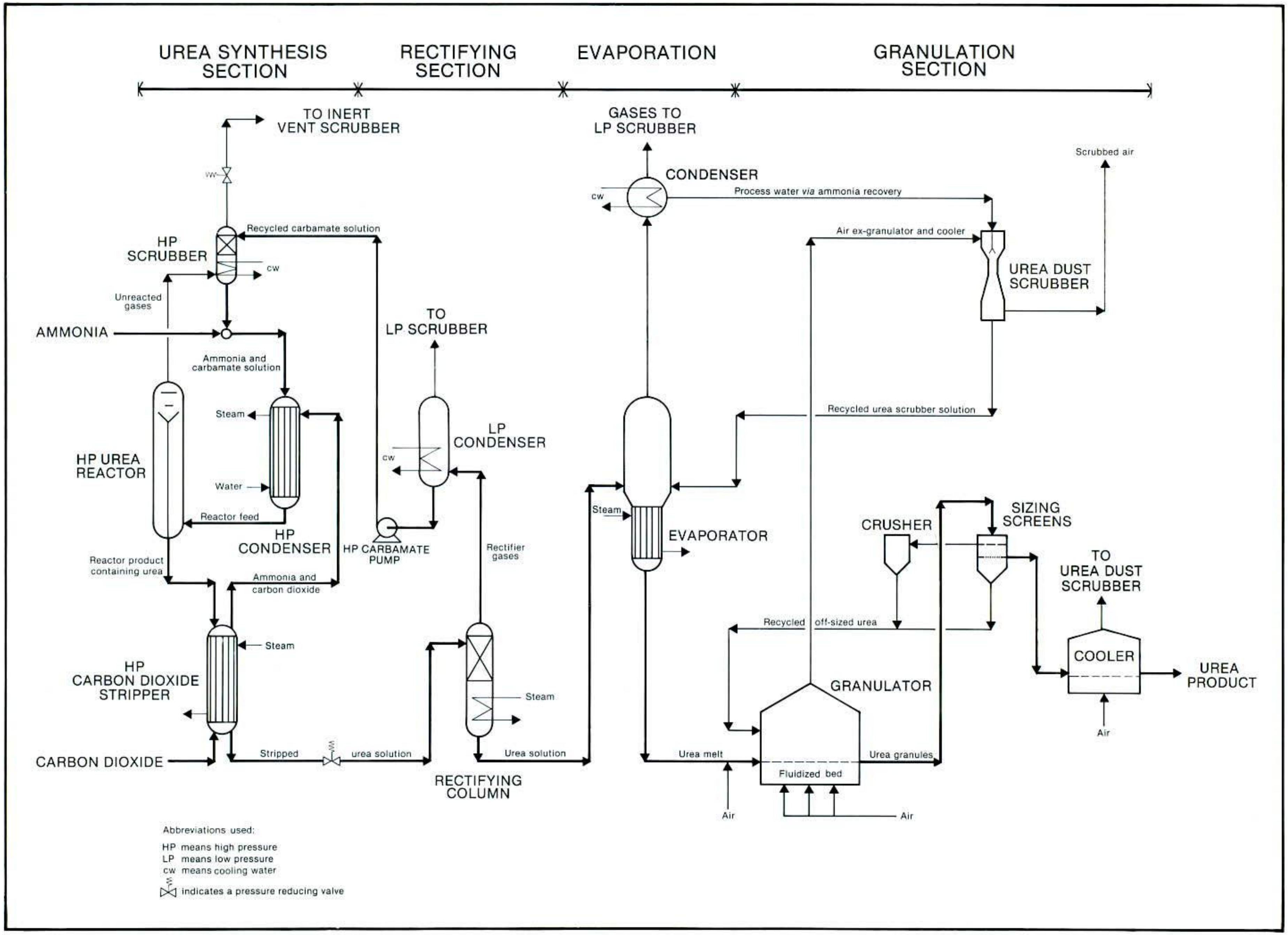


Figure 4.4
THE UREA PROCESS

- Evaporation: The urea-and-water solution is heated and the water evaporated to form a concentrated urea solution. The water vapour is condensed and returned to the process.

- Granulation: Urea-formaldehyde solution is added to the concentrated urea solution and this mixture is fed to the granulator. The urea-formaldehyde solution enhances granulation and helps produce a stronger free-flowing product. The granulator consists of a fluidized bed that suspends the granules in a flow of air. The urea granules are then screened and cooled: product is sent directly to storage, and oversize is crushed and returned to the granulator along with the undersize.

Waste products and emissions associated with this process are described in Section 4.5.

4.3 START-UP AND SHUT-DOWN

This section describes the normal start-up and shut-down procedures for both the ammonia and urea sections of the plant.

4.3.1 Ammonia plant

The first step in start-up of the ammonia plant is the removal of oxygen from the process, which is achieved by purging the system with nitrogen. Circulation of nitrogen through the catalyst beds and process equipment is continued while the plant is heated to near reaction temperature by firing of the primary section of the reformer and the steam systems with natural gas. New catalysts are delivered in an oxidized state and require reduction with hydrogen before they are suitable for the process. The reduction process is accomplished in accordance with a strict and careful procedure. As catalyst beds will be sized for a minimum operating life of two years, the reduction procedure will be required only infrequently.

Once the system has been totally purged of oxygen and start-up temperatures achieved, natural gas and steam are introduced into the process to initiate the catalysed reactions. This is followed by the introduction of air to the secondary section of the reformer, which causes the methane to be converted completely and results in an increased production of steam by the process boilers.

The plant is maintained at 40-50% of capacity, with the process gas being flared until testing indicates that process conditions are suitable for start-up of the ammonia synthesis section. At this stage, the ammonia synthesis catalyst is heated to operating temperature, and process gas is compressed and gradually introduced to the ammonia synthesis loop. Synthesis loop pressure and temperature are then gradually increased until the synthesis reaction starts. Flaring of the process gas is gradually reduced until it ceases completely, about twelve hours after the introduction of natural gas to the process plant. The supply rate of feedstock is then varied to balance with the desired ammonia production level.

Total start-up time for a plant with oxidized (new) catalysts will normally be about three days. Start-up following shorter shut-downs when air is not introduced into the process will usually require less than two days.

Normal shut-down of the ammonia plant is commenced by reducing the supply of natural gas to the minimum required to maintain operating temperatures within the secondary reformer and the synthesis loop: about 40% of the plant design load. The synthesis gas compressor is then stopped and the process gas sent to the flare. Following this, the reformer firing is gradually reduced in order to reduce both steam production and process gas temperatures. Process air is then stopped and the process gas temperature and feedstock supply further reduced. Finally, once catalyst temperatures are at a minimum for operation, the natural gas supply is shut off and flaring ceases. The process is then purged with steam and again with nitrogen.

The shut-down procedure will normally take about six hours. If maintenance is required inside the catalyst reactors, a further six to twenty-four hours will be required, to allow these to cool.

4.3.2 Urea plant

Start-up of the urea plant commences with the purging of oxygen from the system by the introduction of nitrogen. Following this, the process vessels are filled with water to normal liquid operating levels and water is circulated through the plant. Ammonia and carbon dioxide are then drawn from the ammonia plant, compressed and introduced to the process. Finally, steam is admitted to heat the reactants and production commences.

Start-up is generally complete about three hours after the introduction of ammonia and carbon dioxide to the system.

Normal shut-down commences with the cessation of ammonia and carbon dioxide feed to the plant and the decomposition of any ammonium carbamate solution into ammonia and carbon dioxide. The ammonia thus produced will be stored in a tank at the urea plant or returned to the refrigerated ammonia tank. The carbon dioxide will be vented to the atmosphere or stored in a solution. Finally, the plant is flushed by the circulation of water, with any urea solution in the system being kept in a urea solution tank.

If it is known that the shut-down period will be of short duration (less than twenty-four hours), the plant can be left in an operational condition by maintaining the pressure in the synthesis section after the ammonia and carbon dioxide supplies have been turned off. This reduces the start-up time.

4.4 PLANT COMPONENTS

The ammonia/urea plant will comprise the following components:

- ammonia plant
- urea plant, including the granulation section
- utilities
- refrigerated ammonia storage
- ammonia export line and loading arm
- urea storage and export conveyor
- incoming natural gas line
- control room
- cooling towers
- water supply
- effluent treatment facilities
- infrastructure.

The expected arrangement of these components on the 30 ha split site is shown in Figure 4.5, although modifications may be required at the detailed design

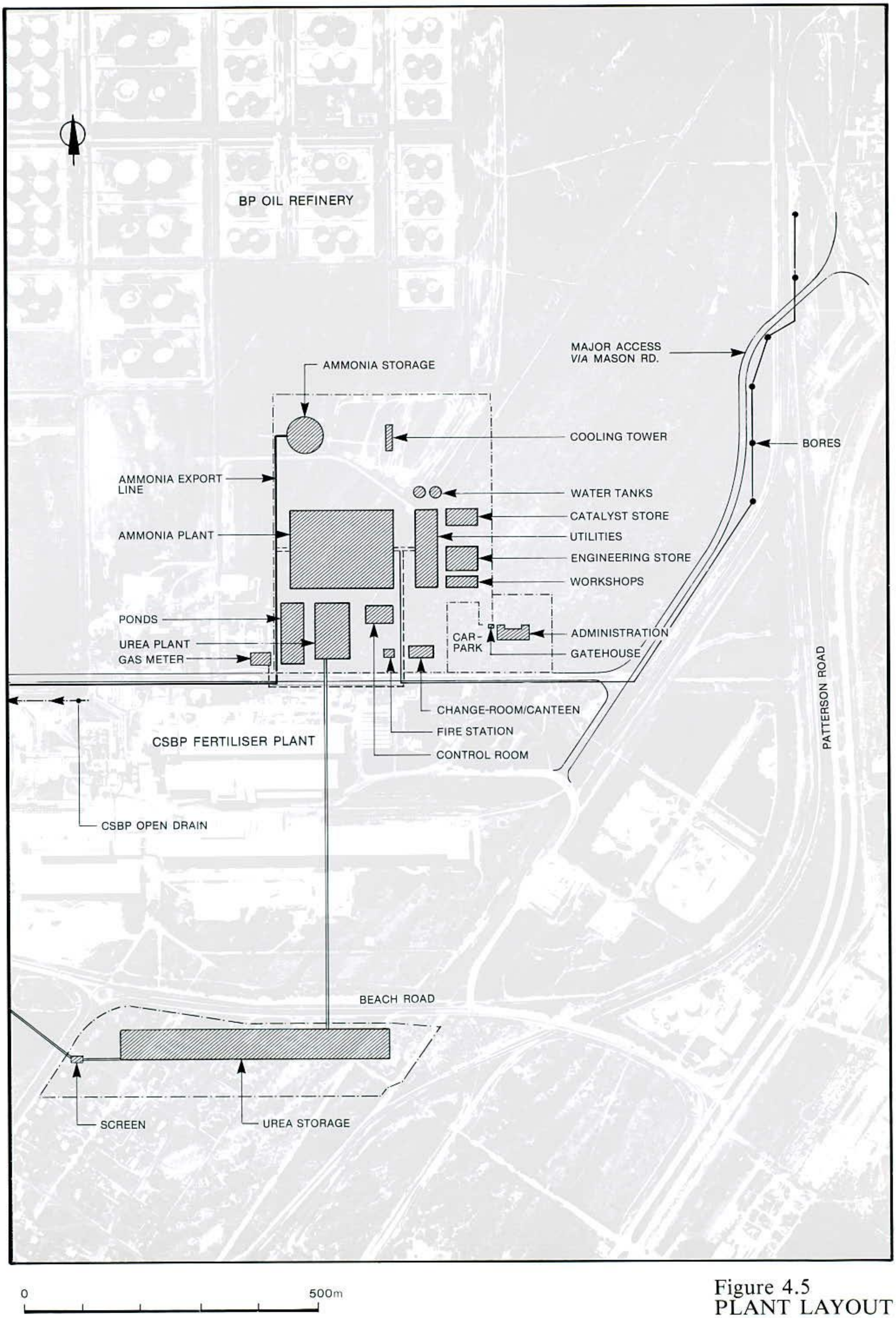


Figure 4.5
PLANT LAYOUT

stage to optimize the use of the site. The overall appearance of the plant is discussed in Section 7.3.

The significant plant components are briefly described as follows.

4.4.1 Ammonia plant

The ammonia plant comprises all the equipment required to perform the process described in Section 4.2.1. It will cover an area of approximately 2.4 ha (180 x 135 m) and will generally be less than 40 m in height. A dominant feature will be a column used in the carbon dioxide removal section of the process, which will be about 70 m in height, on top of which a flare of an additional 10 m will be installed. The flare will have a permanently lit pilot flame so it can be used to dispose of combustible materials arising from process interruptions and in start-up and shut-down operations, as described in Section 4.5.3.

4.4.2 Urea plant

The urea plant, including the granulation section, will cover an area of about 0.6 ha (95 x 60 m). It will generally consist of two levels: the urea synthesis section of about 70 m in height, and the granulation section of 40 m in height. There will be an elevated conveyor from the granulation section spanning across the existing CSBP works to the urea storage building.

4.4.3 Utilities

Plant utilities, including demineralization plant, steam and power generation, electrical substation, nitrogen storage and instrument air compressors, will be grouped together into one area of about 0.5 ha (130 x 40 m) immediately east of the ammonia plant. These utilities will service the entire complex.

Power generation will consist of two gas-fired boilers driving two steam turbo-alternators, each with a capacity of 7.5 MW.

4.4.4 Materials handling

Ammonia storage and export facilities

The storage of ammonia will consist of one refrigerated tank designed for a capacity of 30,000 t at atmospheric pressure and at an operating temperature of -33°C.

The tank will be a single steel shell structure with a diameter of 45 m and height of 30 m. It will incorporate a self-supporting, dome-shaped stiffened roof also constructed of steel. The tank wall will be insulated externally with polyurethane foam and the roof will be insulated with suspended mineral wool.

The tank will incorporate a secondary prestressed concrete containment bund to the full height of the primary steel tank. The capacity of the bund will be greater than that of the primary tank.

A schematic representation of the storage tank arrangement is shown in Figure 4.6.

The tank design will incorporate provisions to withstand earthquake loadings appropriate for such structures at Kwinana and will also take into consideration the site foundation conditions, providing adequate foundation insulation and heating to prevent freezing and subsequent heave of the foundations.

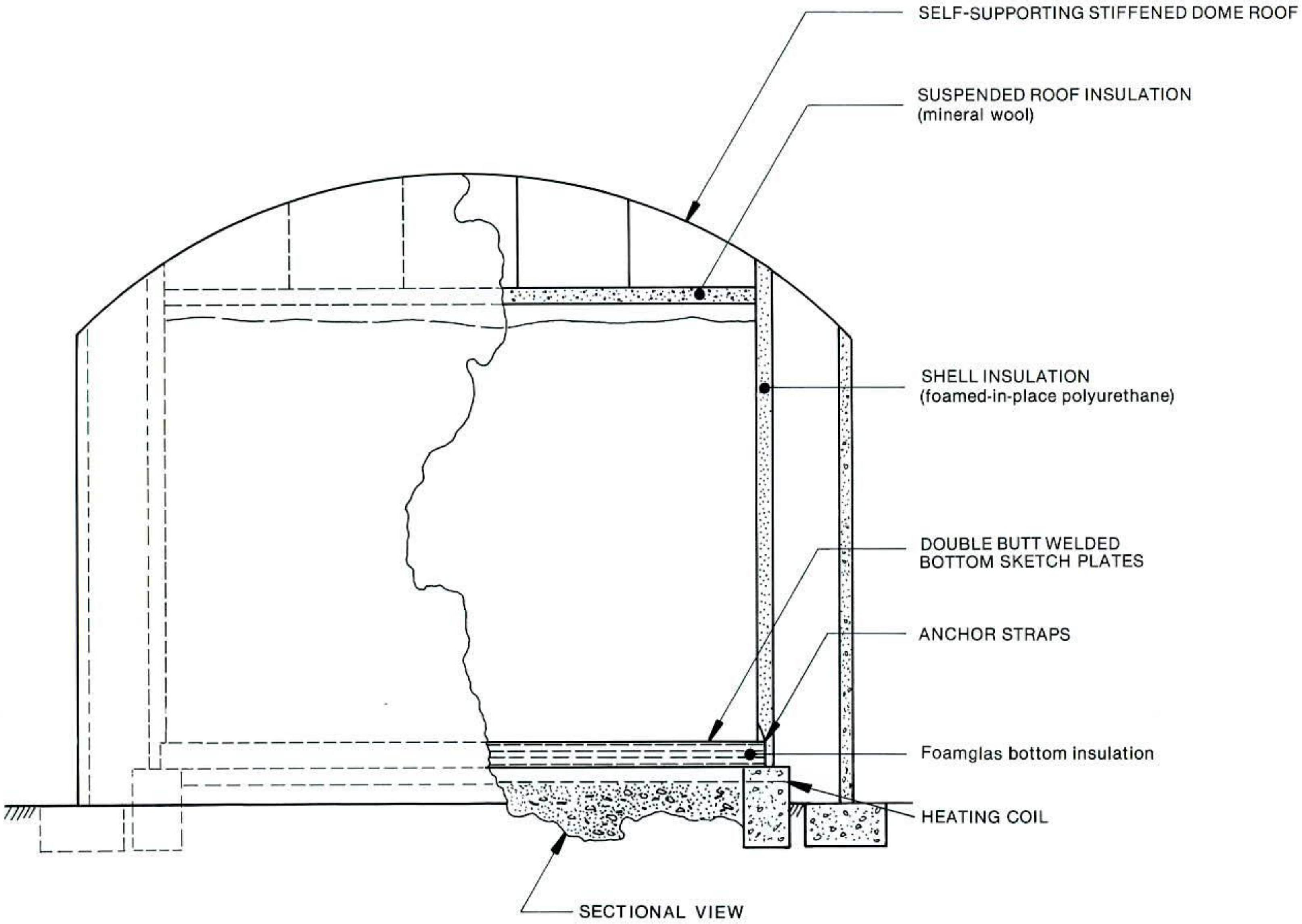


Figure 4.6
DESIGN CONCEPT–REFRIGERATED AMMONIA
STORAGE TANK

The safety of the ammonia storage tank will be enhanced by the following features:

- covering of the gap between the primary tank and secondary bund to prevent rainwater ingress;
- provision of a manifold, which will allow the space between the primary tank and secondary bund to be emptied in the event of any ammonia leakage (with ammonia transferred to export or to the urea plant);
- provision of a foam riser, which will allow injection of blanketing foam into the space between the primary tank and the secondary bund in the event of major leakage;
- duplication of the tank level gauge (incorporating level alarms) and the incorporation of an emergency high-level alarm;
- provision for 900 mm of usable ullage (freeboard) from the design full level of the tank to the underside of the insulation, plus a further 600 mm prior to overflowing.

The storage tank will be designed and constructed in accordance with American Petroleum Institute code API 620, entitled 'Recommended rule for design and construction of large, welded, low pressure storage tanks', including Appendix R of that code.

The refrigeration plant and distribution systems will be designed and constructed in accordance with the various Australian and international codes for this class of work. The refrigeration system will consist of two compressors, each sized so that only one will be required during normal operation, with both being required only during initial cooling of the tank or the export pipeline.

Where applicable, the requirements of Australian Standard 2022-1983, entitled 'Anhydrous ammonia code', will be incorporated into the project specifications.

Ammonia for export will be pumped via an insulated 250 mm diameter steel pipeline leading from the ammonia storage tank to the ship-loading point on the Kwinana Bulk Cargo Jetty, a distance of 1,800 m.

Transfer of ammonia to specially designed refrigerated ships will be via a trailer-mounted mobile loading arm, which will be removed between ship visits and suitably stored. Prior to each shipment, the loading arm will be subject to operability checks to ensure that it performs as designed.

The loading of refrigerated ammonia into the ship will involve cooling down of the export line prior to export by the circulation of liquid ammonia through the export line and vapour return line.

It is expected that the ships used for export will be of about 20,000 t capacity and designed to operate at -33°C and at atmospheric pressure. They will also have their own refrigeration system.

Ammonia transfer to KNC will be via a pipeline delivering liquid ammonia at -33°C.

Urea storage and export facilities

Granulated urea product will be stored in a dry, clean environment inside a specially designed storage building located to the south of the existing CSBP works. The storage building will be a portal-frame construction 470 m long, 55 m wide and approximately 15 m high, and will have the capacity to store 100,000 t of urea. Transfer of urea from the plant will be via covered overhead conveyors that will also discharge into CSBP's existing storage and distribution facilities.

CSBP's well-established fertiliser distribution network within Western Australia will be used to supply urea to farmers and other users.

Loading of bulk cargo ships for the export of urea will be via a high-capacity conveyor, which will be covered to allow loading during inclement weather conditions and to minimize the generation of dust. In order to prevent disruption to traffic, provision will be made for this conveyor to pass underneath Kwinana Beach Road.

Incoming natural gas line

Natural gas will be supplied from the existing natural gas pipeline installed for KNC, BP Refinery and CSBP, at a supply pressure of 4-5.5 MPa. Gas will be metered from a station immediately east of KNC, close to the KNC access road, and transported east from the metering station and then north into the plant via a pipeline 250 m in length and 300 mm in diameter.

4.4.5 Control room

A central computer control system will be used in the operation of the entire plant. This will be housed in a control room, from which all process parameters will be monitored. Should a process be interrupted, alarms will be highlighted in the control room, allowing the operator to take corrective action or to shut down the plant, whichever is appropriate. In addition to the provision for manual control, there will be an automatic shut-down system, based upon additional instrumentation and an interlock system, to further protect the operating personnel and process equipment.

Due to the importance of the control room to the safe operation of the plant, it will be designed to withstand an explosion with a peak over-pressure of 70 kPa for a period of 0.02 seconds.

The control room will be located to the east of the urea plant and will be 50 m in length, 30 m in width and 5 m in height. This facility will be manned at all times.

4.4.6 Cooling system

The proposed plant will be based upon state-of-the-art knowledge on energy efficiency; therefore, the resulting cooling load of 240 MW is the minimum that is economically achievable at present.

The cooling system will be based upon the use of air coolers and air fin condensers for about 140 MW of the cooling load and, for the balance, a cooling tower (44 m in length, 11 m in width and 6.7 m in height). The cooling tower will recirculate 10,000 m^3/h of water, which will be used to transfer the heat load, principally by evaporation, to 6,900 t/h of air. Therefore, operation of the cooling tower will result in loss of pure water by evaporation (152 m^3/h) and the concentration of the dissolved salts present in the cooling tower feedwater. To prevent an excess build-up of these salts, water being recirculated will be continuously bled off, at a rate of 44 m^3/h, as waste and disposed of - this is called cooling tower blow-down. Make-up water will be continuously added to the recirculating water to compensate for the blow-down, water lost to evaporation and the small quantity (4 m^3/h) of water lost as small droplets to the air stream (drift).

Prior to its use in the cooling tower, the make-up water will be treated with small quantities of the following:

- chlorine, which will be added by a conventional dosing system at a rate of 10 kg/h; this acts as a biocide to control the build-up of algae in the recirculating water. The residual chlorine will be principally lost to the atmosphere via the plume of steam that will rise from the cooling tower, and a lesser amount will be lost with the cooling tower blow-down;

- a biocide dispersant, Nalfloc 7348, which will be added at a rate of 5 kg/d; this will be lost as drift and in the cooling tower blow-down.

Wastes from the cooling system are discussed in Section 4.5.

4.4.7 Water supply system

Water will be required at a rate of 264 m^3/h, of which approximately 200 m^3/h will be used as cooling tower make-up and 64 m^3/h will be required by the demineralization plant, which produces water for steam generation. It is proposed that this water be supplied by a series of six bores located adjacent to the eastern boundary of BP Refinery (see Figure 4.5).

Preliminary investigations based upon existing groundwater abstraction in the area (Appendix B) have indicated that these bores should yield an adequate supply of water from the Tamala Limestone aquifer, which occupies a zone between 17 and 28 m below the surface. The water quality obtainable from these bores is discussed in Section 5.3. The impacts of establishing the supply are considered in Section 6.1.

Scheme water will be required for potable water and fire-fighting services.

4.4.8 Effluent treatment facilities

Facilities will be provided for the treatment and disposal of process-based gaseous and liquid emissions.

The ammonia and urea plants will use current state-of-the-art methods of effluent treatment, including:

- ammonia plant process condensate stripping and treatment for reuse;

- containment of MDEA by use of a closed collection drain system that serves the carbon dioxide removal system, which is contained within a bunded area;

- flaring of ammonia-containing vapour releases from plant and storage areas;

- containment and transfer to the urea plant of aqueous ammonia produced during initial reduction of the ammonia synthesis catalyst;

- use of evaporative scrubbing for disposal of the urea plant process condensate and dust recovered from the urea granulation emissions;
- collection of urea spillages and strong effluents via a drainage network, and dissolving of these for reprocessing in the urea synthesis plant;
- release of other gaseous emissions via columns discharging to the atmosphere at high level.

In addition to these features, the whole site area will incorporate good effluent treatment practices, including:

- diversion of oily waste to sumps for retention and skimming, with disposal of skimmed oil by truck and of water by runoff to the stormwater pond for neutralization;
- diversion of stormwater, via holding ponds, to the CSBP open drain for discharge to Cockburn Sound;
- neutralization of effluent from the water treatment plant.

4.4.9 Plant infrastructure

Plant infrastructure will include the following:

- two-storey administration office;
- stores and workshop buildings that will provide facilities for plant maintenance and repair services, as well as securing ample space for on-site supply of spares, chemicals and catalysts;
- emergency medical attendant facilities;
- canteen;
- toilet/change-room facilities to adequately cater for the entire on-site workforce;
- gatehouse;
- fire station.

All plant infrastructure buildings will be architecturally designed to ensure aesthetic compatibility with the surrounds, and will incorporate up-to-date facilities for the comfort and safety of the workforce.

Sufficient landscaped on-site car-parking will be provided to comply with local authority requirements and to cater for the requirements of the on-site workforce.

The plant will be surrounded by a security fence, and access to the site will be via the gatehouse.

Sewage will be disposed of in a septic system installed in accordance with the requirements of the Town of Kwinana and the Water Authority of Western Australia.

Public utilities that will be required by the plant are water (groundwater and scheme water), telephone, natural gas and electricity.

4.5 WASTE PRODUCTS AND DISPOSAL

Aspects related to the generation of waste products and their disposal are addressed as follows for the construction phase and for normal plant operations.

4.5.1 Construction

During the construction phase, some quantities of earth spoil will be generated from the site preparation works. The spoil (comprising topsoil and clean sand) that cannot be used for site landscaping purposes will be transported off site for use by local authorities as cover material at sanitary landfill sites or by land developers requiring clean fill.

Strong wind conditions may cause some topsoil to be blown off site, particularly during site preparations. To minimize dust generation, water will be regularly sprayed over cleared areas.

Construction wastes will be collected in large containers, which will be transported to the local refuse site and disposed of in accordance with the requirements of the local authorities.

4.5.2 Operation

Liquid discharges

The major source of liquid wastes during normal plant operations will be about 44 m^3/h of cooling tower blow-down, which will contain about 3,000 mg/L or less of total dissolved solids resulting from the concentration of dissolved solids present in the cooling tower feedwater. Typically, the cooling tower blow-down will be of pH 6.8-7.2 and at a temperature of 27-30°C, and will contain the following:

. alkalinity, expressed as carbonates (dissolved)	1,040 mg/L
. chlorides (dissolved)	800 mg/L
. calcium (dissolved)	700 mg/L
. sodium (dissolved)	440 mg/L
. sulphates (dissolved)	290 mg/L
. magnesium (dissolved)	240 mg/L
. suspended solids	100 mg/L
. dispersant	5 mg/L
. free chlorine (biocide)	0.3-1 mg/L

No significant concentrations of heavy metals have ever been measured in the groundwater proposed for use as cooling tower feedwater; hence these should also not be present in the cooling tower blow-down or other water discharges.

Other sources of liquid effluent will include:

- 1.3 m^3/h of blow-down from steam generation plants
- 8.7 m^3/h of neutralized regeneration water from demineralization plants
- 1.2 m^3/h of condensate from air compressors.

These will produce a combined total of about 11.2 m^3/h of effluent, some of which will contain small quantities of dissolved salts. The pH of the demineralization plant effluent will be corrected to pH 6.5-8.5; other effluents will not require pH correction.

Water effluent from the sources discussed will be discharged into the existing open drain system at the CSBP Kwinana works, from where it will gravitate to Cockburn Sound.

Because the process area will be sealed with impervious paving, there will be more stormwater runoff than would presently occur at the site. Stormwater and washwater runoff, which may contain trace quantities of dissolved urea and nitrogen, will be channelled to a holding pond, where it will be treated before being channelled via the CSBP open drain to Cockburn Sound. Treatment will include neutralization of pH and oil skimming, with oil wastes being diverted to sumps for retention and subsequent disposal by truck.

The quantity of urea entering stormwater will be minimized by reducing the release of urea dust from equipment, by good housekeeping practice and by careful design of solids handling equipment and recovery of urea dust wherever possible. It is estimated that an average of 20 kg/d of nitrogen originating from urea will be discharged to Cockburn Sound.

Stormwater from areas where urea is not handled will be channelled directly to the CSBP open drain.

A diverter will be provided on the contaminated stormwater line upstream of the holding pond, so that, in the event of prolonged rainfall, uncontaminated flow can be directed to Cockburn Sound without the need for holding and treatment. This diverted water will also be fed into the open drain.

Domestic sewage from amenity facilities will be treated in a septic system in accordance with the requirements of the Town of Kwinana and the Water Authority of Western Australia.

Atmospheric discharges

About 4 m^3/h of water of similar composition to the cooling tower blow-down will be discharged to the atmosphere in the form of drift (fine droplets) from the cooling tower.

In terms of quantity, the single largest gaseous emission will be 232 m^3/h of water vapour and 6,900 t/h of air forming the cooling tower steam plume. The environmental impact of water vapour discharge is negligible. The cooling tower steam plume may also contain less than 1.4 p.p.m. of chlorine, which will be added to the cooling tower feedwater to act as a biocide, and less than 2.5 p.p.b. of the biocide dispersant Nalfloc 7348.

Flue gases from the ammonia reformer will be vented from the reformer stack at a height of approximately 50 m above ground level, at a rate of 303 t/h and at a temperature of 160°C. These gases will primarily contain the atmospheric components nitrogen, oxygen and inert gases (principally argon), and products of combustion (water vapour and carbon dioxide), together with about 170 p.p.m. (0.35 g/m^3) of oxides of nitrogen (expressed as NO_2) and about 0.7 p.p.m. (2×10^{-3} g/m^3) of sulphur oxides (expressed as SO_2).

Flue gases from the utility power generation turbine and auxiliary boiler, resulting from the burning of natural gas, will also be vented from the reformer stack at a rate of 102 t/h and at a temperature of 160°C. These gases will principally comprise nitrogen (from air), together with products of combustion and about 100 p.p.m. (0.2 g/m^3) of oxides of nitrogen (expressed as NO_2) and 0.8 p.p.m. (2.3×10^{-3} g/m^3) of sulphur oxides (expressed as SO_2).

The combined discharge from the ammonia reformer, utility power generation and auxiliary boiler will contain 152 p.p.m. (0.31 g/m^3) of oxides of nitrogen (expressed as NO_2) and 0.7 p.p.m. (2×10^{-3} g/m^3) of sulphur oxides (expressed as SO_2).

Vents from the carbon dioxide removal section of the ammonia process will discharge 40 t/h of carbon dioxide containing small concentrations of water vapour (2.1%, by weight) and hydrogen (0.007%, by weight) at a height of approximately 80 m above ground level.

All gaseous discharges from the urea plant will be scrubbed prior to discharge to the atmosphere. Water used for scrubbing will concentrate ammonia into solution and this will be stored in an aqueous ammonia tank prior to use in the process.

The scrubber vent servicing the urea synthesis and evaporation sections will discharge 2.4 t/h of air containing small quantities of water vapour (1.8%, by weight) and ammonia (1.0%, by weight). This discharge will be approximately 75 m above ground level.

The scrubber vent servicing the urea granulation section will discharge 482 t/h of air containing water vapour (7.4%, by weight) and urea dust (40 mg/m^3 in air). This discharge will be approximately 45 m above ground level.

There will also be some tank losses arising from the filling and emptying of tanks in the urea plant. Those from the urea tank will consist of 90 kg/h of air containing 1.3% (by weight) ammonia; losses from the granulation tank will consist of 410 kg/h of air. These gases will pass to the scrubber servicing the urea synthesis and evaporation section of the plant.

Some ammonia vapour is expected to be emitted during ship-loading operations. This loss is unlikely to exceed 9 kg of ammonia per year, representing only about 1 kg per ship-loading operation.

Emissions from the refrigerated ammonia storage tank will originate mainly from air leakage into the tank as the liquid ammonia feed is flashed to atmospheric pressure in the ammonia plant. These emissions will be sent to the ammonia flare for burning, resulting in decomposition of the ammonia to principally nitrogen and water vapour. The height of the flare will be approximately 80 m above ground level.

Total annual quantities of emissions can be estimated by assuming that the plant will be operational for 7,920 h/a.

Solid wastes

The plant will not produce any solid industrial wastes other than used catalysts, which will be periodically replaced. It is proposed to adopt the following disposal practices:

- sale of catalysts containing nickel and other valuable metals for reprocessing;

- testing for contaminants in iron-based catalysts used for ammonia synthesis, followed by disposal by burial at sanitary landfill sites as approved by local authorities.

Domestic solid wastes will be disposed of in the approved manner and to the satisfaction of the local authorities.

4.5.3 Plant start-up and shut-down

During the normal start-up and shut-down procedures of the ammonia and urea sections of the plant (as described in Section 4.3), gaseous waste products will be discharged into the atmosphere.

In the ammonia start-up and shut-down procedures, the waste gases will be vented via the high-temperature shift vent in the shift conversion section of the plant, the methanator inlet vent during methanation and via the syngas compressor suction vent during purification (cryogenic). They will then be burnt in the flare and the resultant exhaust gases will be released to the atmosphere. Based upon a plant load of 60% of capacity, the exhaust gases will have the following composition:

- 281 m^3/h water
- 50 t/h carbon dioxide
- 184 t/h nitrogen.

The quantity of carbon dioxide discharged will be reduced if the urea plant is also operating.

In the urea plant start-up and shut-down procedures, gases will be discharged directly into the atmosphere at a rate of 21 t/h at 50% capacity, the emission consisting of 20.5 t/h of carbon dioxide, 0.28 t/h of nitrogen, 0.25 t/h of oxygen and 1 kg/h of hydrogen.

In the event of urea plant shut-down while the ammonia plant is still processing, excess carbon dioxide will be vented to the atmosphere rather than being channelled to the urea plant, resulting in a maximum discharge of carbon dioxide of 84 t/h.

Upon the shut-down of both the ammonia and urea sections, the steam-based power generation facility may continue to operate, with flue gas emissions of a composition similar to those during normal plant operating conditions, but at a reduced rate. In a prolonged shut-down situation, the total emission rate will be about 20% of operating condition rates.

4.6 NOISE EMISSIONS

The design of the plant will restrict the maximum noise level from any item of equipment to 85 dB(A) at a distance of 1 m, which is lower than the current occupational health limit of 90 dB(A) at 1 m. Items of equipment that cannot meet this criterion will be housed in appropriate sound attenuating enclosures such that the noise emitted from the enclosure will be in compliance with the criterion. In addition, the design process will recognize the need to minimize noise emissions to levels that can reasonably be achieved. Although these commitments relate directly to occupational health, they also have a significant influence on noise levels perceived outside the plant site.

As an aid to estimating the noise levels likely to be generated by the proposed plant, the proponents have obtained the results of monitoring of noise levels surrounding an ammonia plant of similar design and capacity overseas. The measured noise levels included plant utilities, but not a urea facility. It is believed that, in the off-site noise level predictions, this omission is compensated for by the following:

- The design standard is 85 dB(A) at 1 m.

- In the dispersion modelling, no account is made of the significant shielding that will occur from plant items within the ammonia/urea plant and adjacent industries - in particular, shielding to the south by the CSBP works.

Noise dispersion modelling first involves the representation of the measured noise levels as one equivalent point source, located at the centre of the ammonia plant, emitting sound levels for the eight frequency bands commonly measured between 63 Hz and 8,000 Hz. In order to assess the noise levels at specified distances from this equivalent point source, the following factors that cause attenuation of sound are considered:

- dissipation due to radial divergence from the source
- attenuation due to absorption by the ground, grass and trees
- attenuation due to atmospheric humidity and viscosity.

The degree of attenuation is strongly dependent on the frequency of the sound.

In order to reduce the spectrum of noise levels to a single value at each distance, a weighting system is commonly used. The standard A-weighting scale follows closely the frequency response of the human ear to sound. The spectra of sound values at each distance from the plant are then summed logarithmically to yield a single combined noise level in decibels for distances from 100 to 2,000 m from the source.

This approach applies for calm, ideal atmospheric conditions. However, both wind and temperature gradients will modify the results.

Under normal atmospheric conditions, the wind increases with height over the ground. A sound ray propagating in the air will then be refracted downward with the wind direction and upward against the wind. Hence, upwind of the noise source, an observer may be left in a kind of sound shadow, whereas downwind, a distant observer may hear sounds that have curved over the intermediate groundcover with minimal attenuation.

Similarly, temperature gradients cause refraction of sound rays. If the temperature decreases with height, as is usual during the daytime, the sound rays will be refracted upward, and a sound shadow may result at some distance all around the source. At night, there can be an inversion of the temperature gradient, and sound rays will be bent downwards. As for the wind effect, rays with an initial upward elevation may bypass obstructions and the absorbing ground, and so attain distances quite far from the source.

To account for these atmospheric conditions, two sets of dispersion models have been analysed. Table 4.1 summarizes the predicted noise emissions with radial distance, assuming no ground attenuation, to approximate adverse atmospheric conditions, while Table 4.2 allows for ground attenuation from grass and low shrubs.

Table 4.1 Predicted noise emissions - no ground attenuation

Distance (m)	Frequency (Hz)/A-weighting factor								Combined noise level (dB(A))
	63/-26.2	125/-16.1	250/-8.6	500/-3.2	1,000/0.0	2,000/1.2	4,000/1.0	8,000/-1.1	
100	71	66	63	61	60	58	56	44	65
200	65	60	57	55	53	51	48	33	58
400	59	54	50	48	46	43	37	17	51
600	55	50	47	44	40	36	28	4	46
800	53	48	44	41	36	31	21	0	42
1,000	51	46	42	38	33	27	14	0	40
2,000	45	39	35	29	20	18	0	0	31

Table 4.2 Predicted noise emissions - with ground attenuation

Distance (m)	Frequency (Hz)/A-weighting factor								Combined noise level (dB(A))
	63/-26.2	125/-16.1	250/-8.6	500/-3.2	1,000/0.0	2,000/1.2	4,000/1.0	8,000/-1.1	
100	70	65	61	59	58	56	53	40	63
200	63	58	54	52	49	46	41	25	54
400	56	50	45	42	38	32	24	1	44
600	50	44	39	34	29	21	9	0	36
800	46	40	34	28	21	11	0	0	30
1,000	43	36	29	22	13	2	0	0	25
2,000	29	19	10	0	0	0	0	0	10

At the nearest plant boundary, a distance of about 120 m from the centre of the ammonia plant, noise levels of about 65 dB(A) can be expected. This boundary presently adjoins vacant land that is zoned for industrial use. Impacts relating to noise are discussed in Section 7.2.

4.7 CONSTRUCTION

Detailed plant design and site preparation will commence soon after all required development and statutory approvals are received.

Construction and assembly are expected to extend over a twenty-five—month period and the construction phase will require a maximum workforce of around 1,200 personnel. The workforce requirements with regard to time and trade are shown in Figure 4.7.

Construction will involve mainly the assembly of items of plant such as pipework and tankage, pressure vessels, scrubbers and solids handling equipment, with many of these being constructed off site and assembled on site.

In order to provide access for unloading heavy plant components, a temporary land groyne platform may be constructed on the foreshore of Cockburn Sound close to the site. This structure would be removed once all such components had been delivered.

Construction activities will generally be carried out between the hours of 7 a.m. and 6 p.m. Monday to Friday, and on Saturday mornings.

All construction materials and practices will comply with the relevant Australian standards and codes of practice. The proponents will meet all relevant local authority requirements, including standard precautions to minimize the generation of dust and noise during the site preparation and construction phases.

4.8 COMMISSIONING

The commissioning of the facility, including pre-testing of equipment and parts of the process, will involve cleaning of the plant with steam. Elevated noise levels may occur during this period; however, all efforts will be made to minimize any inconvenience to the outside environment: silencers will be used where possible, the hours in which such activities can take place will be restricted and the public will be informed in advance of commissioning plans. The EPA will be informed about the timing of the plant's commissioning.

This period will also involve more flaring of gas in the plant than is expected during normal operation.

Cleaning of some of the equipment with water or other liquids will be required during commissioning. Proper care will be taken to dispose of such liquids either via the controlled holding ponds for water or off site as required by the relevant authorities.

4.9 OPERATION

With the exception of maintenance shut-downs, the plant will be designed to operate continuously. A high level of automation will contribute to the operational stability of the plant.

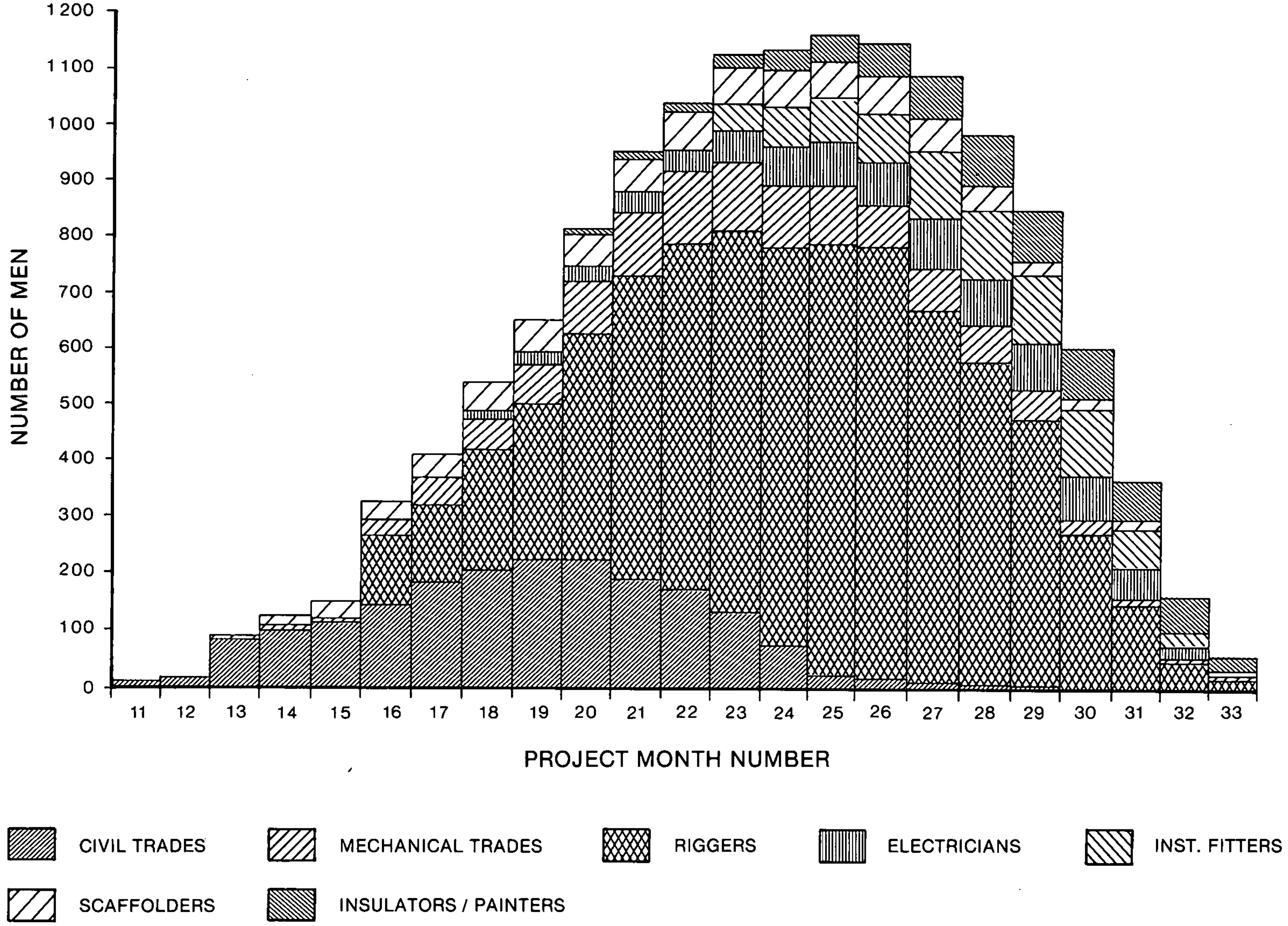


Figure 4.7
CONSTRUCTION WORKFORCE
REQUIREMENTS

The plant workforce (up to 200 people) will be engaged in:

- continuous operation (shift basis)
- maintenance
- administration
- supervision and management
- miscellaneous duties.

All employees will be trained in safe work practices and emergency procedures. Plant safety and contingency planning are discussed further in Section 4.10.

4.10 PLANT SAFETY

Both CSBP and Norsk Hydro have extensive experience in the operation and maintenance of modern fertiliser and chemical plants, and this will be used in developing the best possible operational and maintenance safety procedures for the plant.

4.10.1 Design and safety features

The incorporation of safety aspects into operations will commence with the selection of technologies and plant design that will minimize the risk of plant failure and human error. During the design phase, the proponents will undertake a Hazard and Operability (HAZOP) study in conjunction with the technology suppliers and engineering contractors to further enhance the plant's safety. In the procurement and construction phase, close attention will be paid to the quality control systems, both in vendors' equipment fabrication and in the plant construction.

The plant will be equipped with gas-monitoring systems and equipment condition monitors, either permanently installed in specific locations or as part of a mobile surveillance routine, in order to assist the detection of any gas leaks or equipment malfunction that may possibly result in a hazardous situation.

To ensure the safe supply of natural gas to the plant, it is proposed to install a telemetric system linked to SECWA's control centre. With this system, trip valves located in the Kwinana junction station will ensure that downstream line failure will activate a low-pressure trip, terminating supply to the plant. This system would also be expected to provide an early warning system for shut-down of the ammonia plant in the event of upstream line failure.

A continuous supply of nitrogen for purging of the plant free of oxygen prior to start-up and for rendering the plant inert after shut-down will be available via pipeline from an existing distribution system in the Kwinana region. In addition, a supply of liquid nitrogen stored on site, equipped with separate evaporator capacity, will ensure safe and quick handling of any hazardous condition in the plant.

Plant operation under normal conditions will involve very little manual work. Instrument readings not available in the control room will be checked regularly and corrective action taken if necessary.

4.10.2 Training

The commissioning and operational phase will be preceded by recruitment and training of personnel for the safe operation and maintenance of the plant. Theoretical and practical safety training courses will be taught by experienced senior personnel, who will provide detailed safety operations and maintenance instructions. These instructions will address all factors required to effectively operate the plant, including safety aspects relating to start-up, normal operation and shut-down procedures, and all emergencies.

Senior personnel (including the shift supervisor level) will be trained in the technology licensors' plants, in Norsk Hydro plants and on site at Kwinana, with emphasis being placed on the understanding and handling of the plant under all possible situations. These training courses will be repeated at planned intervals to ensure that all personnel are fully familiar with the operations.

All personnel, including outside contractors working on site, will be made aware by the management of all operational and personnel safety requirements, including familiarization with, and adherence to, all safety and work routines.

4.10.3 Maintenance

Maintenance procedures are an important aspect of safe plant operation. As such, specific routines and controls will be developed to ensure that effective maintenance programmes are conducted. These will involve the use of written work permits, which will specify the safety procedures to be adopted and how they will be controlled, actual work required and how the equipment will be tested prior to recommissioning.

When alterations to existing equipment or installation of new equipment are suggested, detailed check procedures on the design, including hazard and operability analysis, will be undertaken and approved before requisitions are issued for the work. This will ensure that safety standards set by the HAZOP study carried out in the detailed design phase of the project are maintained.

Routine plant and equipment checks will be carried out continuously by the operators and, periodically, by plant inspectors to ensure that any unsafe or environmentally unacceptable condition is detected and corrected.

4.10.4 Fire control

The plant will have a fire main system supplied from a separate tank and pumping system fed from the production bores, with back-up from the scheme water main. Permanent hydrants will be situated at selected locations around the plant, together with foam generators in areas of the plant where ammonia leaks could occur. The operational workforce will include personnel trained in fire-fighting techniques applicable to this type of plant and will be under the control of a safety superintendent. Trained personnel will be in attendance during each shift.

4.10.5 Operating procedures

Any abnormal operating circumstances will be recorded and dealt with in a proper manner, which may vary from immediate shut-down to corrective maintenance actions while operating. Routines or instructions for dealing with these situations will be described in operational and maintenance manuals, which will form part of the training programmes.

The ammonia/urea plant, being dependent on high and regular throughput, will be operated via a central computerized control system, from which all process parameters will be monitored. Should equipment in this system fail, alarms will immediately sound, enabling operators to adopt corrective action.

Additional instrumentation will directly intervene if conditions that risk process equipment or personnel develop. Based on carefully selected process or equipment performance criteria, an interlock system will automatically effect safe emergency shut-down of the plant.

All essential input signals to the interlock system will be based on a two-out-of-three voting system, ensuring that instrument failure does not lead to unnecessary shut-downs and that any real situation is correctly dealt with. This system will have an independent power supply, which will be provided by batteries. All shut-off valves will have the capacity to fail to the safe position (open or closed, according to the emergency shut-down procedure).

The automatic emergency shut-down by the interlock system will only function when plant operators are not reacting, or do not have the time to react, to the pre-alarms on process or equipment signals reaching the control room. The objective of this automatic and manual emergency shut-down procedure is to maximize safety for the plant operators and equipment and to minimize environmental impacts. The system will be tested periodically.

4.10.6 Emergency procedures

Other than emergency procedures planned for specific operational requirements, a general procedure to cover site emergencies will be developed prior to plant commissioning. This will be based upon the control of emergency procedures as presently used by CSBP, where the appropriate level of response and use of emergency resources are selected for each emergency incident.

This procedure will involve definition of the following:

- when the procedure shall be initiated
- what level of action is required for the given situation
- who is responsible for the overall control of the prescribed actions
- which public or statutory bodies shall be notified and what are their roles.

Prior to plant commissioning, the following outside agencies will be advised of the plant's emergency procedures and facilities and will be asked to comment, if necessary:

- Police Department
- Western Australian Fire Brigades Board
- Western Australian State Emergency Service
- FPA
- Red Cross
- local hospitals
- St John Ambulance Brigade
- Kwinana Industries Mutual Aid Group.

The last of these groups represents an understanding between Kwinana-based companies to assist one another.

There will be emergency procedure drills prior to commissioning, with regular drills at various levels being conducted once the plant is operational. The response to these will be audited.

4.11 PROJECT SCHEDULE

It is expected that, once environmental and planning approvals are secured, the following schedule will be followed:

. commencement of process design	January 1988
. commencement of site works	September 1988
. mechanical completion	August 1990
. commercial operation	October 1990.

5 EXISTING ENVIRONMENT

Section 5 provides a description of the environment as it pertains to the proposal. Only the physical, ecological and social systems that have the potential to be affected in either a positive or negative manner have been appraised.

5.1 METEOROLOGY

The climate of Kwinana, as for the entire Perth Metropolitan Area, is characterized by mild, wet winters and hot, dry summers.

Sea/land breezes predominate in the coastal region around Kwinana. The strongest winds blow from the south-west and occur mainly in winter; however, offshore easterly winds can reach gale force in summer. The average wind speed is approximately 14 km/h.

Figure 5.1 shows the prevailing wind frequencies applicable to Kwinana, averaged over a twelve-month period.

The average annual rainfall for the area is 789 mm, recorded at BP Refinery, Kwinana. The average rainfall per month is shown in Figure 5.2, along with the maximum rainfall recorded per month. Rainfall patterns in the Metropolitan Area are characterized by most of the rainfall falling in short periods of time: the maximum rainfall falling in one hour is 48 mm.

Further meteorological data for the region, pertaining specifically to atmospheric dispersion, are presented in the preliminary risk analysis for the plant prepared by Det norske Veritas (1987).

5.2 COCKBURN SOUND

Cockburn Sound is of high environmental, economic and social importance, providing a valuable recreational asset to the region and, at the same time, a focus for industries reliant on import/export facilities and related services. Population growth in the region has produced increasing demands for the protection of the high-quality aesthetic and ecological condition of the waterbody. Important recreational uses of the Sound include fishing, crabbing, swimming, boating, sailing, picnicking, beach walking and vacationing, and the enjoyment of these is dependent, to a greater or lesser extent, on the environmental health of the system.

5.2.1 Water circulation

Cockburn Sound is part of a shallow depression between the Spearwood Ridge and the Garden Island Ridge, and has a central basin approximately 20 m deep. A shallow sill across the southern opening (2-3 m deep) almost encloses the waterbody at this end. Parmelia Bank, extending from Woodman Point to Carnac Island, also substantially restricts water movement through the northern entrance. Steedman and Associates (1979) showed that the volume of water

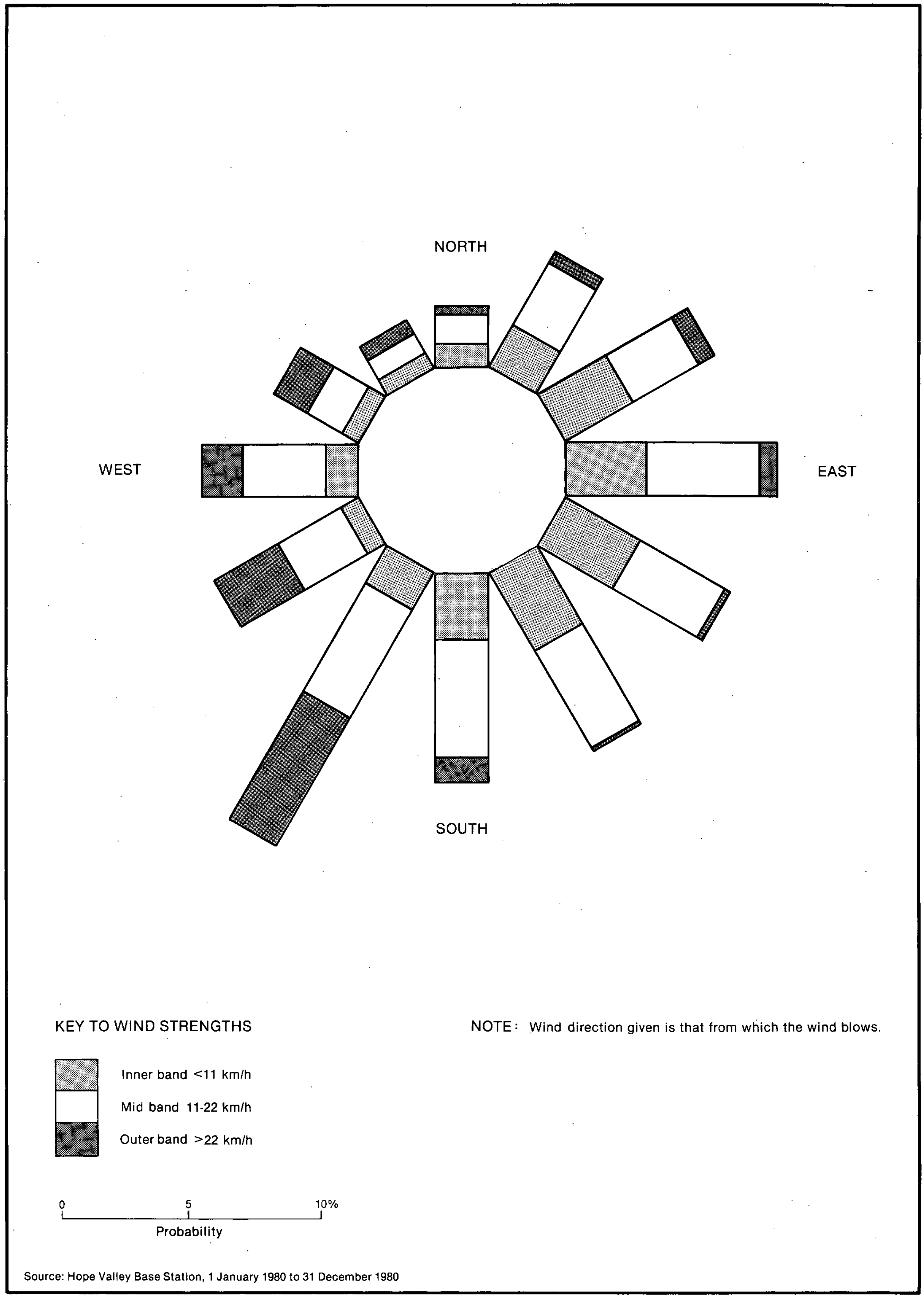
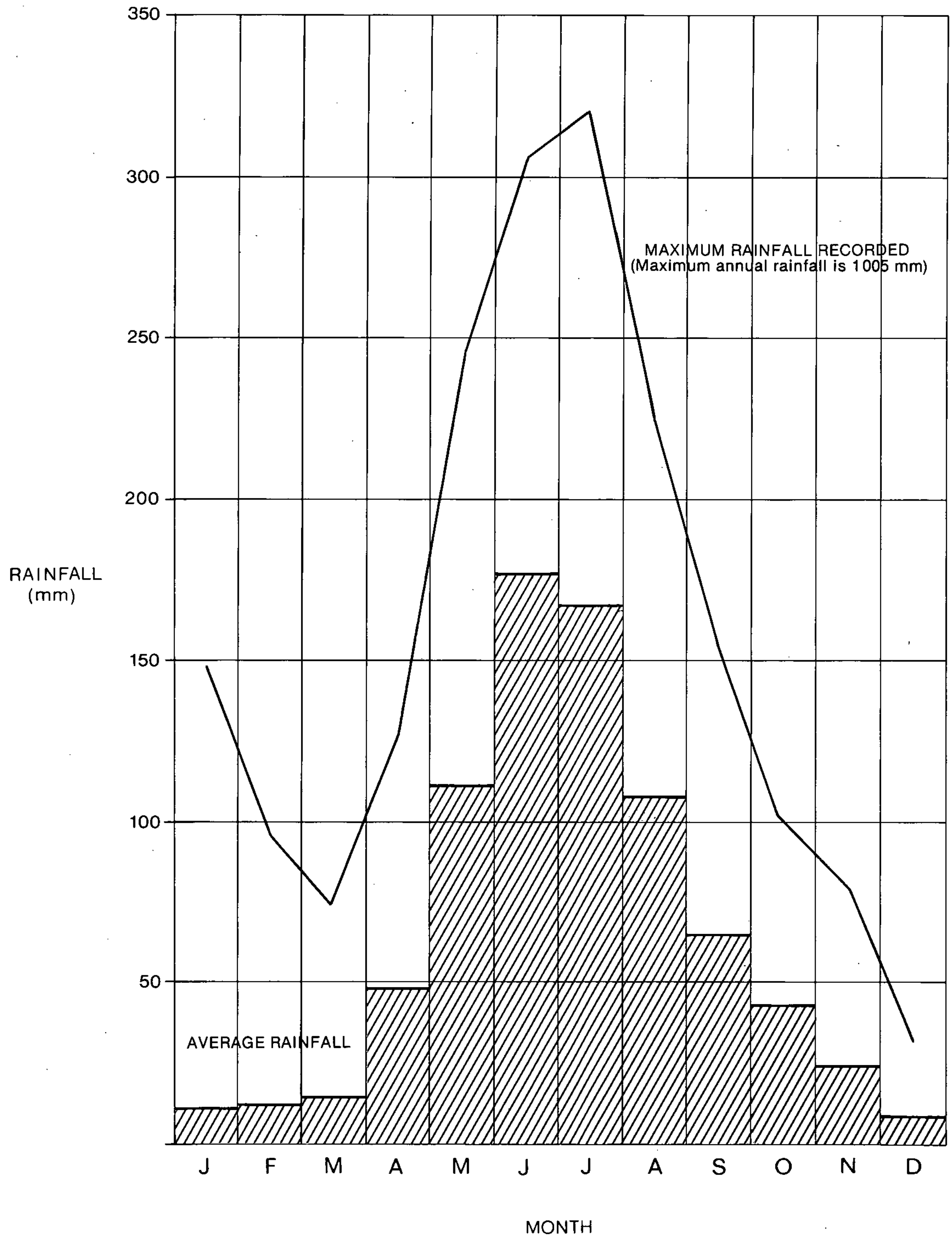


Figure 5.1
WATTLEUP BASE STATION WIND DIRECTION FREQUENCY



Source: Bureau of Meteorology, measured at BP Refinery, Kwinana (1955-86)

Figure 5.2
RAINFALL PATTERNS

transported through each opening was low: less than 1,000 m^3/s for an estimated 80% of the time. The volume of water within Cockburn Sound is of the order of 10^9 m^3.

The water current regime within Cockburn Sound is variable and appears to be primarily wind-forced (Steedman and Associates 1979). It is evident from the wind data provided in Section 5.1 that wind forcing of surface water in the Sound is predominantly towards the northern two quarters, but is highly variable on both a seasonal and a short-term time-scale.

Definition of localized water currents is made complex during low wind conditions by fine-scale water movements induced by tidal circulation, and by sea temperature and related density variations. Detailed water current profiling along the eastern margins of the Sound by Steedman and Associates (1979) showed that, under low wind conditions (<5 m/s, which occur for up to 47% of the time), relatively high current speeds were still occasionally recorded. The profiling also revealed a fine structure in the waterbody, with horizontal scale lengths generally less than 1,000 m. Within these distances, salinity, temperature and current speeds showed substantial variation, horizontally and vertically.

Observation and theoretical analysis have shown that the general water movement within the Cockburn Sound basin is very slow. The typical velocity range is 0.01-0.1 m/s, with 70-90% of speeds in the range 0.01-0.05 m/s. During gales, speeds of 0.35 m/s may be reached. Tidal currents are very small, less than 0.01-0.02 m/s.

5.2.2 Resources

Cockburn Sound offers diverse biological and human resources, the principal of which are the marine faunal and floral communities, fishery resources, shipping and recreational amenity. Each of these is discussed briefly as follows.

Marine communities

Penn (1977) identified two major reasons why Cockburn Sound provides an ideal and essential environment for many species of marine life. Firstly, the Sound is the only significantly protected embayment between Cape Naturaliste and Shark Bay, a distance of 1,000 km. Secondly, as the Sound contains expansive shallow banks, it has many of the advantages of productive coastal estuaries without being subject to the radical salinity and temperature fluctuations that occur seasonally in estuaries.

Before industrial development began on the eastern shore of Cockburn Sound in 1954, it is estimated that sea-grass meadows occupied approximately 4,000 ha of the sand banks rimming the deep basin of the Sound and extended down the sand slopes to a depth of about 11 m. As is discussed in Section 5.2.3, these sea-grass beds declined substantially until the last few years, and now appear to be recovering. Sea-grass stabilizes the sea floor and provides a habitat for a wide variety of fish and invertebrates. The breakdown of leaf material provides an important food source for organisms at the base of the food-chain; these, in turn, provide food for other invertebrates and fish.

Detailed studies on the marine faunal resources of Cockburn Sound are limited, and have mostly investigated the commercially exploited species. A fish productivity study (Dybdahl 1979), conducted as part of the Cockburn Sound Environmental Study (Department of Conservation and Environment 1979), identified 144 species and considered that this represented a substantially incomplete survey. Of these, seventy-three fish species and eight invertebrate species were of commercial and recreational fishing interest.

In these terms, the Sound is seen to support a rich and diverse assemblage of fauna. For comparison, Lenanton (1976) found twenty-eight commercially and recreationally important species in the Blackwood River estuary and thirty-one species of importance to fishermen in the Swan-Canning estuary.

Cockburn Sound is also an important nursery and breeding area for species that spend most of their life cycle outside the Sound. In documenting the fish and crustaceans of the Swan-Canning estuary, Lenanton (1978) found that the bulk of the catch of both commercial and amateur fishermen was composed of juvenile members of species derived from adult oceanic stocks. The nearest oceanic population for many species is Cockburn Sound. Penn (1977) suggested that Cockburn Sound would provide the spawning stock and, hence, recruitment to the Swan River for such species as the blue manna crab (Portunus pelagicus) and the western king prawn (Penaeus latisulcatus).

Fishing

Cockburn Sound has historically been a major commercial fishing area from which most of the fresh fish for the Metropolitan Area has been caught. More recently, the fishery has become dependent upon catching bait fish, mainly to supply the rock lobster fishery in Western Australia.

The total commercial catch (including fish, crustaceans and molluscs) from Cockburn Sound for 1984-85 was 1,330 t, and for 1983-84 was 1,275 t (Australian Bureau of Statistics 1986). The number of full-time commercial fishermen working in the Sound was estimated at fifty-six in 1985 and thirty in 1984. The maximum number of professional fishermen deriving their livelihood from Cockburn Sound during any month in 1985 was seventy-four - several of these were semi-retired and fished only occasionally.

The commercial fishery in the Sound appears to have increased since 1978, when thirty full-time fishermen caught a total live weight of 760 t.

A total of some thirty species are caught commercially in the Sound, but over 95% of the catch is accounted for by the six principal species, as shown in Table 5.1.

Table 5.1 Principal species commercially fished in Cockburn Sound, 1985

Common name	Scientific name	Total catch (live weight - t)
Scaly mackerel	Amblygaster postera	601
Pilchard	Sardinops neopilchardus	181
Australian herring	Arripis georgianus	23
Blue manna crab	Portunus pelagicus	105
Octopus	Octopus tetricus	10
Mussel	Mytilus edulis	371

Source: Australian Bureau of Statistics 1986.

Cockburn Sound is also popular for amateur fishing, mainly from boats. As part of the Cockburn Sound Environmental Study (Department of Conservation and Environment 1979), a creel survey of amateur fishermen was conducted by Dybdahl (1979), during which 2,035 people were interviewed as they returned to boat ramps bordering the Sound. The results of this survey showed that the six most important species to amateur fishermen were blue manna crab (Portunus pelagicus), Australian herring (Arripis georgianus), whiting (Sillago sp.), skipjack (Caranx georgianus), garfish (Hyporhamphus melanochir) and yellowtail scad (Trachurus mccullochi). The estimated weight of crabs and fish caught by amateur fishermen in 1978 amounted to nearly 120 t and 210 t, respectively.

The most popular areas for amateur fishing were found to be the central basin (i.e. inside the 10 m depth contour), Jervoise Bay (i.e. the nearshore area north from BP Refinery to Woodman Point), and the Southern Flats (i.e. immediately to the east of the Garden Island causeway). This is in contrast to the commercial fishermen, who primarily fish Owen Anchorage and Success Bank.

Shipping

Shipping access to Cockburn Sound is by a single channel through Success and Parmelia Banks, dredged to 14 m. During 1985-86, a total of 553 ships, with a gross registered tonnage of 11,424,000, entered the Sound. Total imports and exports by these vessels are summarized in Table 5.2.

Table 5.2 Imports and exports - Cockburn Sound, 1985-86

Cargo	Mass (t)
Inward	
Received from intrastate ports	572,266
Received from interstate ports	1,973,752
Received from overseas ports	2,244,300
Total inward	4,790,318
Outward	
Shipped to intrastate ports	699,417
Shipped to interstate ports	581,318
Shipped to overseas ports	6,485,900
Total outward	7,766,635
Total cargo	12,556,953

Source: Port of Fremantle, Western Australia, 1986.

Recreation

Cockburn Sound provides an extremely valuable recreational asset to the Perth Metropolitan Area. The advantages of close proximity to suburban populations, clear, protected waters, a productive fish and crab population and diverse recreational amenities attract considerable shore-based and water-oriented activities. The Cockburn Sound Recreational Survey (Feilman Planning Consultants Pty Ltd 1978) documented high recreational use throughout the Sound, and demand has probably substantially increased since the time of that survey.

Peak recreational use occurs during the summer on hot weekends. Feilman Planning Consultants Pty Ltd (1978) estimated that a maximum of about 7,000 people were on the Cockburn Sound and Owen Anchorage beaches and that about 600 boats, containing about 2,200 people, were on the offshore waters. For comparison, the Swan and Canning Rivers Activity Study (Forbes and Fitzhardinge 1977), conducted at about the same time, estimated that peak usage of that waterway involved about 2,400 people using the foreshores and 2,900 in boats.

Cockburn Sound beaches were found to be used predominantly by family groups, most enjoying half or full—day family swimming and picnic outings. Most beach users are concentrated at the five main developed beaches: Palm Beach, Rockingham Beach and Kwinana Beach in Cockburn Sound, and Coogee and South Beaches in Owen Anchorage. Rockingham Beach was found to accommodate over half of the beach users (Feilman Planning Consultants Pty Ltd 1978).

Fishing was found to be the principal boating activity in boats launched from public ramps, with general pleasure boating second in importance. Virtually all of these activities occurred within Cockburn Sound itself, i.e. to the south of Woodman Point.

The shoreline for approximately 500 m south and 3.5 km north of the proposed development site is zoned Industrial, and there is no immediate public access. Kwinana Beach, located immediately to the south of this sector of shoreline, is used for boat launching, swimming, sunbathing, picnicking and games. The residential estate east of the beach was zoned Special Industrial in 1975, and, as is discussed in Section 5.4, the land has progressively been acquired by the FPA since then. It is expected that usage of Kwinana Beach would probably have declined since the Feilman survey in 1977-78, and may decline further when development that is permitted under the zoning progresses.

Jetties, wastewater outfalls and fences inhibit pedestrian movement along the beach north of Kwinana Beach into the industrial area.

5.2.3 Eutrophication

The 1976-79 Cockburn Sound Environmental Study (Department of Conservation and Environment 1979) showed that Cockburn Sound was eutrophic (nutrient-enriched), and that substantial dieback of sea-grass beds had occurred in the Sound since industrial development of the area commenced in 1954. Analysis of aerial photographs indicated that the area of sea-grass beds had diminished from approximately 4,000 ha in 1954 to 900 ha in 1979. Evidence indicated that this decline was due to epiphytic growth on the sea-grass and the increased growth of phytoplankton, both of which were associated with increased nitrogen loading to the system. The report recommended that nitrogen loads to Cockburn Sound be substantially reduced to improve water quality and arrest the sea-grass dieback. The long-term objective was identified as being the reduction of nitrogen inputs to 1,000 kg/d, which was believed to be the input level in the late 1960s before major dieback of sea-grass occurred.

The two principal nutrient sources to the Sound in 1979 were identified as the combined outfall of KNC and CSBP, and that from the Water Authority of Western Australia's wastewater treatment plant at Woodman Point. At the time, the KNC/CSBP outfall was contributing an estimated 3,075 kg/d of nitrogen (as total nitrogen) to the Sound, with the treatment plant outfall adding a further 1,422 kg/d.

Since the Cockburn Sound Environmental Study, active steps taken by KNC and CSBP have reduced their combined outfall contribution of nitrogen to 1,000 kg/d, and the treatment plant effluent has been diverted to a new pipeline that discharges into oceanic waters west of Point Peron. Hillman (1986) has subsequently reported that the several years of reduced nitrogen loading and improved water clarity have successfully halted the dieback of sea-grasses and enabled existing sea-grass meadows to stabilize and even extend their distribution.

5.2.4 Beneficial uses

The Department of Conservation and Environment's Bulletin No. 103 (Department of Conservation and Environment 1981) identifies minimum water quality targets for conditions necessary to ensure the protection of identified beneficial uses of marine and estuarine waters in Western Australia. From the list of beneficial uses noted and considered in Bulletin No. 103, those applicable to Cockburn Sound include:

- navigation and shipping;
- direct contact recreation;
- harvesting of aquatic life (including molluscs) for food;
- passage of fish and other aquatic life;
- aquaculture of all forms;
- industrial water supply;
- maintenance and preservation of aquatic ecosystems - high level of protection;
- maintenance and preservation of foreshores and banks;
- flushing water and water replenishment.

The relevant water quality criteria for Cockburn Sound, which have been derived from Bulletin No. 103, are discussed in Section 6.3.

5.3 GROUNDWATER

The proposed plant will require a supply of good quality groundwater, at the rate of 264 m^3/h, for cooling and process water purposes.

The following aquifers are relevant to the proposed site:

- The Safety Bay Sand aquifer extends from the surface to about 17 m and is only capable of yielding 15 m^3/h.

- The Tamala Limestone aquifer extends from the base of the Safety Bay Sand to the Rockingham Sand and/or Leederville Formation aquifers at a depth of 26-28 m. The limestone aquifer is very permeable and high-yielding. The present major users in the vicinity of the abstraction area are CSBP and Nufarm, whose production bores maintain a constant groundwater quality with chloride concentrations in the range of 170-190 mg/L and sulphate concentrations of 50-60 mg/L. Previous operations have resulted in limited contamination of this aquifer with phenol, 2,4-D and 2,4,5-T in the vicinity of Nufarm, and this company proposes to adopt a closed cooling water system in the near future because of this problem.

- The Leederville and Yarragadee Formations are artesian aquifers that underlie the Tamala Limestone/Rockingham Sand aquifers, and extend to a depth of over 500 m. They are high-yielding, slightly brackish, slightly acidic and have a significant iron concentration.

Further groundwater information is presented in Appendix B.

5.4 LAND USE

5.4.1 Background

In 1955, a planning study (Stephenson and Hepburn 1955) recommended that the Kwinana district be developed as a major industrial centre. The subsequent industrialization of the area led to the decline of the residential communities of Naval Base and Kwinana Beach, and the development of Kwinana 'New Town', including the residential suburbs of Medina, Calista, Orelia and Parmelia, to house the Kwinana industrial workforce.

5.4.2 Existing land use

Residential

The nearest major residential area to the plant site is Kwinana 'New Town', approximately 2 km inland to the east. The town is screened from the industrial strip on the coastal plain by a ridge of well-vegetated dunes.

A smaller isolated pocket of residential development was located at Kwinana Beach, but residents have now been relocated in accordance with a State Government directive to allow development of this land in accordance with its Special Industrial zoning and to provide adequate buffering of existing and proposed developments in the vicinity. The populations of each of these communities for 1966 and 1981 and estimates for full development are shown in Table 5.3.

Table 5.3 **Population in surrounding communities: 1966, 1981 and at full development**

Neighbourhood unit	1966 population	1981 population/dwelling	Full development population
Kwinana 'New Town'	4,132	12,216/3,936	32,260
Kwinana Beach	846	310/98	-

Source: CSBP et al. 1986.

Industrial

The existing major industrial operations in the vicinity of the site, together with their maximum on-site workforce, are shown in Table 5.4.

Table 5.4 **Industrial workforce near the site**

Company	Type of industry	Maximum on-site workforce
BP Refinery (Kwinana) Pty Ltd	Oil refining	450
Kwinana Nitrogen Company Pty Ltd	Nitrogen chemicals manufacture	25
CSBP & Farmers Ltd	Fertiliser and chemical manufacture	420
Western Mining Corporation Ltd	Nickel refining	440
Coogee Chemicals Pty Ltd	Chemical manufacture	25
BHP Steel International Group/ Australian Iron & Steel Pty Ltd	Steelworks	270
Commonwealth Industrial Gases Ltd	Industrial gas production	15
Co-operative Bulk Handling Ltd	Grain terminal	150
State Energy Commission of Western Australia	Power station	450
Alcoa of Australia Ltd	Alumina refinery	1,360
Nufarm Chemicals Pty Ltd	Chemical manufacture	36
Cockburn Cement Ltd	Cement and lime production	360
CBI Constructors Pty Ltd	Structural engineering	60

Company	Type of industry	Maximum on-site workforce
Electric Power Transmission Pty Ltd	Fabrication for transmission projects	130
Transfield (WA) Pty Ltd	Structural engineering	170
Steel Mains Pty Ltd	Pipe manufacture/light engineering	65
Total		4,426

Recreational

The Cockburn Sound Environmental Study (Department of Conservation and Environment 1979) recognized that Kwinana Beach and adjacent Wells Park constituted an important recreational resource for residents in the Kwinana area. Even though residential occupation has now been phased out of the immediate vicinity, the resource retains its importance to the greater population of the Town of Kwinana.

Accordingly, a draft coastal management plan (Department of Conservation and Environment 1984) has been prepared for the location to ensure that its attributes are protected and enhanced in the future.

5.4.3 Zoning

Zones and reserves of the Metropolitan Region Scheme (MRS) (State Planning Commission 1986) are represented in Figure 5.3. The plant site is zoned Industrial under the MRS and is surrounded by Industrial-zoned land to the north, south, east and west. Further to the east, a 1 km wide parks and recreation reserve preserves an attractive landscape buffer between the site and Urban-zoned land at Medina.

The plant site falls within Industrial-zoned land under the Town of Kwinana Town Planning Scheme No. 1.

5.4.4 Land use studies

A number of studies that have been, or are currently being, undertaken may influence the land use of the Kwinana industrial area. These include the following:

- Kwinana Regional Strategy study;
- study commissioned by the local councils of Kwinana, Rockingham and Cockburn;
- cumulative risk study commissioned by the Department of Resources Development;

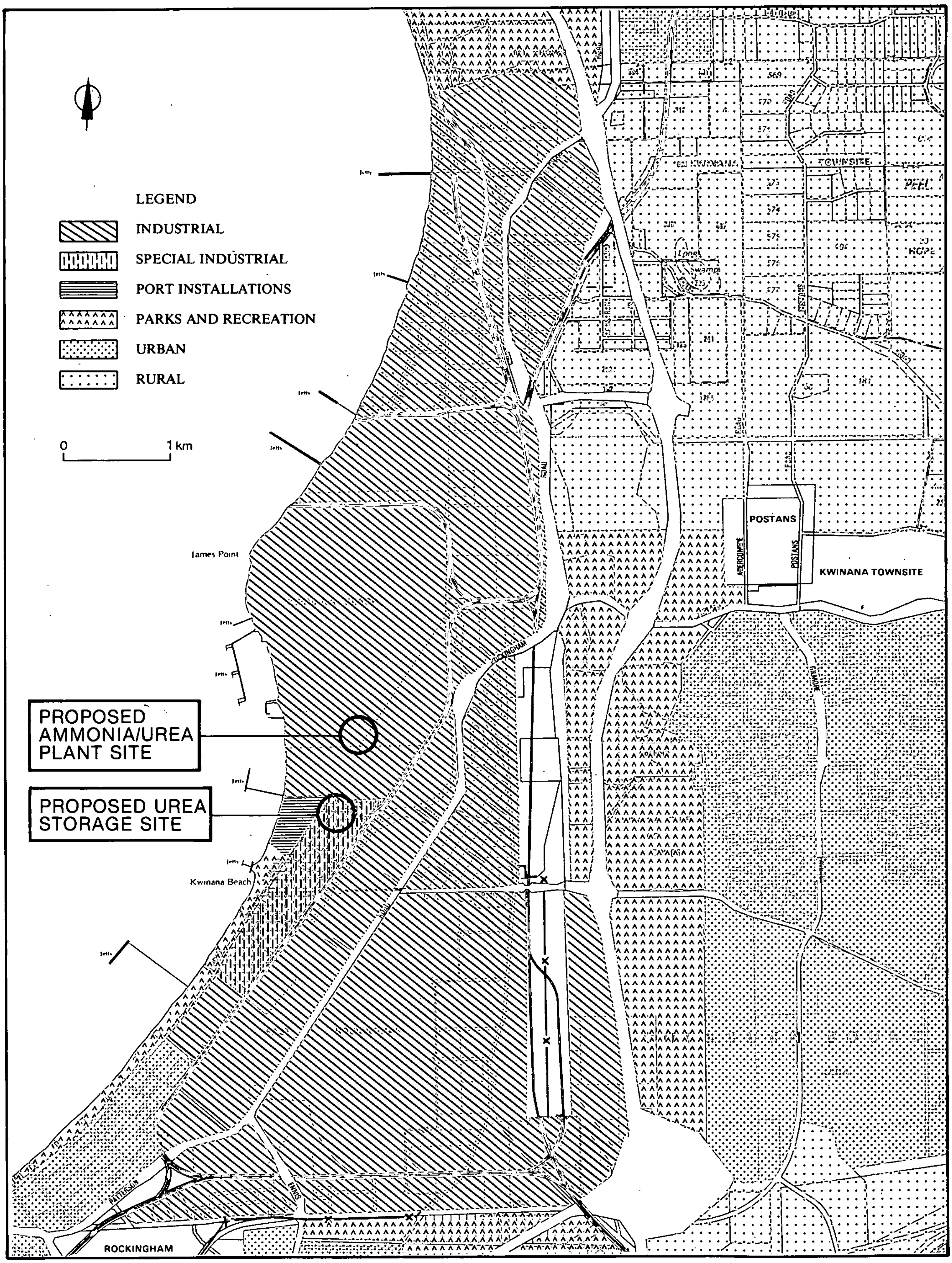


Figure 5.3
ZONING

- Kwinana Industries Co-ordinating Committee (KICC) studies, including activities by the Air Quality Working Group and the Groundwater Quality Working Group;

- Kwinana landscaping study commissioned by KICC.

5.5 NOISE

The background noise environment around the proposed plant site is characterized by industrial activities such as those of nearby land users CSBP, KNC, BP Refinery, WMC nickel refinery, Commonwealth Industrial Gases Ltd and Nufarm, and by traffic on Patterson Road.

Although regular comprehensive monitoring of these background noise levels has not been undertaken, an outdoor noise survey was conducted by CSBP in October 1985. This survey assessed noise levels at eight sites at 3.00 p.m., 9.30 p.m. and 3.30 a.m. along the southern boundary and toward the north-eastern section of the Kwinana site.

The levels recorded indicated that background noise levels along the southern boundary ranged between 45 dB(A) (3.30 a.m.) and 60 dB(A) (3.00 p.m.), with most recorded levels around 50 dB(A). CSBP's rock crushing plant and WMC's nickel refinery activities were the primary sources of these background noise levels. Passing freight trains (88 dB(A)), squealing truck brakes (80 dB(A)) and steelwork activity east of Patterson Road (68 dB(A)) were responsible for several recorded peak noise levels.

Background noise levels in the north-eastern section were between 46 dB(A) (3.30 a.m.) and 60 dB(A) (3.00 p.m.), with the higher levels attributed to heavy peak-hour traffic on Patterson Road.

5.6 LANDSCAPE

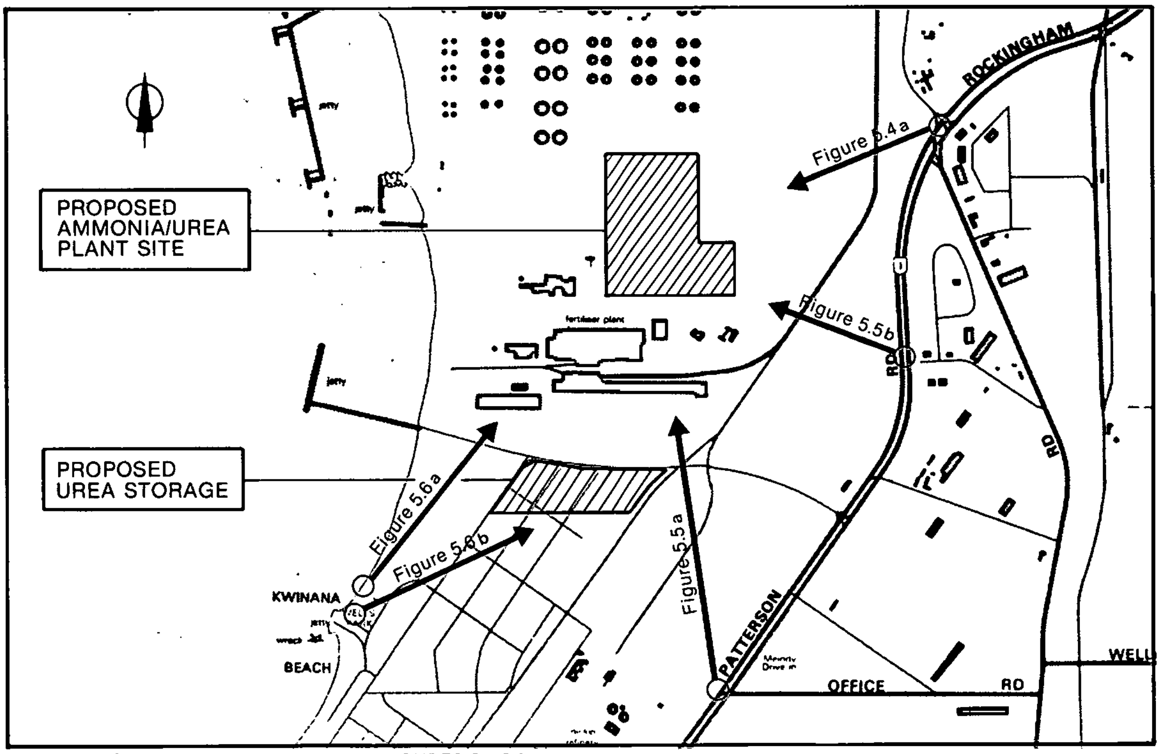
The proposed plant comprises a split site. The actual process plant will be on 20 ha of land owned by BP Refinery, alongside the existing KNC ammonia plant and CSBP fertiliser works. The proposed urea storage facility will be located on 10 ha of FPA/ILDA land, previously a residential area.

Both sites have little aesthetic appeal due to their lack of relief and degraded vegetation.

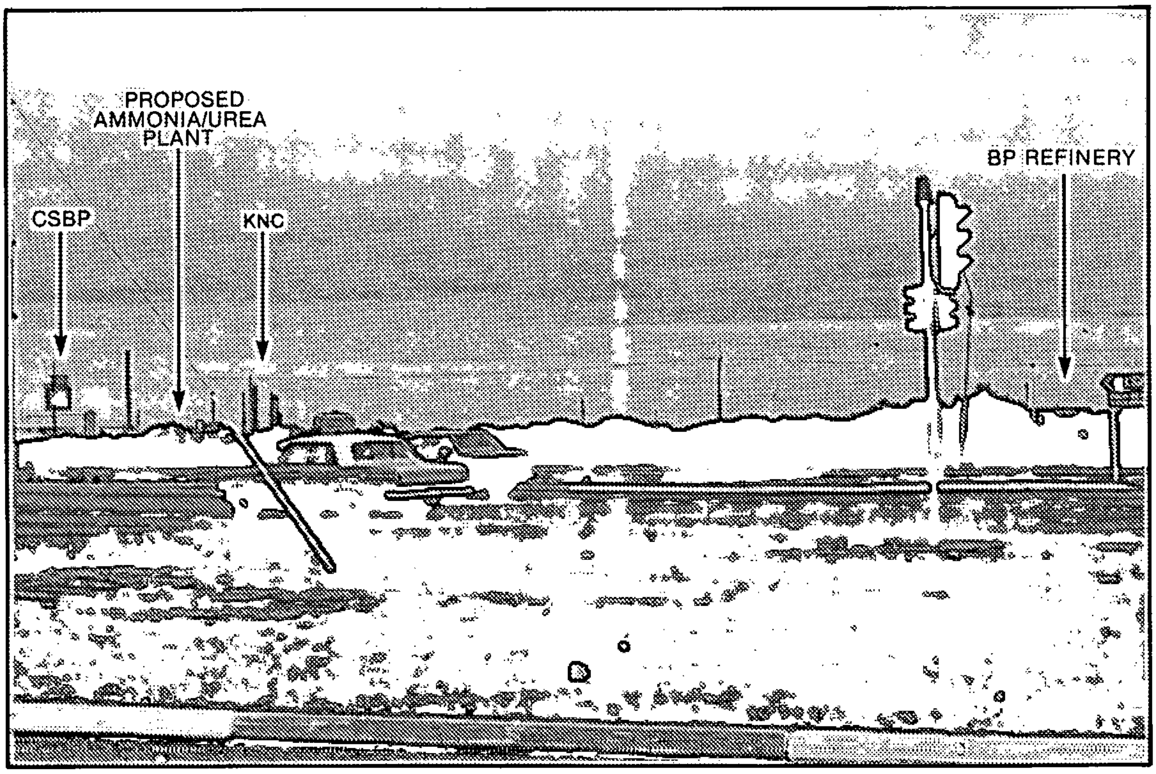
Views across the plant site will be seen by motorists approaching from the north on Patterson Road where it curves near the Mandurah Road intersection (Figure 5.4, view 5.4b).

Motorists approaching from the south on Patterson Road will catch glimpses of tall process vessels such as reactor columns. When viewed north from near the Office Road intersection (Figure 5.5, view 5.5a), much of the plant will be shielded, due to the existing CSBP works and an existing boundary planting that has matured into a tall visual buffer between the site and the view north-west from the Richardson Road intersection (Figure 5.5, view 5.5b).

Similarly, the view of the plant site from Wells Park, Kwinana Beach (Figure 5.6, view 5.6a), is shielded by the existing CSBP works.

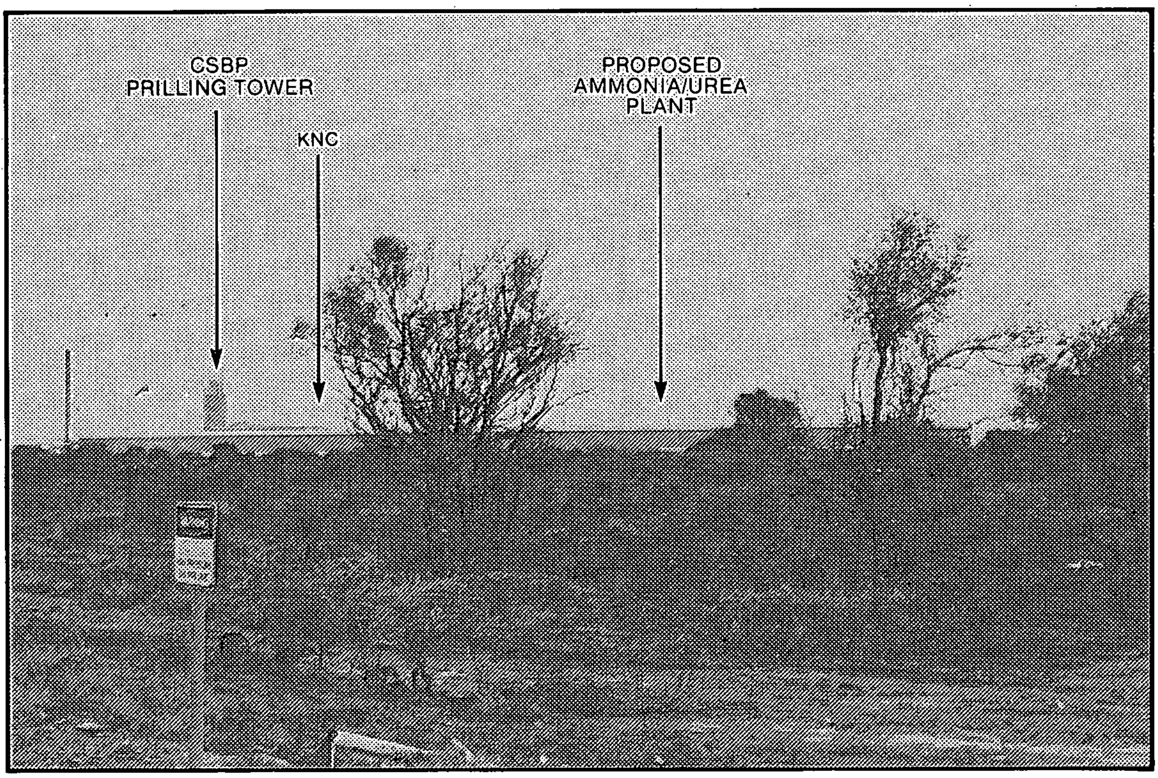


(a) PERSPECTIVE FOR VIEWS SHOWN—FIGURES 5.4-5.6

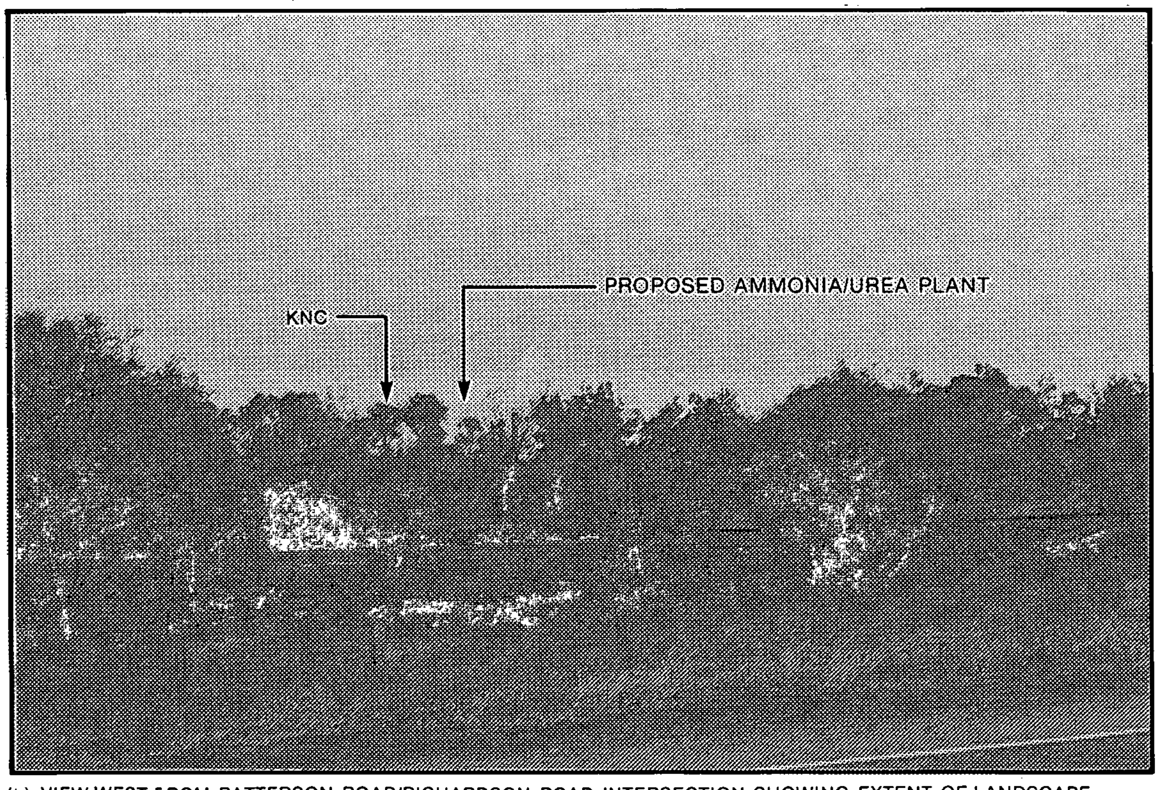


(b) VIEW SOUTH-WEST FROM PATTERSON ROAD FROM THE MANDURAH ROAD INTERSECTION

Figure 5.4
VISUAL IMPACT —
PERSPECTIVE AND VIEW 5.4b

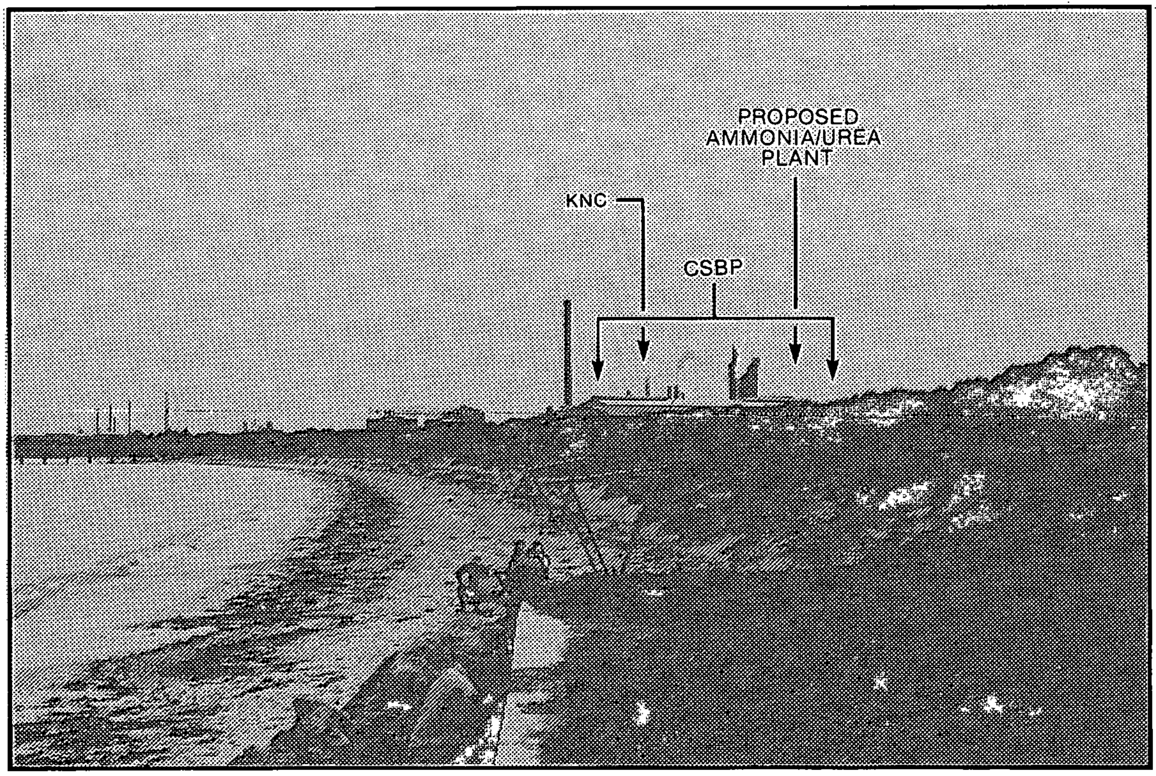


(a) VIEW NORTH FROM PATTERSON ROAD/OFFICE ROAD INTERSECTION, SHOWING THE EXTENT OF SCREENING BY CSBP

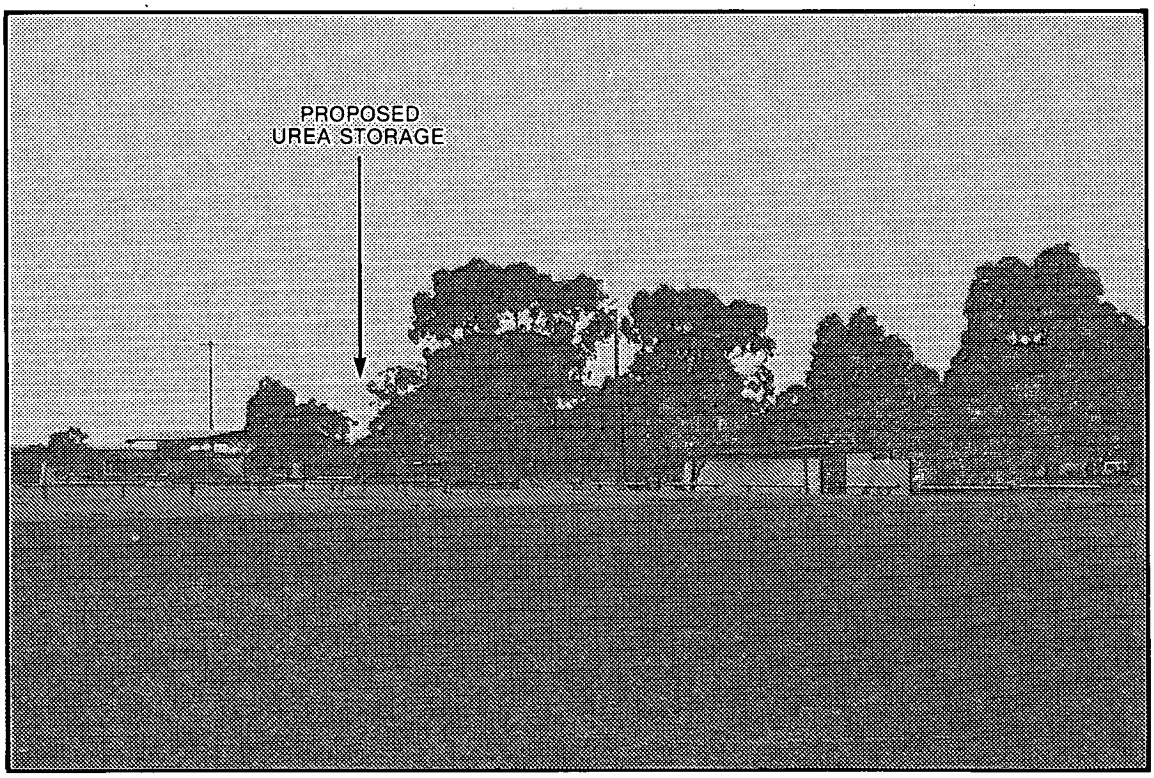


(b) VIEW WEST FROM PATTERSON ROAD/RICHARDSON ROAD INTERSECTION, SHOWING EXTENT OF LANDSCAPE SCREEN

Figure 5.5
VISUAL IMPACT —
VIEWS 5.5a AND 5.5b



(a) VIEW NORTH-EAST FROM KWINANA BEACH



(b) VIEW EAST FROM WELLS PARK, KWINANA BEACH, SHOWING EXTENT OF LANDSCAPE SCREEN

Figure 5.6
VISUAL IMPACT —
VIEWS 5.6a AND 5.6b

The urea storage site can only be seen from Kwinana Beach Road. It is completely obscured from Wells Park, Kwinana Beach, by a stand of tall trees (Figure 5.6, view 5.6b).

5.7 RISKS AND HAZARDS

The State Government, through the Department of Resources Development, has commissioned a cumulative risk study for the Kwinana industrial area. The conclusions of this study, made available on 22 May 1987, showed that, following the relocation of residents from Kwinana Beach, the present individual risk levels associated with the industries in the Kwinana region are within levels considered acceptable by the EPA.

The study also considered the impact of future industrial developments, including the proposed ammonia/urea plant, and found that, although there would be a small increase in individual risk, the predicted risk levels would be well within those considered acceptable by the EPA.

5.8 AIR QUALITY

The proposed ammonia/urea plant will be situated in the most important heavy industrial complex in Western Australia. Several of the industries in this complex discharge air pollutants, including sulphur dioxide and oxides of nitrogen.

Sulphur dioxide is a colourless pungent gas, and its odour has been responsible for numerous complaints by the residents in the surrounding area. Several industries in the vicinity of the proposed plant discharge sulphur dioxide, and the emission level has been monitored over several years by the Department of Conservation and Environment. This level has decreased significantly over the past five years, predominantly due to several industries converting from oil to natural gas as a feedstock. When plans by other companies become operational, a further decrease in the level of sulphur compounds released into the air should become apparent.

Oxides of nitrogen are formed and released in all common types of combustion and are introduced into the atmosphere from furnace stacks and similar sources. The most common oxides of nitrogen are nitric oxide, a colourless, odourless gas, and nitrogen dioxide, an orange-brown gas with a pungent odour, and these are discharged by several industries in Kwinana.

6 IMPACTS ON THE BIOLOGICAL ENVIRONMENT

Section 6 describes the potential impacts of the proposal on the biological environment, demonstrating that, with appropriate management, possible impacts will be minimized and restricted to acceptable levels, similar to ammonia/urea plants operating overseas.

The assessment of the impacts on the biological environment has been confined to areas where the potential for impact is perceived - groundwater, atmospheric and liquid discharges, solid waste disposal and the impacts of the construction phase.

6.1 GROUNDWATER

The cooling and process water requirement - 264 m^3/h - will be met by the establishment of six production bores pumping from the Tamala Limestone aquifer. These bores will each require a capacity of at least 90 m^3/h to ensure adequate reserves and standby capacity.

Preliminary investigations into the capacity of the Tamala Limestone aquifer (Appendix B) have indicated that, under the existing potentiometric gradients, about 100 m^3/h of groundwater flows past the proposed abstraction area and is lost to Cockburn Sound. Abstraction at a greater rate for the plant will cause a steepening of the potentiometric gradients to the east and an eastwards migration of the salt-water wedge at the base of the aquifer until a new equilibrium position is reached. Further detailed studies investigating the extent of the salt-water wedge migration and the optimum location of the bores to minimize impacts to groundwater users to the east of the plant are being undertaken in conjunction with the Water Authority, who would be responsible for managing the groundwater resource when the Cockburn Groundwater Area is proclaimed (this is expected in the next six to twelve months). This further work will also include contingency planning for relocation of the bores east of the proposed abstraction area if problems arise.

The final development of the bores will incorporate sufficient monitoring of the landward migration of the salt-water wedge so that alternative bores can be developed in sufficient time if required. The monitor bores will also be used to determine the movement of the contaminated surficial groundwater in the vicinity of the Nufarm chemical plant, to ensure that it is not incorporated into water abstracted for the plant.

6.2 ATMOSPHERIC DISCHARGES

This section discusses the impacts of atmospheric emissions from the ammonia/urea plant. Specific impacts relating to odours from atmospheric discharges and fugitive emissions are discussed in Section 7.5.

Associated with the introduction of the Environmental Protection Act, 1986, the EPA has stated that it would be desirable to assess atmospheric discharges in terms of impacts upon beneficial uses, rather than relying upon assessments in terms of concentrations of specific discharges. An evaluation based on this approach would require an assessment of specific beneficial uses of the atmosphere at the proposed point of discharge and its surrounds, and the setting of appropriate guidelines regulating discharges such that air quality met desired objectives. Beneficial uses would be dependent upon location. For example, in a predominantly residential area, the primary beneficial use would be for breathing air purposes, whereas in an industrial area, beneficial uses would also include its use as process air, for cooling and for dispersion of gaseous wastes, thereby implying higher allowable levels of contaminants than for residential areas. The important consideration for any area would be the total contaminant load, and this would require the development by regulatory authorities of an equitable system for apportioning the load between existing and future users.

At this stage, assessment of impacts of atmospheric emissions in terms of beneficial use is not appropriate for the ammonia/urea project for the following reasons:

- At present, there are no published policies relating air quality to beneficial use.

- There are insufficient baseline data regarding existing levels of atmospheric contaminants against which additional impacts arising from the proposed plant can be assessed.

Due to these limitations, the only assessment possible is to compare the concentrations of the constituents in the atmospheric discharges with published guidelines. Those prepared by the Australian Environment Council in conjunction with the National Health and Medical Research Council (1985) have been used for this ERMP/draft EIS.

The discussion on atmospheric discharges given in Section 4.5 has been structured in order to highlight the contaminants requiring consideration - oxides of nitrogen, oxides of sulphur and chlorine - allowing direct comparison with the guidelines. These contaminants are diluted into emissions of air and the normal atmospheric components (nitrogen, oxygen, carbon dioxide, water vapour and inert gases), which obviously have no direct environmental impact. Ammonia emissions are also highlighted in Section 4.5, as these are used in Section 7.5 when addressing odours.

The concentrations of the plant emissions compared to the Australian Environment Council/National Health and Medical Research Council criteria (1985) are summarized in Table 6.1. It can be seen from this table that emissions of all contaminants will be well within the adopted guidelines and should therefore be acceptable. Indeed, concentrations of sulphur oxides and chlorine are orders of magnitude less than the adopted guidelines.

Table 6.1 Comparison of emissions with guidelines

Emission source	Contaminant	Concentration (g/m^3)	Guideline standard (g/m^3)
Ammonia reformer stack	Oxides of nitrogen	0.35 (as NO_2)	0.5 for acid gases
Utility power generation and auxiliary boiler	Oxides of nitrogen	0.20 (as NO_2)	0.5 for power generation less than 30 MW; 0.35 for steam boilers fired by gas
Utility power generation and auxiliary boiler	Oxides of sulphur	0.002 (as SO_2)	No applicable standard
Cooling tower	Chlorine	0.002	0.2
Urea granulation	Urea dust	0.04	0.25 for solid particles

The cooling tower plume will also contain extremely small concentrations (2.5 p.p.b.) of the common biocide dispersant Nalfloc 7348. No adverse environmental impacts would be expected from this discharge.

Air discharged from the urea granulation scrubber vent will contain 40 mg/m^3 (in air) of urea dust. A proportion of this will settle on the paved plant areas and will be collected with the stormwater runoff. The impacts of this discharge are discussed in Section 6.3. The remainder of the urea dust will settle in low concentrations on the plant surrounds, and the impact of this should be restricted to a minor stimulation of growth to plants generally deficient in nutrients.

The proponents are aware of theories expounding global warming since industrialization due to the build-up of carbon dioxide (and other gases) resulting from the burning of fossil fuels, as well as contrasting theories expounding global cooling due to the build-up of atmospheric aerosols. The ammonia/urea plant will be an insignificant contributor of carbon dioxide by comparison with industrial complexes around the world. In addition, the plant will produce significantly less carbon dioxide than if the same quantity of natural gas were used as a conventional fuel source. Finally, the use of urea and other nitrogenous fertilisers promotes plant growth, thereby increasing the natural consumption of carbon dioxide from the atmosphere.

6.3 LIQUID DISCHARGES

As discussed in Section 4.5.2, liquid wastes discharged from the proposed plant to Cockburn Sound will comprise approximately 44 m^3/h of cooling tower blow-down water and variable quantities of stormwater runoff, plus approximately 11 m^3/h from other sources. Cooling tower blow-down water will be concentrated groundwater and will contain a total dissolved salts concentration of approximately 3,000 mg/L. The temperature of the blow-down water at the outfall will be 27-30°C.

Stormwater and washdown runoff will contain small quantities of urea dust. It has been estimated that the total nitrogen inflow to Cockburn Sound from this source will be a maximum of 7 t/a, or an average of 20 kg/d, and will probably be substantially less.

It is proposed that these effluent streams be discharged to Cockburn Sound via the existing CSBP open drain (refer Figure 4.5). The typical existing flow in this drain is 3,000 m^3/h, at a discharge temperature of 30-50°C.

6.3.1 Beneficial uses of Cockburn Sound

Section 5.2 describes the diverse beneficial uses identified in the Department of Conservation and Environment's Bulletin No. 103 (Department of Conservation and Environment 1981) that are applicable to Cockburn Sound. Table 6.2 summarizes the relevant water quality criteria for the Sound, which have been derived from Bulletin No. 103. Where the applicable criteria varied with the individual uses, the most rigorous criteria were used. It is important to note that these criteria refer to ambient conditions in the receiving environment necessary to ensure the protection of the stated beneficial uses, and do not refer to effluent quality.

Table 6.2 Water quality criteria applicable to Cockburn Sound

Parameter	Criteria
Nutrients and other biostimulants	The loads of nutrients and other biostimulants to receiving waters should not cause excessive or nuisance growths of algae or other aquatic plants, or deleterious reductions in dissolved oxygen concentrations in those waters.
Temperature	The maximum acceptable variation in the weekly average temperature due to artificial sources is 2°C during all seasons of the year, provided that no single value exceeds the highest summer maximum recorded over the previous five years, inclusive.
Salinity	Unnatural influences should not change the seasonal mean salinity, measured preferably over not less than five years, by more than 0.25 of the standard deviation, nor change the salinity beyond the range recorded over that period.
Ionic ratio	The ratio of major ions should not be altered such that this beneficial use is affected.

6.3.2 Impact of liquid effluent upon water quality

The potential impact of liquid effluent from the proposed plant upon the water quality of Cockburn Sound will be negligible. This conclusion is based upon the following considerations.

Nutrients

As discussed in Section 5.2, Cockburn Sound is eutrophic and, during the period 1960-79, suffered substantial dieback of sea-grass meadows. The underlying cause of this problem was shown to be nitrogen additions to the Sound (Department of Conservation and Environment 1979), and a long-term objective has been set to reduce nitrogen inputs to 1,000 kg/d (365 t/a). The achievement of this objective has, in large part, been met during the last eight years by a 60% reduction of the nitrogen contribution of CSBP and KNC, and by the diversion of the Woodman Point treatment plant outfall to offshore waters. Hillman (1986) documented significant improvement in the trophic condition of the Sound.

The maximum estimated nitrogen contribution of 7 t/a from the proposed plant will have only a marginal effect upon the nutrient status of the Sound, as it only represents about 2% of the long-term objective for nitrogen loading to Cockburn Sound. Therefore, there should be negligible impact upon the sea-grass community. However, the proponents recognize the critical need to minimize nitrogen losses and will adopt appropriate operational practices to achieve this objective.

The potential impact of nutrients in a semi-enclosed waterbody is related to total loading and cannot be ameliorated by high dilution at outfall. Consequently, there would be no advantage gained in this regard by locating the outfall further off shore or by achieving high discharge momentum and consequent dilution.

Temperature

The cooling tower blow-down (flow rate 44 m^3/h) will be discharged at a temperature of 27-30°C, and will be thoroughly mixed within the discharge drain with a much larger volume (3,000 m^3/h) of presently discharged wastewater at a temperature of 30-50°C. Consequently, the combined discharge temperature will be 30-48°C, which is 15-33°C higher than the water temperature in Cockburn Sound during winter and 5-23°C higher than that during summer.

The existing distribution of surface water temperatures surrounding the outfall is shown in Figure 6.1. These data were measured during calm water and slight wind conditions, when dilution dynamics would be minimal. Figure 6.1 shows that the wastewater discharge at 37°C was sufficiently mixed and diluted within approximately 90 m from the outfall to reduce the surface water temperature to within 3°C of ambient. During higher wind and sea conditions, this dilution envelope would be significantly smaller.

The additional heat loading due to the blow-down discharge from the proposed plant will have negligible additional effect to that presently occurring. The maximum temperature of the combined outfall will in fact be marginally less than presently occurs.

Salinity and ionic ratio

The effluent salinity of 3,000 mg/L will essentially provide a freshwater inflow to Cockburn Sound (where the concentration of total dissolved solids is approximately 35,000 mg/L) that is not significantly different to natural groundwater inflows and upwellings that occur at various locations in the Sound. Rapid mixing with salt water in the CSBP drain will ensure that salinity variations essentially reflect background conditions at the time of discharge into Cockburn Sound.

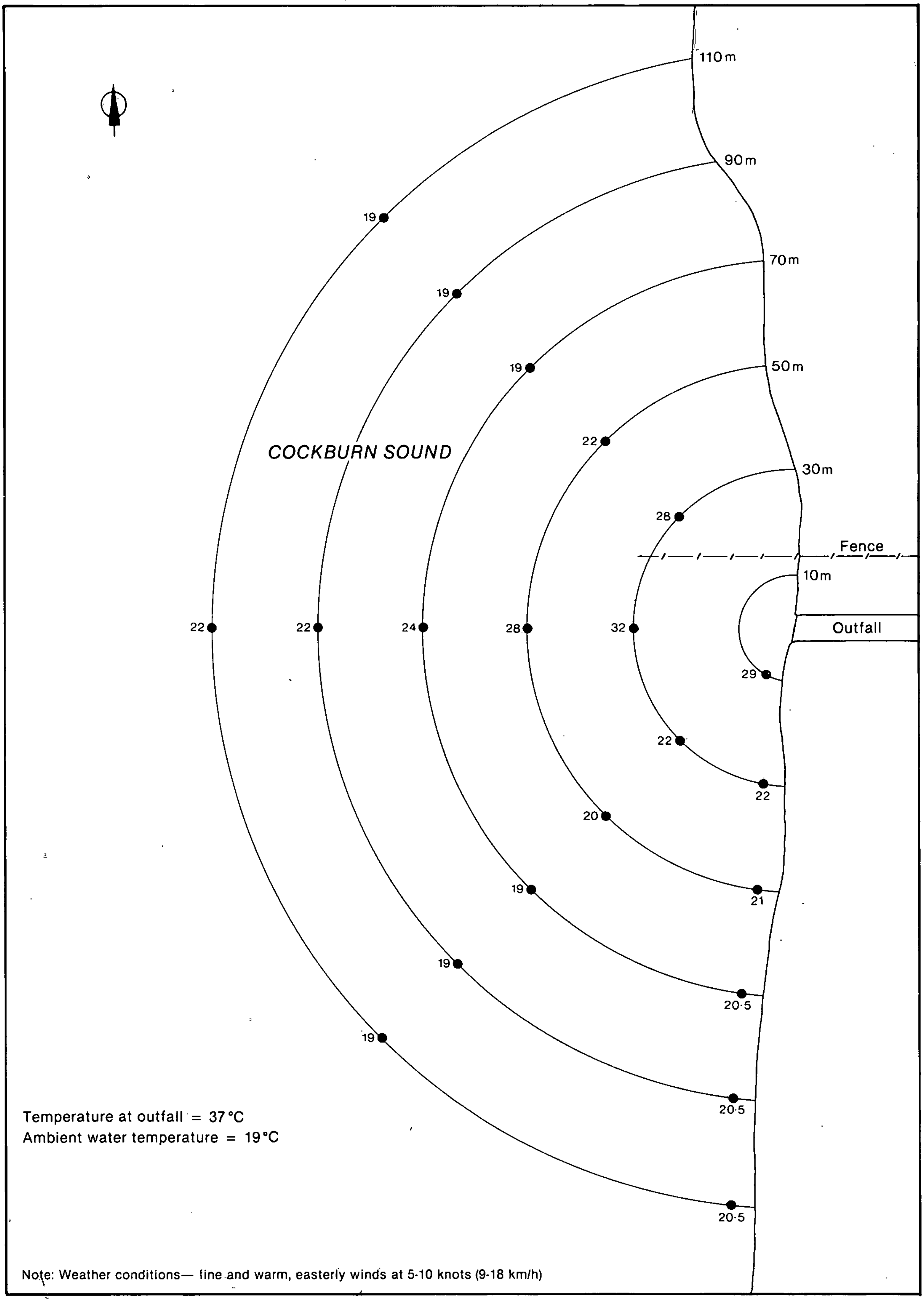


Figure 6.1
SURFACE WATER TEMPERATURE SURROUNDING CSBP/KNC OUTFALL, COCKBURN SOUND, 5 MAY 1987

As the effluent discharge will be concentrated groundwater extracted from beneath the proposed plant site, its ionic ratio will be the same as that of groundwater presently flowing into Cockburn Sound.

6.3.3 Effects upon biota

It follows from the preceding discussion that the effluent from the proposed plant will have negligible effect upon the resident biota near the outfall, which have presently accommodated the substantially greater existing discharge of heated, nutrient-enriched wastewater. The thermal plume from the existing discharge has been shown to rapidly dilute and diffuse. Le Provost, Semeniuk and Chalmer (1983) investigated the effect of heated water upon fish in Leschenault Inlet and concluded that all major commercial species actively avoid water temperatures above 27°C. Under the conditions proposed, fish will be able to successfully avoid any heated water that may be encountered immediately adjacent to the outfall by either lateral or vertical migration.

6.4 SOLID WASTE DISPOSAL

As discussed in Section 4.5.2, solid industrial wastes produced at the plant will be restricted to used catalysts. Those containing nickel will be sold for reprocessing; iron-based catalysts will be tested for contaminants and then disposed of by sanitary landfill.

Domestic solid wastes will be disposed of by sanitary landfill to the satisfaction of the local authorities.

The environmental impact of both domestic and industrial solid waste disposal will be neglible.

6.5 CONSTRUCTION PHASE

The split site selected in Kwinana for the plant is land that is zoned as Industrial and has been cleared for industrial use; therefore, the site is not in a pristine condition. The existing vegetation is generally composed of low-lying shrubs and grass in relatively poor condition.

Site preparation using heavy machinery will be required in order to facilitate construction on level ground. This will result in the removal of vegetation where components of the plant are planned. However, where feasible, vegetation will be maintained to enhance the landscaping of the site.

Dust generated by construction activities may settle over remaining vegetation, causing temporary surface discoloration. This is not expected to present any long-term adverse effects.

The site is not inhabited by any significant native fauna.

7 IMPACTS ON THE SOCIAL ENVIRONMENT

Section 7 presents the results of a preliminary risk analysis undertaken for the proposed plant and examines the impacts of the project on other aspects relating to the social environment such as noise, aesthetics, traffic, odours and planning implications. As with the previous section, only those aspects of the social environment that are likely to be affected are discussed.

7.1 ASSESSMENT OF RISKS AND HAZARDS

The proponents commissioned the specialist firm Det norske Veritas to prepare an assessment of risks and hazards for the proposed plant, and the firm's report is presented as a separate document (Det norske Veritas 1987). This section summarizes the assessment undertaken.

7.1.1 Hazards associated with ammonia/urea plants

Potential hazards associated with ammonia and urea plants can be categorized as follows:

- in-plant hazards to plant workers arising from the use of chemicals and operating equipment containing gases and liquids under high pressures and high and low temperatures;
- off-site hazards associated with the loss of containment of significant quantities of toxic chemicals and, to a much lesser extent, with fire and/or explosion resulting from leakage of flammable gas.

In-plant hazards are generally not within the scope of public reports such as this ERMP/draft EIS. Rather, they are considered in greater detail in association with the relevant authorities at the completion of the detailed design of the facility.

To minimize risks to plant workers, as well as the risk that a minor accident will escalate, the proponents will adopt the following measures:

- incorporation of the latest design features from ammonia and urea plants operating overseas;
- incorporation into the design of relevant requirements of applicable codes of practice and legislative requirements as discussed in Section 1.4;
- commissioning of a HAZOP study, incorporating the plant designers, constructors and operators, at the completion of the detailed design stage;
- staff familiarization and training in operation of the plant and handling of emergencies.

7.1.2 Aims and scope of the preliminary risk analysis

The aim of the preliminary risk analysis prepared by Det norske Veritas was to conduct, subject to available information on the proposed plant and operations, a detailed, independent and objective risk analysis, to enable:

- identification and evaluation of potential hazards and their resulting risks in order to assist the safety of the project through the understanding of risks and the implementation of effective risk reduction measures;

- the proponents to meet the requirements of the EPA and other authorities with respect to planning and approval procedures.

The preliminary risk analysis addresses, in a manner suitable for public documentation, all aspects nominated in the EPA guidelines (Appendix A) and specifically includes assessments of the following risks:

- leakage or failure of process equipment
- hazards of process, storage and operations proposed
- domino effects
- export loading
- shipping.

The form adopted for the analysis is based on the requirements of relevant authorities and is similar to those used previously by Det norske Veritas for comparable facilities. The analysis systematically examined the safety of the plant by addressing the following issues:

- the determination of where and how releases, spills or leakages are likely to occur;

- the estimation of the likelihood of failure (frequency) and size of releases, spills or leakages and the probability of ignition;

- calculation of the consequences of failure, including dispersion and diffusion characteristics;

- development of risk levels relating to people in the area, adjacent facilities or nearest residences.

In view of the preliminary phase of project development, emphasis was given to conceptual aspects, including siting, layout and design philosophy.

7.1.3 Acceptance criteria

The risk assessment criteria considered appropriate for the project are those contained in the EPA's recently released final position on the evaluation of the risks and hazards of industrial developments on residential areas in Western Australia (EPA Bulletin No. 278, which is included as Appendix C). This essentially categorizes risk to residential areas into the following three classes:

- a small level of risk, which is acceptable to the EPA (individual risk of fatality levels of less than one in one million years are so small as to be acceptable);

- a high level of risk, which is unacceptable to the EPA and which warrants rejection (individual risks of fatality exceeding ten in one million years are so high as to be unacceptable);

- a middle level of risk, which, subject to further evaluation and appropriate actions, may be considered to be acceptable to the EPA.

7.1.4 Results of the risk assessment

The result of the preliminary risk analysis is the quantification of the individual risks associated with the plant. These can then be used to determine whether the project is acceptable when compared to the criteria given in Section 7.1.3. The individual risk contours determined by the preliminary risk analysis are shown in Figure 7.1. These have been determined on the basis of 100% outdoor exposure and for toxic gas concentrations and durations that would be lethal to the average person. These contours are therefore consistent with those usually adopted for fatality risk assessment in the general population.

The contours indicate locations that present a risk to an individual at that point. The actual chance of a person being exposed also depends on the time spent at the location.

The contours show that the one in one million risk level does not approach residential areas or other areas where individuals at particular risk would be expected to reside or visit frequently for significant periods; thus, the proposal complies with the EPA criteria given in Section 7.1.3. This conclusion is also in accordance with the results of the Kwinana cumulative risk analysis, which was recently released by the Department of Resources Development (Technica 1987) and is referred to in Section 5.7.

In the industrial areas at or above the one in one million level, the individual risk (per year) to an employee will be approximately one-fifth of the level shown when the normal shift period is taken into account. The majority of people would be expected to survive exposure to the hazard levels considered, particularly as emergency response actions to avoid inhalation of toxic gas and to provide medical treatment would reduce risks of fatality to below the levels shown.

7.1.5 Conclusions of the risk assessment

The risk assessment for the project arrived at the following conclusions:

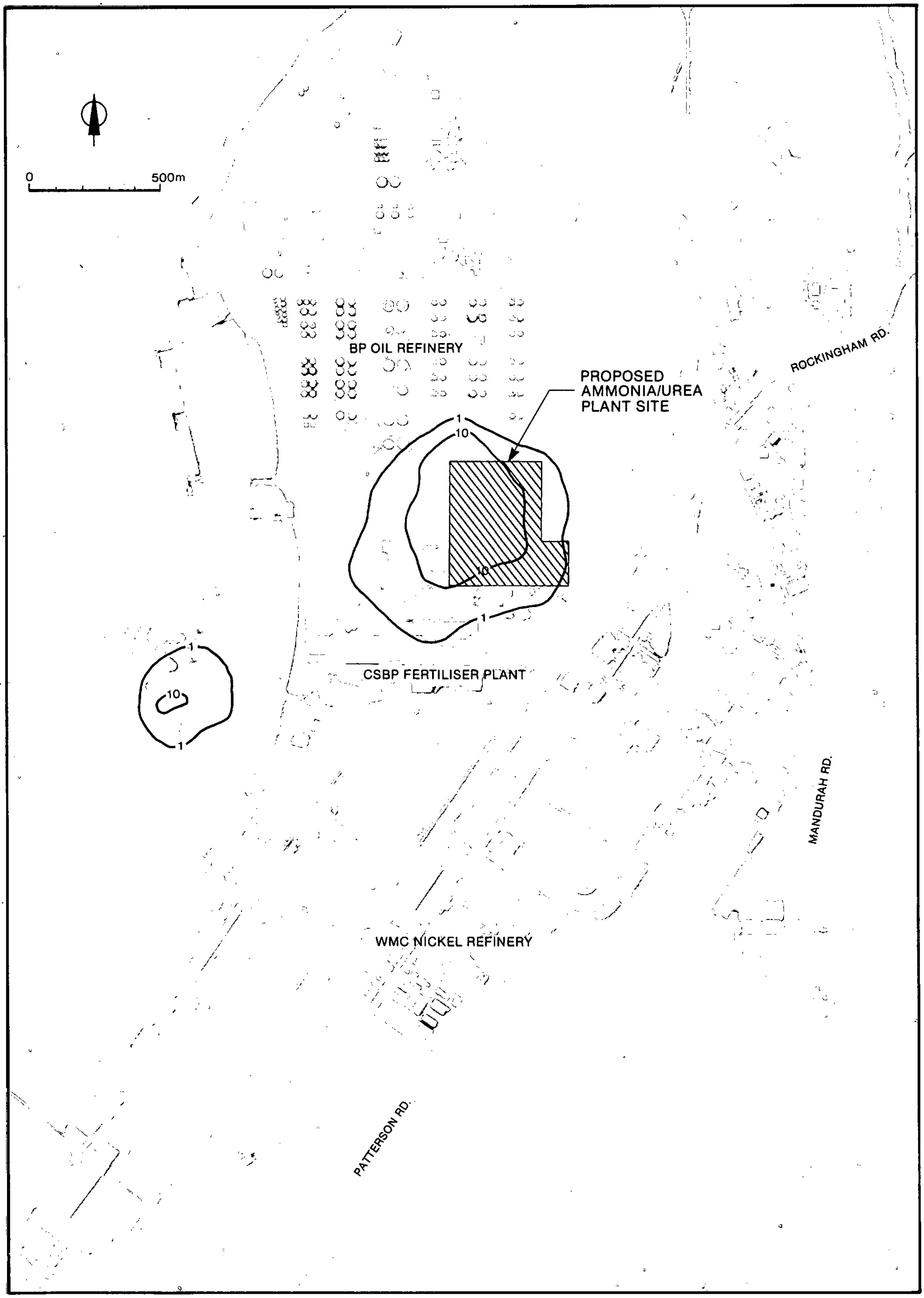
- The site is considered suitable with regard to risks.

- The risk of lethal concentrations of ammonia gas reaching local population centres is negligible for a range of release scenarios, even under the most unfavourable atmospheric conditions. Quantified risk levels at residential areas are well below the EPA acceptance criteria given in Section 7.1.3.

- The risk to neighbouring industries of exposure to accidentally released ammonia is considered small; the risk of serious injury or fatality resulting from such a release is well below common industrial risks.

- During normal operation, there are no significant hazards to areas outside the plant boundary associated with release of other chemicals involved in plant operations.

- There are no significant hazards associated with heat flux and explosion over-pressure resulting from ignition of leaking flammable gases.



Contours show risk levels per million years

Figure 7.1
INDIVIDUAL RISK CONTOURS

- The total quantity of ammonia vapour released to the atmosphere during the unlikely event of serious leak or rupture of the ammonia storage tank would be limited by the full-height concrete bunding; this height would also aid dilution and dispersion of ammonia to a non-toxic level.

- The risk levels calculated for ship-loading operations - the most serious potential source of ammonia spillage - are low and considered acceptable.

- The risk of a major release of ammonia caused by a shipping accident is low and is considered acceptable.

- The risk levels for adjacent industries have been calculated as being below the EPA acceptance criteria.

- The plant will not present a significant contribution to cumulative risk levels at residential areas.

- The proposed standards of engineering, operation and maintenance for the plant are considered appropriate for the achievement of acceptable risk levels.

- The effect on risk levels of a possible future increase in ammonia production rate to about 1,750 t/d, resulting from an upgraded plant design capacity or from future 'debottlenecking' and fine-tuning of the process parameters, should be negligible to slight. The maximum adverse effects would be limited to a few increased hazard distances from the process plant of less than 10%, and the increase in frequency of major releases would vary from nil for storage and the process area, to a maximum of 50% in the case of the export pipeline and ship-loading. Therefore, the project would still easily comply with the acceptance criteria for risk levels.

7.2 NOISE

The maximum noise level emitted from any item of equipment at the proposed ammonia/urea plant will be restricted to 85 dB(A) at a distance of 1 m.

As the proposed plant will be situated in a heavy industrial complex, it would be reasonable to compare the noise generated from it with that of the surrounding industries. However, there are no comprehensive noise surveys available of the existing complex, so discussion on potential impacts must rely upon comparison with statutory levels.

In Western Australia, allowable community noise levels and methods for assessment of noise annoyance are set out in the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979, (as amended) of the Environmental Protection Act, 1986. These regulations assign maximum allowable noise levels for a variety of categories, which vary with respect to the area classification, time of day, nature of sound and the distance from major arterial roads.

Two categories that pertain to the proposed ammonia/urea plant are shown in Table 7.1.

Table 7.1 Assigned outdoor neighbourhood noise levels

Category description/ time period	Category A.2	Category D.4
Category description		
Use of premises at place of reception	Residential, domestic or private recreational	Industrial
Description of neighbourhood in which place of reception is situated	Only or predominantly residences with infrequent transportation	Predominantly heavy industry
Time period		
Monday-Friday 7 a.m.-7 p.m.	45 dB(A)	70 dB(A)
Monday-Friday 7 p.m.-10 p.m., weekends and public holidays 7 a.m.-10 p.m.	40 dB(A)	70 dB(A)
Always 10 p.m.-7 a.m.	35 dB(A)	70 dB(A)

The nearest residential area to the plant site is Medina/Calista, approximately 2 km to the east and falling into Category A.2. This area yields an assigned outdoor neighbourhood noise level of 35 dB(A). Category D.4, which limits the noise levels to 70 dB(A) at all times, is relevant to the industries surrounding the proposed plant, the nearest being 250 m away (KNC and CSBP).

As discussed in Section 4.6, dispersion of noise is dependent upon various factors, including absorption by the ground and atmospheric humidity. Dispersion models produced for the plant are shown in Tables 4.1 and 4.2: Table 4.1 reflects the predicted noise emissions with radial distance assuming no ground attenuation, and Table 4.2 allows for ground attenuation from grass and low shrubs.

The maximum noise level expected at Medina/Calista under adverse conditions is 31 dB(A) (Table 4.1), which is 4 dB(A) below the appropriate neighbourhood noise level and hence considered acceptable.

Similarly, the maximum noise levels expected at KNC and CSBP are between 59 and 51 dB(A) (Table 4.1), well below the set standard of 70 dB(A).

Wells Park at Kwinana Beach, which constitutes an important recreational resource, is approximately 1 km from the proposed site. Although there is no category within the Noise Abatement (Neighbourhood Annoyance) Amendment Regulations, 1979, (as amended) for a recreational area, the expected noise levels reaching Wells Park will be below 40 dB(A), which is within the maximum level required for a residential area during daylight hours.

In summary, noise generated from the proposed plant will have minimal impact on the surrounding environment and will be within statutory levels.

7.3 VISUAL IMPACTS

The proposed plant will be quite large in area, with structures up to 80 m in height. If it were situated on its own, it would make quite a strong visual statement. However, when viewed in context with neighbouring operations, as shown in the artist's impression (Figure 7.2), the landscape impact of the proposed plant will be relatively minor. The buildings will be in neutral colours that will blend in with their setting.

The urea storage facility will be approximately 15 m high and constructed similarly to a light industrial facility, thereby having only a minimal impact upon the environment.

In the long term, supplementary bunding of road verges and screen planting along Patterson Road will significantly reduce the cumulative impact of industry in this location. CSBP is a participant in the State Government's landscape improvement initiatives for the Kwinana area.

The area within the confines of the site, buildings and car-parks will be attractively landscaped to Council requirements.

7.4 TRAFFIC

The major raw materials required to operate and maintain the ammonia/urea plant will not be transported by road. Other than occasional loads of chemicals and general supplies, most materials will be made available on site. Natural gas will be supplied via pipeline, while air and water will be obtained using compressors and boreholes, respectively.

Ammonia and urea products will be transported by pipeline or conveyor within the site and from the site to the wharf loading facilities or adjacent user industries. Most urea will be transported by rail to the major wheat-belt centres for distribution. Road transport will be utilized for some distribution of urea and only occasionally to supply ammonia. Apart from distribution of urea by rail from Kwinana in place of imports through other ports, ammonia and urea produced at the plant will be transported via the existing distribution systems for these products.

Consequently, the main additional road traffic generated by the plant will be from the construction and operational workforce. As previously stated, the construction workforce will be up to 1,200, while the operational workforce will number about 200.

The principal thoroughfare that is expected to be utilized by this workforce traffic is Patterson Road, which becomes Rockingham Road northwards of Naval Base. This road is a four-lane, divided arterial road with a design capacity of 34,000 vehicles per day. Current usage is 23,060 vehicles per day.

It is planned that access to the plant will be via Mason Road, as illustrated in Figure 4.5.

During the construction phase, the proposed plant will generate additional traffic of approximately 2,400 vehicles per day, assuming that each worker drives to and from work. During normal plant operations, only 400 additional vehicles per day will be generated.

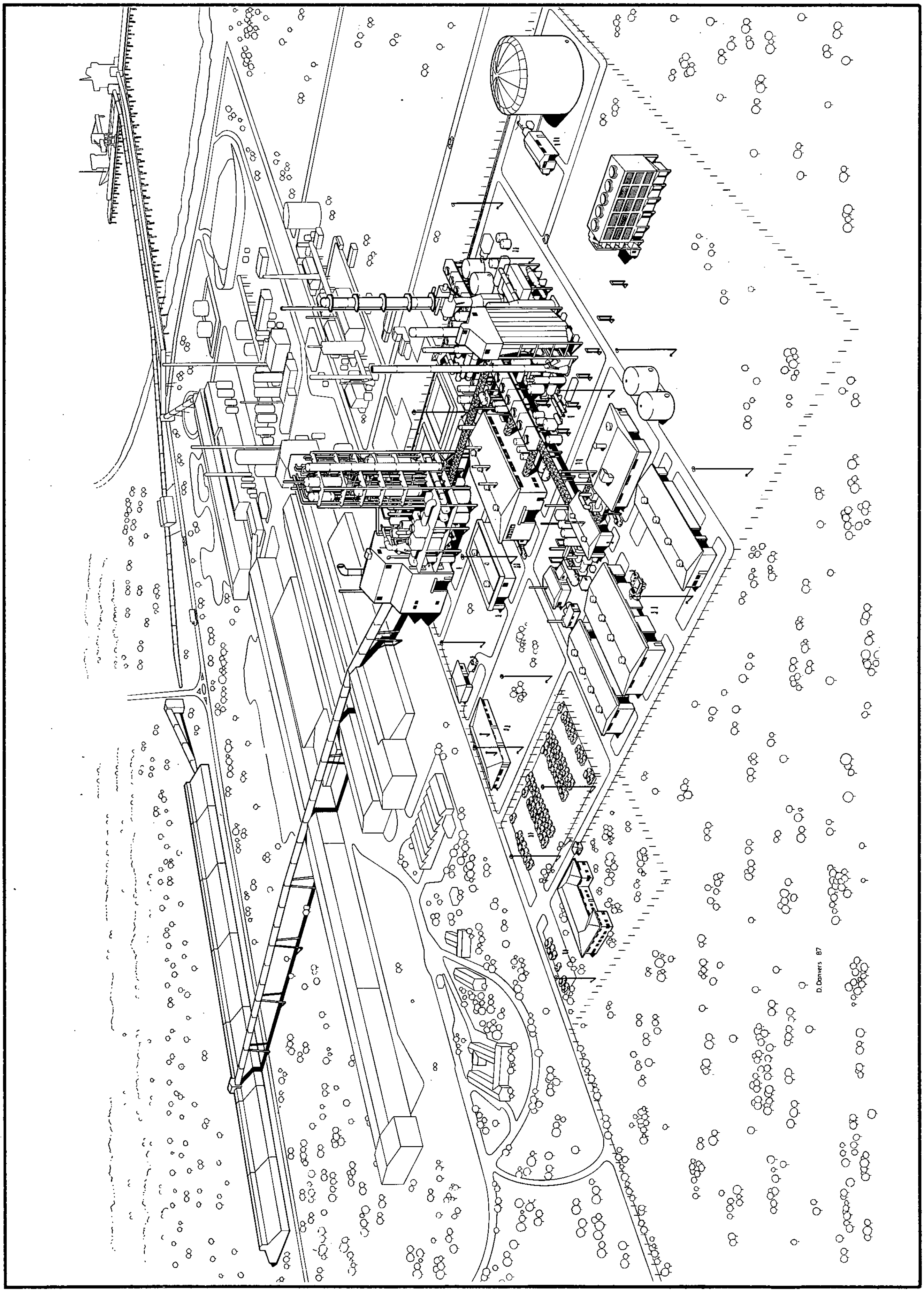


Figure 7.2
ARTIST'S IMPRESSION OF AMMONIA/UREA PLANT

Both these estimates represent the most extreme scenario, because some workers will share vehicles, cycle or use public transport. However, it is apparent that, even in this situation, Patterson Road has sufficient capacity to handle the expected increase, both in the construction and operational phases.

At present, Patterson Road is the major route linking Perth/Fremantle with Kwinana, Rockingham and Mandurah. However, the Uloth and Associates (1984) traffic study confirmed the need for a Fremantle to Rockingham controlled access highway by the year 2001 to meet north-south traffic demands. Should this be constructed, the role of Patterson Road would be reduced to a local road carrying around 20,000 vehicles per day, well below its design capacity.

In summary, the plant will not cause any significant increase in road traffic leading to congestion, due to the high capacity of the major arterial road that provides access.

7.5 ODOURS

The bulk of the atmospheric emissions discharged to the atmosphere will be the atmospheric components nitrogen, oxygen and carbon dioxide, which are odourless. The only components that can be detected by smell are ammonia, the sulphur oxide group and nitrogen dioxide.

The population identification threshold for ammonia is generally accepted to be in the range 20-50 p.p.m. (Det norske Veritas 1987). As described in Section 4.5.2, ammonia will be discharged from the urea manufacturing process and, following discharge, will then be dispersed subject to wind speed and atmospheric stability. In Kwinana, the atmospheric stability falls into Pasquill categories C and D, with wind speeds between 4 and 7 m/s for 55% of the time (Det norske Veritas 1987). Using these variables via the Pasquill formula for calculating gas concentrations at a distance, it is possible to verify that the maximum ground level concentration of ammonia will be found at approximately 500-800 m at 0.16 p.p.m. (by volume). This is much less than the population threshold for odour; therefore, it can be concluded that the impact of odour due to ammonia discharge will be negligible.

Nitrogen dioxide has an odour threshold of about 0.5 p.p.m. (by volume) (Lee 1980). As described in Section 4.5.2, the principal source of nitrogen dioxide discharge will be the reformer stack. Simple dispersion modelling similar to that previously discussed for ammonia has shown that maximum nitrogen dioxide concentrations at ground level will be orders of magnitude less than the odour threshold. Therefore, odour impact due to nitrogen dioxide discharges will be negligible.

Sulphur oxides will be emitted at concentrations of 0.7-0.8 p.p.m. (by volume) during the ammonia manufacturing process. As the threshold for the detection of sulphur oxides is between 20 and 30 p.p.m. (by volume), it can be concluded that there will be no odour caused by the emission of these compounds.

Although chlorine will be used in water treatment, only trace quantities will be present in the cooling tower plume, and these will not create any odours either on or off site.

7.6 PLANNING IMPLICATIONS

The area around the site of the proposed plant is currently zoned for industrial land use and has experienced extensive industrial development. The nearest residential areas are Medina and Calista, more than 2 km to the east. This situation, together with the adoption of appropriate environmental management, will result in potential impacts on the existing regional amenity being maintained at acceptable levels.

Future planning for the area should be structured so as to avoid the development of land use conflicts. To achieve this, the State Government has directed that a regional plan be prepared for rational development of the Kwinana industrial area. A recently released discussion paper (GHD-Dwyer Pty Ltd 1987) has outlined the principal objectives as being:

- to improve understanding and communication between governments (State and local), industry, the public and the various interest groups connected with the region;
- to identify regional, social, economic and environmental issues, and to prepare strategies to improve planning and development in the region;
- to prepare strategies for improved co-existence of residential, industrial, rural and recreational uses of the region;
- to provide a rational basis for decision-making relating to location of industry in the region;
- to provide a basis for government policy for the Kwinana region.

The discussion paper mentions the proposed ammonia/urea plant as a possible future industry in the Kwinana industrial area. The final regional strategy plan should incorporate the ammonia/urea plant once all approvals for development have been granted.

7.7 CONSTRUCTION PHASE

During the twenty-five—month construction/assembly phase, a maximum workforce of approximately 1,200 will be required, most of whom will commute from residences in the Perth-Fremantle and Rockingham—Safety Bay areas, while some will seek accommodation close to Kwinana. It is unlikely that any increased demand on the existing accommodation market or community infrastructure will impose undue stress on the local communities.

The principal impacts on the human environment that are normally associated with the construction phase of industrial projects are related to the generation of dust and noise. Because the nearest residents to the site are located approximately 2 km away at Medina and Calista, and screened from the industrial area by the well vegetated coastal ridge, these impacts will be minimal.

As is normal practice with large construction projects, careful dust management practices (such as sprinkler watering) will be employed to prevent dust from becoming a nuisance to the surrounding areas and the local community.

The construction of the plant will involve the construction of buildings and the assembly, using bolted or welded connections, of process components and pipelines manufactured off site. The impact of noise during this phase will be limited to normal working hours. Although it is difficult to accurately assess the cumulative impact of all construction activities, it is considered that the noise level generated will not be excessive and will be in compliance with statutory requirements.

As discussed in Section 7.4, increased traffic levels during the construction phase are unlikely to present any problems on adjacent roads such as Patterson Road and Rockingham Road.

7.8 COMMISSIONING PHASE

Prior to commercial operation of the plant, all pipes and vessels will be cleaned internally to remove loose material, including any products of corrosion. In the case of pipelines, this is normally achieved by purging with steam at high velocity, resulting in elevated noise emissions. Effort will be made to utilize silencers to reduce noise where possible, and to inform the public of the activities scheduled.

The ammonia plant will incorporate a flare, which will be used to dispose of combustible materials arising from process interruptions and start-up and shut-down operations as described in Section 4.5.3. When not in use, the visual impact of the flare will be restricted to a permanently lit pilot flame. During use, the visual impact will be increased depending upon the quantity and nature of the materials being flared, but will generally only occur for short durations. Commissioning of the plant may necessarily involve greater use of the flare than normal operations.

8 ENVIRONMENTAL MANAGEMENT

Section 8 outlines the environmental management safeguards that are planned to be incorporated into the design, construction and operation of the plant. Environmental management encompasses the formulation of commitments aimed at protecting workers, the public and property, and the environment generally, plans by which those commitments will be executed, and monitoring programmes to assess the effectiveness of management practices.

The considerable experience of the proponents in the operation of ammonia/urea and similar plants - CSBP in Western Australia and Norsk Hydro world-wide - has enabled them to recognize the most appropriate and effective environmental management and safety procedures. This will ensure that procedures that cause minimal environmental impacts are adopted for the proposed plant and that safety features have previously been tested and proven successful.

8.1 DESIGN

The plant design will comply with relevant Australian and international standards and will incorporate the combined experience of the proponents in materials technology.

The plant will utilize modern technology in terms of plant instrumentation and computer process control, to ensure stable operating conditions. The range of critical safety interlock systems to be included is designed to detect any deviation or imbalance in flow, temperature, pressure, vacuum or level, and will initiate automatic plant shut-down in an emergency situation.

Input signals to the interlock system will be based on a two-out-of-three voting system to ensure that unnecessary shut-downs do not occur and that genuine situations are dealt with promptly. All safety systems will be wired so that the plant will shut down in a fail-safe condition. Installed standby equipment will increase operational reliability in all key process stages.

Storage facilities will be designed to minimize hazards associated with the refrigerated ammonia storage and to provide a dry, clean environment for urea storage.

Load-out facilities, such as the ammonia export pipeline, urea conveyor, export pump and marine loading arm, will be designed to rapidly transport ammonia and urea products in the safest manner possible.

The whole of the ammonia/urea process area will be paved for safety and housekeeping purposes, allowing rainwater or washwater to be collected in holding ponds and treated prior to disposal.

Prior to commissioning of the plant, the proponents will undertake a full HAZOP study in conjunction with the plant designers and process licensors.

8.2 CONSTRUCTION

During the construction phase of the project, the proponents will take those measures necessary to ensure that noise and dust caused by construction activities are minimized. Activity will be restricted to normal construction industry working hours, and dust suppression watering practices will be adopted.

All construction materials and practices will be in accordance with the relevant Australian codes.

8.3 COMMISSIONING

The precommissioning and commissioning phases will include cleaning and testing of all components of the plant, then component systems and finally the entire plant. Component testing will be conducted to conditions similar to operating conditions prior to actual operation.

During commissioning, personnel of the process licensors and plant designers will be in attendance.

8.4 EMERGENCY PROCEDURES

The proponents will draw upon the operational and emergency procedures experience of the two existing ammonia plants in the Kwinana region, and of a number of modern ammonia/urea plants overseas operated by Norsk Hydro.

Personnel will be trained prior to operation and will undergo retraining at planned intervals to ensure that all workers are fully familiar with plant operations.

The plant, being dependent on high and continuous throughput, will be comprehensively instrumented and computer-controlled. Further, it will be equipped with interlock systems that, upon initiation by carefully selected process or equipment performance criteria, will ensure safe emergency shut-down.

Apart from the emergency procedures developed for specific operational requirements, procedures will be formulated, prior to commissioning, to cover the requirements of the site, including:

- definition of emergency situations (e.g. fire, gas leaks);
- organization of emergency control teams;
- escape routes and assembly points for personnel;
- liaison requirements with local and State authorities, SECWA and the general public;
- warnings to fire brigades and hospitals.

On-site facilities will include first aid facilities, with the assistance of a trained nurse. The close proximity of the existing CSBP operations makes it logical to combine the two sites' requirements, thereby strengthening the total coverage.

The plant will be equipped with a separate fire main system, with permanent hydrants situated at selected locations, together with foam generators in areas of the plant where ammonia leaks could occur. The plant will also have its own fire tender, and trained safety inspectors/fire fighters on site each shift.

8.5 MONITORING AND REPORTING

At present, a comprehensive environmental management and monitoring programme is followed at all CSBP's manufacturing locations. At Kwinana, the monitoring programme involves regular sampling and testing of scheduled plant and works liquid discharges, airborne emissions from individual plants, ambient air quality, groundwater quality, solid waste quality, and noise and dust levels. It is envisaged that a similar programme will be operated for the ammonia/urea plant.

Formal reports are sent to the Water Authority of Western Australia in compliance with conditions of licences issued under the Rights in Water and Irrigation (Prevention of Pollution of Waters) Regulations, 1977, (as amended). The Pollution Control Division of the EPA regularly monitors emissions, in addition to the monitoring that CSBP undertakes in compliance with its licence issued under the Environmental Protection Act, 1986.

Groundwater will be monitored for quantity and quality. Any wastewater to be disposed of will be channelled into holding ponds before being sent to the sea. This wastewater will be regularly monitored for nutrients and heavy metals, although the latter are not expected to be present in significant quantities.

8.6 AUDITING

In 1985, CSBP introduced a new health and safety policy, instituting an internationally recognized auditing system - the International Safety Rating System (ISRS), developed by the International Loss Control Institute.

A Loss Control Superintendent has been appointed to co-ordinate the development of health and safety manuals. Internal audits will be used to check on progress, with periodic external audits. The programme will be assessed by external audit against the ISRS 'gold star' rating system, and CSBP has set a target to achieve a 'five star' rating (the highest) within three years for its existing works. It is envisaged that the ammonia/urea plant will be included in CSBP's ongoing ISRS programme or will adopt a similar approach to safety auditing.

8.7 DECOMMISSIONING

Unlike a mineral development project whose life-span is limited to the length of time the particular resource can be exploited, the proposed plant does not have a known or planned operational life. However, with constant improvements through advances in technology, the life-span of the plant is estimated to be at least twenty to thirty years.

Eventual decommissioning might simply involve the plant being used for other purposes, in which case another environmental impact study might be required; alternatively, it could involve dismantling and removal of the facilities from the site. The decommissioning strategy selected would only be determined near the time it was required.

8.8 SUMMARY OF COMMITMENTS TO ENVIRONMENTAL MANAGEMENT

The commitments that the proponents have made to environmental management during the design, construction and operational phases of the plant are as follows:

- Design:
  - Australian and international standards will be used in the design of the facilities.
  - A HAZOP study of the final design will be conducted.
  - The process licensors' design philosophy will be adhered to.
  - The process will be designed to meet or improve on current emission guidelines.
- Construction:
  - Liaison with local authorities will be conducted to ensure that impacts associated with noise, dust and traffic are minimized.
  - Construction activity will be restricted to normal construction industry working hours.
  - Dust suppression watering practices will be implemented.
  - All construction materials and practices will be in accordance with the relevant Australian and international codes.
- Operation:
  - The plant site will be attractively landscaped, and buildings will be aesthetically designed and have neutral coloration for compatibility with the surrounding industrial setting.
  - Ongoing control of dust will be implemented.
  - Noise levels within the plant and at the plant boundaries will be in accordance with statutory requirements.
  - Operational stability will be achieved by duplication of critical equipment, a high level of automation and intensive training of operators.
  - The plant will be highly instrumented and computer-controlled, and will be equipped with interlock systems which, upon initiation from carefully selected process or equipment performance criteria, will ensure a safe emergency shut-down of the plant.
  - Regular preventative maintenance programmes will be implemented to minimize plant component failures.
  - The plant will normally produce minimal solid wastes. Septic systems will be provided for the sanitary system.

- All liquid and gaseous waste products will be regularly monitored and disposed of in an environmentally safe manner and in accordance with statutory requirements to the satisfaction of the EPA.

- Surface runoff from the process areas of the plant will be channelled into holding ponds and appropriately treated before disposal to Cockburn Sound.

- A fire protection system will be incorporated in accordance with the requirements of the plant design and the Western Australian Fire Brigades Board. This system will be equipped with a separate fire main, with permanent hydrants appropriately located around the plant, together with foam generators for possible ammonia leaks. All plant personnel will be trained in the appropriate fire-fighting techniques.

- The fire-fighting capability of CSBP's Kwinana works, and the Kwinana Industries Mutual Aid Group, established by industrial operators in the Kwinana industrial area, will be available for emergency assistance.

- Security around the plant will be ensured by the installation of chain-link boundary fences, with access to the plant via a single gatehouse and emergency exits.

- All employees will be trained in the safe work practices and emergency procedures appropriate to the operation of the plant and handling of all associated materials.

- Written work permits for plant maintenance will be required, to ensure safety of the workforce and effective operation of the plant.

- Installation of equipment and alterations to existing equipment will undergo a detailed check procedure on the design, including hazard and operability analyses, prior to requisition.

- Plant operator training will be provided, based on the experience available to the proponents from their existing ammonia/urea establishments. Some personnel will have practical training in these plants.

- On-site first aid facilities will be provided, together with support from CSBP's Kwinana works facilities, which include the availability of an ambulance and an occupational health nurse during normal working hours.

9 CONCLUSIONS

The proposed ammonia/urea plant will be a significant industrial facility for Western Australia in terms of capital expenditure, consumption of raw materials, generation of export income and employment, and reduction in the balance of payments.

Two important considerations associated with the proposal were the selection of the site and selection of the preferred cooling system. By two independent and detailed site selection studies, it has been demonstrated that Kwinana is the most appropriate location on the basis of economic and environmental considerations. It has also been shown that maximum use of air cooling is preferred based on economic and environmental grounds, and that supplemental water cooling should be based upon a cooling tower in preference to sea-water cooling due to environmental considerations.

The principal issues that were regarded as requiring consideration in the proposal included the imposition of additional risks and hazards, biological impact on Cockburn Sound, impacts on public amenity, temporary impacts during the construction phase, and impact on the local groundwater regime.

Through this ERMP/draft EIS, the proponents have been able to demonstrate that these issues can be managed so as to reduce adverse impacts to a minimum and to levels considered acceptable; to this end, extensive management commitments have been made. In particular, the proponents have demonstrated that:

- although it is unavoidable that plants handling toxic chemicals will impose some risk to surrounding areas, the adoption of the proposed site, plant design and operating philosophy will ensure that additional risks will be sufficiently low as to be acceptable when compared to published EPA criteria;

- the biological impact on Cockburn Sound will be minimal, localized and restricted to the vicinity of the outfall;

- the reduction in amenity due to noise and odours will be localized around the plant site and therefore generally restricted to areas that are not available to the public. The plant will have some visual dominance, but will not be out of character with the surrounding land use;

- construction phase impacts will be minimized by appropriate housekeeping techniques developed in accordance with the requirements of the local authorities;

- impacts on the groundwater regime will be managed in conjunction with the requirements of the Water Authority.

The proponents intend the plant to be operational over a long time span. Therefore, design will concentrate on making the plant as modern and as efficient as possible, incorporating every available safeguard and the relevant experience of existing producers.

Management commitments have been outlined, encompassing control methods, safety features, operational philosophies and monitoring procedures. The proponents, by the publication of this ERMP/draft EIS, are committed to the establishment of a safe, efficient plant, designed in accordance with statutory requirements and with the continuing co-operation of local authorities.

GLOSSARY

biocide	a chemical capable of killing living organisms
biuret	an insoluble crystalline substance formed from urea
broadcasting	application of fertiliser to surface (i.e. not direct sowing into soil)
cryogenic	of, or relating to, very low temperatures
debottlenecking	removal of restrictions in the system
epiphytic	of, or relating to, a plant that grows on another plant, but is not parasitic on it
eutrophic	nutrient-enriched; having excessive plant growth
flash	vaporization of ammonia by reduction in pressure
heat flux	heat radiated from an energy source
mercaptans	sulphur-bearing compounds used to odorize gas for safety purposes
Pasquill formula	a common formula used for evaluating gas dispersion from point sources
phytoplankton	plankton consisting of plants
potentiometric gradient	variation in water elevation; i.e. slope of groundwater surface
prilling	spray solidification of molten salts to form small spheroids
syngas	synthesis gas; a mixture of hydrogen and nitrogen prepared for subsequent conversion to ammonia
trophic	of, or relating to, nutrition

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GENERAL ABBREVIATIONS AND ACRONYMS

BP Refinery	BP Refinery (Kwinana) Pty Ltd
CSBP	CSBP & Farmers Ltd
DAP	diammonium phosphate
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
ERMP	Environmental Review and Management Programme
FPA	Fremantle Port Authority
HAZOP	Hazard and Operability
ILDA	Industrial Lands Development Authority
ISRS	International Safety Rating System
KICC	Kwinana Industries Co-ordinating Committee
Kinhill	Kinhill Engineers Pty Ltd
KNC	Kwinana Nitrogen Company Pty Ltd
LPG	liquefied petroleum gas
MDEA	methyldiethanolamine
MRS	Metropolitan Region Scheme
Norsk Hydro	Norsk Hydro a.s
NOI	Notice of Intent
Nufarm	Nufarm Chemicals Pty Ltd
PER	Public Environmental Report
SECWA	State Energy Commission of Western Australia
WMC	Western Mining Corporation Ltd

TECHNICAL ABBREVIATIONS

°C	degrees Celsius
d/a	days per annum
dB(A)	decibel (A-weighted)
g/m^3	grams per cubic metre
h/a	hours per annum
ha	hectare
Hz	hertz
kg	kilogram
kg/d	kilograms per day
kg/h	kilograms per hour
kg/ha	kilograms per hectare
km	kilometre
km/h	kilometres per hour
kPa	kilopascal
m	metre
m/s	metres per second
m^3	cubic metre
m^3/d	cubic metres per day
m^3/h	cubic metres per hour
m^3/s	cubic metres per second
mg/L	milligrams per litre
mg/m^3	milligrams per cubic metre
mm	millimetre
MPa	megapascal
MW	megawatt
pH	degree of acidity
p.p.b.	parts per billion
p.p.m.	parts per million
t	tonne
t/a	tonnes per annum
t/d	tonnes per day
t/h	tonnes per hour
TJ	terajoule
TJ/d	terajoules per day

STUDY TEAM

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APPENDIX A
ERMP GUIDELINES

APPENDIX A
EPA GUIDELINES* FOR AN ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME (ERMP) (INCORPORATING A PRELIMINARY RISK ANALYSIS)

SUMMARY

This section should contain a clear and concise summary of the salient features of the proposal, site location, alternatives, existing environment, the magnitude and extent of potential environmental impacts, and environmental safeguards and management.

It would also be desirable for the proponent to make the summary available free as a separate document.

1 INTRODUCTION

This section should include:

- background, objectives and scope of the proposal;
- details of the proponents;
- relevant legislative requirements and approval processes (State and Commonwealth);
- explanation of the purpose of the ERMP and why the document has been prepared. A brief description of the EIA process should be included;
- environmental interaction with other developments (present and future).

2 NEED FOR THE PROPOSAL

This section presents an opportunity for the proponent to describe, in a general way, the broad costs and benefits of the project to the joint partners and community. These should be described at local, State and national levels.

3 EVALUATION OF ALTERNATIVES

The evaluation of alternatives is considered to be one of the more important parts of the document. A description should be given of how the project proposal has developed and the degree to which development alternatives have been examined.

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* These guidelines may be amended if a joint State-Commonwealth environmental assessment is necessary by virtue of the Commonwealth's Environmental Protection (Impact of Proposals) Act applying to the project through, for example, the requirement for approval from the Foreign Investment Review Board.

Considerable attention should be given to the process of site selection and selection of technology options.

A description of the basic requirements of the development, relevant to site selection, should be given. Each site considered should be described sufficiently to provide an appreciation of its salient characteristics.

The criteria employed to evaluate sites should be described and the relative advantages and disadvantages of each site given. Discuss the reasons for the rejection or acceptance of each site.

In addition, the rationale or criteria used in the evaluation of alternative technologies to achieve the objectives of the proposal should be given. Wherever options in process or storage technology exist, these should be explained. Environmental consequences of alternative technology options available should be discussed.

4 THE PROPOSAL

The document should provide descriptions of the important elements of the development. It should cover the construction and operation phases.

The description should specifically include location and layout, development schedule, anticipated life of the project, utilities and services required. Reference should also be made to the workforce requirements for such utilities and services. Associated development (infrastructure or service developments), such as accommodation, roads, gas pipeline, sewerage and communications, should be described to allow an appreciation of the primary as well as secondary impacts of the proposal.

A detailed description of the ammonia/urea plant operations and processes, including the supply and use of raw materials, water and energy, should be given.

Also provide details of emissions to the environment and emission controls.

Details of workforce numbers and composition should be provided.

5 EXISTING ENVIRONMENT

This section should provide an overall description of the environment and an appraisal of the physical and ecological systems likely to be affected by the proposal.

In particular, the methods used to reach this appraisal should be given. Only the habitats, existing environmental quality, resources and potential resources and land use which could be influenced by the project should be defined.

6 ENVIRONMENTAL IMPACTS

This part of the document should aim to show the overall potential effect of the proposal on the total environment, present and future land uses and surroundings of the area. Before synthesizing the impacts in such a manner, it will be necessary to address the impacts on the individual environmental components. In particular, there should be a detailed discussion of risks and hazards analysis, its results and the safeguards proposed. The section should also discuss the other potential biophysical impacts, e.g. air emissions and odours, liquid and solid waste collection, treatment and disposal, noise, aesthetics and environmental impacts of traffic.

It will be necessary to examine the construction stage separately from the operational stage.

The document should also consider potential cumulative impacts (including risk impacts) in the context of existing and future developments.

The section should clearly indicate by reasoned discussion the impacts the development will have on environmental quality, land uses, resources (including energy requirements, water, soil and biological) and environmental amenity.

The preliminary risk analysis should be incorporated within the ERMP. However, it may be appropriate for a summary to appear in the body of the document, with details contained in an appendix.

The preliminary risk analysis component of the ERMP should include the issues identified in Appendix A [nominated in this document as Attachment A1] of these guidelines.

7 ENVIRONMENTAL MANAGEMENT

This section should outline the programme of controls and safeguards (particularly for risks and hazards and emissions) proposed to minimize or ameliorate adverse environmental impacts already described in the ERMP. The relationship between this proposal and any other known proposals for the surrounding area should be made explicit, as should the respective responsibilities for environmental management. The document should also address environmental management for decommissioning and site rehabilitation. The objectives, scope and details of the programme should be described. Particular attention should be given to the role of buffer zones in managing impacts.

Emphasis should be placed on how the environmental and risk management programmes will be adapted where necessary in the light of monitoring or auditing results. The document should indicate how results of the monitoring and auditing programme may modify ammonia/urea plant operations and management of the buffer zone.

The procedures for reporting results of monitoring environmental impacts to the appropriate authorities should be outlined and appropriate management measures proposed.

8 CONCLUSION

Conclusions of the overall impact of the proposal (including the role of ameliorative measures) should be stated, together with an assessment of the environmental acceptability of the project.

9 REFERENCES (BIBLIOGRAPHY/ABBREVIATIONS)

ATTACHMENT A1
EPA GUIDELINES FOR THE PRELIMINARY RISK ANALYSIS

1 SUMMARY

The document should contain a clear and concise summary of the preliminary risk analysis.

2 INTRODUCTION

- Background to this study
- Study aims and objectives
- General nature of the project
- Philosophy of approach to risk assessment
- Risk standards and guidelines.

3 PROJECT DESCRIPTION

- Site location and environment of the project site.
- Meteorology, including wind direction, atmospheric stability, temperature and surface roughness length.
- Process description.
- Other parameters in the surrounds of the chosen site which need to be considered in the risk analysis.

4 FACTORS AFFECTING SITE SELECTION AND RISK TO PUBLIC AND NEARBY FACILITIES

- Hazardous material properties
- Hazards associated with ammonia/urea plants and ammonia
- Hazards of process, storage and proposed operations
- Review of safety record of similar facilities
- Review of engineering codes and standards
- Review of safety engineering design
- Review of other factors, i.e. domino effect, export loading, shipping, etc.

5 RISK ASSESSMENT

- Methodology.
- Identification of potential major unwanted events, i.e. checklist of hazards.
- Estimation of likelihood of failure.
- Calculation of consequences of failure, including diffusion characteristics.

- Development of risk levels, i.e. relationship between likelihood and consequences of failure.

- Discussion of 'acceptability' of risk levels in Western Australia.

6 CONCLUSION AND RECOMMENDATIONS

- Results of risk assessment and conclusions as to site acceptability.

- Discussion of safety assumptions taken into account, including safety engineering design, management and operational aspects, safety auditing, etc.

- Recommendations of additional safety factors which need to be considered by the proponent.

7 APPENDICES

- Failure rate data
- Meteorology of the site, including wind rose
- Risk assessment calculation methods
- Summary of major ammonia release incidents.

APPENDIX B
GROUNDWATER EVALUATION - GROUNDWATER RESOURCE CONSULTANTS

APPENDIX B
GROUNDWATER EVALUATION - GROUNDWATER RESOURCE CONSULTANTS

1 INTRODUCTION

Groundwater Resource Consultants (GRC) has been requested to evaluate the quantity and quality of groundwater available from the eastern part of the BP Refinery site, directly north of CSBP & Farmers' (CSBP) gypsum ponds. A supply of 264 m^3/h of good quality groundwater is required for cooling water and process water purposes.

2 HYDROGEOLOGY

A number of aquifers underlie the proposed site.

2.1 Safety Bay Sand aquifer

The Safety Bay Sand aquifer extends from surface to about 16-17 m depth. It is a medium grained sand capable of yielding up to 15 m^3/h. The water table is at shallow depth, generally 2-3 m, and, where unaffected by industrial activities, contains low salinity groundwater.

However, as shown in Figure B1, there are several groundwater contamination plumes originating from a number of sources, including the Nufarm chemical plant, the BP Refinery and the CSBP gypsum ponds.

Because of its low yield capacity and variable groundwater quality, the Safety Bay Sand cannot be recommended as a water supply source.

2.2 Tamala Limestone aquifer

The Tamala Limestone aquifer extends from the base of the Safety Bay Sand to the Rockingham Sand and/or Leederville Formation aquifers at a depth of 26-28 m. The aquifer is semi-confined, with a potentiometric level equivalent to, or slightly lower than, the water table in the Safety Bay Sand (i.e. 2-3 m below ground surface).

The limestone aquifer is very permeable and high yielding. A production bore at the BP Refinery (BP no. 4) was tested at 136 m^3/h for a period of thirty-eight hours, at which time the drawdown was 1.5 m.

Groundwater flows into the aquifer on the eastern margin of the site, and is supported by rainfall recharge further inland. The quantity of flow in the area of the proposed ammonia/urea plant, calculated from a knowledge of potentiometric gradients and aquifer permeability, is presently about 100 m^3/h and is equivalent to the long term sustainable yield of the aquifer. Abstraction in excess of this figure will cause landward migration of the sea-water wedge, which exists at the base of the aquifer closer to the ocean. When this occurs, a new equilibrium will establish, and a higher long term abstraction rate would be supported without deterioration in groundwater quality.

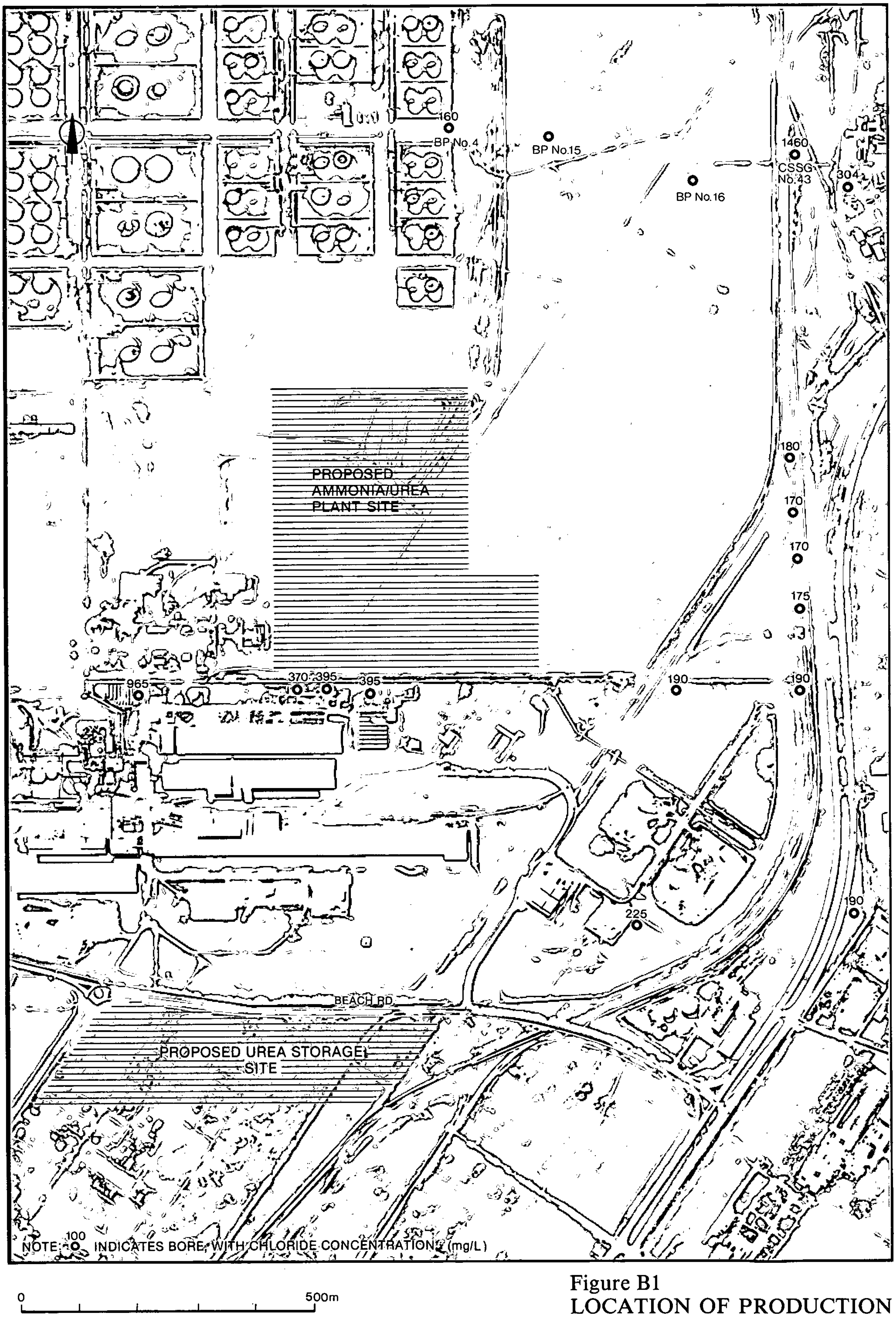


Figure B1
LOCATION OF PRODUCTION AND MONITOR BORES

Present major users of this aquifer in adjacent areas are CSBP and Nufarm.

Early production bores at CSBP did experience deteriorating groundwater quality, not necessarily because of landward migration of the sea-water interface, but possibly due to upcoming of the salt water wedge which underlies the western part of the site. Later production bores, north of the gypsum ponds, maintain a constant groundwater quality, with chloride concentrations in the range 170-190 mg/L and sulphate concentrations of 50-60 mg/L.

BP Refinery is not a major user of groundwater from the limestone, but Nufarm uses two production bores for cooling water supply. The Nufarm supply is contaminated with phenol, 2.4-D and 2.4.5-T and the company proposes to adopt a closed cooling water system in the near future because of this problem. The origin of these contaminants is clearly from the plume in the overlying Safety Bay Sand, but evidence suggests that a thin clay layer in the base of the Safety Bay Sand is preventing migration of the contaminants into the limestone. It is believed that, during construction of the Nufarm production bores, the clay seal was breached, allowing localized leakage of pollutants to the limestone. This pollution in the limestone should not, therefore, be evident away from the immediate vicinity of the Nufarm bores.

However, because the pollution plume in the Safety Bay Sand does extend over a part of the area identified for the ammonia/urea plant production bores, the design and specification of these bores must ensure that no leakage can occur across the clay seal separating the Safety Bay Sand from the limestone.

The only operational problem identified with development of water supplies from the limestone aquifer is the deposition of calcium carbonate scale on the screen apertures, causing a progressive reduction in bore efficiency, marked by greater drawdown levels and lower pumping rates. Acidizing of the bores annually is a simple procedure which overcomes this problem, but requires the installation of sufficient standby capacity for back-up supply during annual maintenance and rehabilitation.

2.3 Leederville and Yarragadee Formations

The Leederville and Yarragadee Formations are artesian aquifers which underlie the Tamala Limestone/Rockingham Sand and extend to a depth of over 500 m. They have the capacity to yield in excess of the total water supply requirement from a single bore. Water quality is slightly brackish, pH is 6-6.5 and there is a significant iron content. The water is, therefore, slightly acidic and generally requires treatment by aeration/flocculation to remove iron, dependent on the purpose for which the water is to be utilized.

Development of these aquifers requires a licence from the Water Authority of Western Australia. Licence approval would normally be granted for development of brackish groundwaters.

3 GROUNDWATER QUALITY

A comparison of groundwater chemistry from the various aquifers is given. That for the Leederville/Yarragadee aquifers is representative of the Cockburn Cement production bores at Woodman Point north of the site. The analysis for the Safety Bay Sand aquifer is from the Nufarm contamination plume, the extent of which is shown below. All analyses are as milligrams per litre, unless otherwise stated.

	Safety Bay Sand (bore no.)				Limestone (bore no.)			Leederville Yarragadee
	BP15	BP16	CSSG43	Nufarm	BP15	BP4	CSBP	
Conductivity (mS/m @ 25°C)				154			140	250
pH	7.7	7.7	7.1	6.4	7.5		7.8	7.7
T(°C)						22		30
TDS	450	1,570	21,300	980	640		900	1,600
Na						100	137	539
K						26		
Ca						90	102	15
Mg						69	38	12
Cl				305		162	235	705
SO_4				59			40	110
HCO_3						317	360	210
NO_3							10	
F							0.5	<1
Total Fe							0.8	
Phenol	0.13	27	62	0.026	0.022			
2.4-D	<0.0002	2.3	80	0.007	<0.0002			
2.4.5-T	0.0086	0.23	7.3	0.003	0.0003			

4 CONCLUSIONS

The 264 m^3/h water requirement for the proposed ammonia/urea plant can be met from the shallow limestone aquifer on the eastern margin of the BP Refinery. It is probable that there will be landward migration of the salt water wedge at the base of the aquifer, and close monitoring of this movement will be necessary, using specially constructed monitor bores. Establishment of a new equilibrium may be sufficient to provide long term security of supply. The alternative is to make allowance for construction of additional production bores east of the site, perhaps five to ten years after plant commissioning.

It is recommended that six production bores equally spaced along a north-south line on the eastern margin of the property be constructed, each with a capacity of 90 m^3/h. This will ensure adequate reserve and standby capacity. The groundwater quality in the limestone aquifer where it underlies the pollution plume from the Nufarm chemical plant will require careful checking.

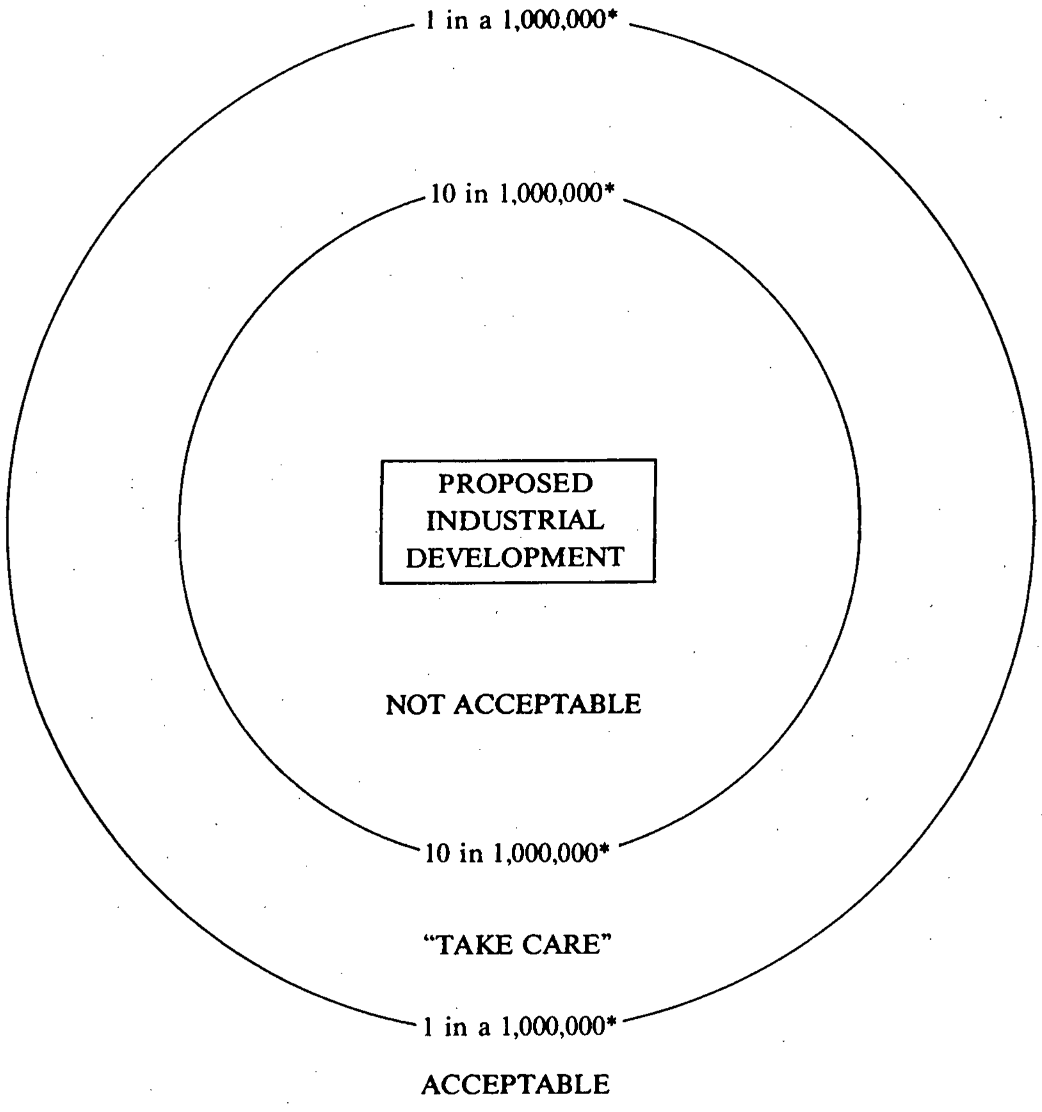
At the present time, no groundwater licences are required for bores constructed in the limestone aquifer, but this is expected to change in the next six to twelve months when the Cockburn Groundwater Area is proclaimed. However, because the area is situated near the ocean discharge of the groundwater system, the Water Authority is not likely to raise objections to the development of the required supply.

APPENDIX C
EPA BULLETIN NO. 278

ENVIRONMENTAL PROTECTION AUTHORITY
BP HOUSE,
1 MOUNT STREET, PERTH, WESTERN AUSTRALIA 6000

ENVIRONMENTAL PROTECTION AUTHORITY GUIDELINES

RISKS AND HAZARDS OF INDUSTRIAL DEVELOPMENTS ON RESIDENTIAL AREAS IN WESTERN AUSTRALIA



* LEVEL OF RISK FROM PROPOSED INDUSTRIAL DEVELOPMENT TO RESIDENTIAL AREAS, IN UNITS OF FATALITIES PER YEAR.

EPA BULLETIN 278.

ENVIRONMENTAL PROTECTION AUTHORITY STATEMENT ON THE EVALUATION OF THE RISKS AND HAZARDS OF INDUSTRIAL DEVELOPMENTS ON RESIDENTIAL AREAS IN WESTERN AUSTRALIA

INTRODUCTION

The Environmental Protection Authority has required environmental impact assessment for a number of new industrial projects recently, and more may be submitted in the near future. In addition to conventional environmental issues, many of these industries have risk and hazard factors associated with them. The Authority believes that the quantitative assessment of risk to the community is an important part of the evaluation of such proposals. Historical records show that industrial accidents occur, and that technical safeguards have their limitations. However, with proper planning, review and control during the plant design, commissioning and operational stages these risks and hazards can, in most cases, be minimised, managed and made acceptable in the sense that they can be reduced to a level that the community is prepared to tolerate.

In this statement, the term 'hazard' is used to describe a set of conditions that could lead to a harmful accident. 'Risk' is defined in terms of both the likelihood of a hazard, and the consequences of that hazard.

In November 1986 the Environmental Protection Authority prepared for public comment a draft statement on the evaluation of risks and hazards of industrial developments on residential areas in Western Australia.

A total of 39 submissions were received from individuals and various organisations including interstate and overseas groups. An analysis of these submissions is given at the Appendix. In revising this Statement the Authority has taken into account the comments received.

REQUIREMENTS AND APPROACH TO BE ADOPTED FOR EVALUATION OF RISKS AND HAZARDS

The Authority will adopt the following approach to the evaluation of risks and hazards for new industrial developments of a potentially hazardous nature:

1. Where the Authority is of the opinion that a project involves a significant element of risk it will require a quantitative risk assessment at an early stage of the environmental impact assessment process.The need for such an assessment will be determined on a case by case basis.

2. The quantitative risk assessment should be undertaken and certified to the Authority's satisfaction by a competent, reputable and objective analyst, approved by the Authority, and at the proponent's expense. This process requires the risk analyst to certify to the Authority that the assessment was done independently.

   In most circumstances the Authority would not seek or undertake a separate verification of the independent risk assessment but could do so if it considered exceptional circumstances so justified.

3. The scope and extent of the assessment will vary from project to project, and the Authority will provide specific advice to each proponent. However, in general, assessment will include an identification of all relevant hazards, a quantification of their consequences and the likelihood of their occurrence, and estimations of outdoor risk levels. The assessment is to address specifically proposed safeguards and their effectiveness in reducing and managing risk.

4. The Authority may require the proponent to make public all or part of the assessment, as part of the environmental impact assessment documentation. Key findings of the risk assessment will be required to be published in the document describing the proposal submitted to EPA.

5. NEW INDUSTRIAL INSTALLATIONS

The following are proposed by the Authority, as a guide for the assessment of the fatality risk acceptability of <u>new</u> industrial installations:

5.1 The Authority has taken note of how decisions on risks are taken in other parts of the world. In the light of that knowledge the Authority will classify decisions into three categories. These are as follows:

- A small level of risk which is acceptable to the Environmental Protection Authority;
- A high level of risk which is unacceptable to the Authority and which warrants rejection; and
- A middle level of risk, which subject to further evaluation and appropriate actions may be considered to be acceptable to the Authority.

5.2 An individual risk level in residential zones of less than 1 in a million a year is so small as to be acceptable to the Environmental Protection Authority.

5.3 An individual risk level in residential zones exceeding 10 in a million a year is so high as to be unacceptable to the Environmental Protection Authority.

5.4 Where the preliminary risk level in residential zones has been calculated to be in the range 1 in a million to 10 in a million a year, the Authority will call for further evaluation of the risks associated with the project. The Authority may then be prepared to recommend that the project be acceptable subject to certain planning and technical requirements.

A major technical requirement will be the commissioning of a Hazard and Operability Study at an appropriate stage or stages of the project. Such a study is an effective technique for discovering potential hazards and operating difficulties at the design stage. Significant reductions of hazards, and in the number of problems encountered in operation, as a result of such studies are possible. The Hazard and Operability Study should be undertaken by the proponent with a qualified person, approved by the Authority, who will be required to certify to the Authority that the study was carried out in a proper manner. This study should explore all feasible ways of reducing hazards. The proponent may be required to update the risk analysis, and make the results public.

6. CUMULATIVE RISK IMPACTS

Where a number of hazardous industries or activities exist in a region, it is appropriate for a cumulative risk and hazard analysis for existing and proposed developments in the region to be undertaken before assessing new developments in the region. No extra risk would be acceptable where the cumulative risk of existing industry, combined with the assessed risk of the proposed new industry, exceeds the risk levels proposed for new industry (item 5).

7. EXISTING INDUSTRY

The Authority is aware that some existing industry and industrial areas may give rise to risk levels to residential zones which exceed the guidelines in this statement. In such cases, a programme shall be agreed between the relevant agencies and the industry in order to reduce the impact of major risk generators. This may entail recommendations for action by either the industry or government, or both. The Authority believes that the long-term targets for individual risk level in residential zones for existing industry should be the same as those proposed for new industry (item 5).